Natural History of Oregon Coast Mammals

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Abstract

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The book presents detailed information on the biology, habitats, and life histories of the 96 species of mammals of the Oregon coast. Soils, geology, and vegetation are described and related to wildlife habitats for the 65 terrestrial and 31 marine species. The book is not simply an identification guide to the Oregon coast mammals but is a dynamic portrayal of their habits and habitats. Life histories are based on fieldwork and available literature. An extensive bibliography is included. Personal anecdotes of the authors provide entertaining reading. The book should be of use to students, educators, land-use planners, resource managers, wildlife biologists, and naturalists.

Keywords: Natural history, mammals (marine), mammals (land), Oregon coast, wildlife habitat.

Foreword

It is a privilege to write a foreword to *Natural History of Oregon Coast Mammals. I* have observed the production of this book since its inception and believe it has two qualities that especially recommend it: First, it is timely, attuned to the almost indescribable sense of frustrated urgency that environmental matters must be dealt with by a mixture of wisdom, information, and common sense that seems impossible to obtain. Second, this book is one of authority, by writers who are able to give the best and most accurate accounting of the ecosystems that make up the coastal region of Oregon. It can be looked on as a model for similar treatises, and in fact it contains much information that is applicable to other areas. Allow me to expand briefly on these two points.

We are living in a schizophrenic time: There is need for wise use of our resources and there is the companion need for sensible conservation. As residents of the Pacific Northwest, a phenomenally satisfying part of the world, we see the require- ment and the push to provide an ever-better life for more and more people. This may be called the "Development Syndrome." It is well known and self explanatory.

At the same time we know the extreme preciousness of naturalness and nature, called by many terms and related to inner feelings. This may be termed simply and best as the "Concern for Nature Syndrome." This syndrome is difficult to describe for it is different in each person. It embodies emotional requirements of feelings and perceptions. It combines remembrances with objective appraisals and hopes for the future. It is concerned with a basic need for stability in a chang- ing world, for places that are changeless from childhood memories through pres- ent experiences into plans for the future.

As many writers have compellingly stated, wilderness (or varieties of wilderness as perceived by the individual) is the symbolic evidence of the concern for nature. We, each of us, have our own needs and our own interpretations, stated or not, as to how these needs may be manifested and fulfilled. Theodore Roosevelt wrote

(Hunting Trips of a Ranchman, Century, 1885): "In the after years there shall come forever the memory of melancholy marshes-of the great breadth of the evergreen forest in summer-of all the innumerable sights and sounds of the wilderness—and of the silences that brood in its still depths." Rachel Carson stated (The Edge of the Sea, Houghton Mifflin Co., 1955): "The shore is an ancient world for as long as there has been an earth and sea there has been this place of meeting of land and water. Each time that I enter it, I gain some new awareness of its beauty and its inner meanings, sensing that intricate fabric of life by which one creature is linked with another, and each with its own surroundings." Vic Scheffer brings an up-to-date quote (Adventures of a Zoologist, Charles Scribners Sons, 1980): "Public attitudes are beginning to change as a result of awareness of our dependence upon, and responsibilities for, natural ecosystems, and awareness of the value of living organisms whether human or not."

Thinking people want information that allows them to arrive at decisions that may be stated with confidence and that will withstand the attacks of other persons less well informed. Whenever concerned individuals are caught between the Development Syndrome and the Concern for Nature Syndrome, as they may be in personal or business actions, in voting, or in simply making their minds up on items of personal satisfaction, there must be "best ways" of proceeding. This book allows the reader to look clearly at the ecosystems-the soil and its determining contributions, the plant communities and their influencing of habitats, and the spectrum of mammalian species from the oceans into the coastal mountains.

The perceiving reader will no longer believe that management for any single species of plant or animal is the proper way to evaluate programs. This reader will better understand why natural ecosystems of smaller or larger sizes are required by our fellow mammalian beings, and will thus be able to help act as a concerned citizen for the benefits of those now living and those of the future. When developing or changing an ecosystem becomes necessary, as indeed it will in many particular areas, our modern citizen of the Oregon coast (and other similar areas) will be able to consider the balance of destruction and preservation and make the "best" decisions.

So much for my perception of the major reason for this text, as an educative and reference resource for us, the ordinary citizens.

Beyond that, we are privileged to have refined for us the specialized knowledges of several distinguished scientists in special fields, Chris Maser, Bruce Mate, Jerry Franklin, and Ted Dyrness. Each is an active research scientist of stature and author of numerous significant articles. Most significant from my perspective is that they each qualify as a "resident" scientist-one who has lived in the area for a prolonged period-who has experienced the environmental stresses, the "good" and "bad" years, felt the rain and wind and freezing, the sun and salt spray, and can sense the many factors that make up the ecosystem needed by the mammals described.

We have, therefore, a book that is worthy, an authoritative accurate reference book for the scientist.

Many books in natural science purport to be suitable for both the scientist and the interested amateur. This is a most difficult combination, but I believe one will find that this book satisfies the criteria in an admirable way. And I would add this suggestion of fact: Another frequently sought attribute for a book has been accomplished-although not written as a book to read at length, I daresay that on many occasions the reader will look for a particular subject, then be fascinated with the unfolding of the descriptive story and proceed to discover the ecosystem and its inhabitants.

This is the way all books should be written!

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Preface

Natural disturbances, such as wildfires and catastrophic windstorms, have always been part of the scene on the Oregon coast-creating, destroying, and altering habitats. Wind and rain of severe winter storms unleashed erosion, changing mountain slopes, streams, rivers, wetlands, and beaches.

In recent times, human activity has caused rapid and extensive changes in the landscape. Forests have been cut for wood fiber and cleared for farmlands and towns. Wetlands have been drained and diked to pasture dairy herds. Fishing has removed natural stocks of salmon, steelhead, and trout, only to be substituted by stocks from hatcheries. Sand dunes have been stabilized to prevent encroachment on human developments. Recreational activities and facilities have become increasingly popular. Exotic plants and animals have been introduced. Some of the plants have displaced native organisms; others have created new habitats and ecosystems.

The forest lands of the Oregon coast are among the most productive in the world. As demands for wood fiber increase, these forests will be used and managed more intensively. This in turn will affect the wildlife species in the area and will have an impact on both the species present and their numbers. As resource management becomes more and more complex, land managers will need more complete and accurate information about the wildlife and their habitats.

This book is a reference for students, educators, planners, and managers. It is not simply a guide to the mammals but is an attempt to portray a dynamic picture of the habitats, the habitat requirements, and the life histories of the 96 species that inhabit the Oregon coast. Each life history is based both on our fieldwork and on information in the literature.

Most of the land mammals of the Oregon coast occur throughout much of the State. Although the habitats discussed pertain specifically to the coast, the life history information is valid for each animal throughout its range.

Acknowledgments

Contents

Orders, families, genera, and species in chapter 3

Order	Family	Genus	Species	Common Name	Terrestrial (T) or Marine(M)
Marsupialia, p. 38				Pouched mammals	T
	Didelphidae, p. 39			Opossums	T
		Didelphis, p. 40		Opossum	T
			virginianus, p. 40	Opossum	T
Insectivora, p. 43				Insect eaters	T
	Soricidae, p. 46			Shrews	T
		Sorex, p. 47		Long-tailed shrews	T
			vagrans, p. 47	Wandering shrew	T
			obscurus, p. 50	Dusky shrew	T
			yaquinae, p. 51	Yaquina shrew	T
			pacificus, p. 53	Pacific shrew	T
			bendirei, p. 57	Marsh shrew	T
			trowbridgei, p. 60	Trowbridge shrew	T
	Talpidae, p. 63			Moles	T
		Neürotrichus, p. 64		American shrew-mole	T
			gibbsi, p. 64	American shrew-mole	T
		Scapanus, p. 71		Western American moles	T
			townsendi, p. 71	Townsend mole	T
			orarius, p. 77	Coast mole	T
Chiroptera, p. 79				Bats	T
	Vespertilionidae, p. 84			Evening bats	T
		Myotis, p. 86		Myotis bats	T
			lucifugus, p. 87	Little brown bat	T
			yumanensis, p. 89	Yuma bat	T
			evotis, p. 91	Long-eared bat	T
			thysanodes, p. 93	Fringed bat	T

Orders, families, genera, and species in chapter 3 (continued)

Order	Family	Genus	Species	Common Name	Terrestrial (T) or Marine(M)
			volans, p. 95	Long-legged or hairy-winged bat	T
			californicus, p. 97	California bat	T
		Lasionycteris, p. 100		Silver-haired bat	T
			noctivagans, p. 100	Silver-haired bat	T
		Eptesicus, p. 103		Big brown bats	T
			fuscus, p. 103	Big brown bat	T
		Lasiurus, p. 108		Hairy-tailed bats	T
			cinereus, p. 709	Hoary bat	T
		Plecotus, p. 114		Long-eared bats	T
			townsendi, p. 115	Western long-eared bat	T
Lagomorpha, p. 121				Hares, rabbits, and allies	T
	Leporidae, p. 122			Hares and rabbits	T
		Lepus, p. 123		Hares	T
			americanus, p. 124	Snowshoe hare	T
		Sylvilagus, p. 127		Cottontail rabbits	T
			bachmani, p. 128	Brush rabbit	T
Rodentia, p. 132				Rodents	T
	Aplodontidae, p. 139			Mountain beaver	T
		Aplodontia, p. 139		Mountain beaver	T
			rufa, p. 140	Mountain beaver	T
	Sciuridae, p. 146			Chipmunks and squirrels	T
		Eutamias, p. 147		Western chipmunks	T
			townsendi, p. 148	Townsend chipmunk	T

Orders, families, genera, and species in chapter 3 (continued)

Order	Family	Genus	Species	Common Name	Terrestrial(l) or Marine(M)
		Spermophifus, p. 151		Ground squirrels	T
			beecheyi, p. 152	Beechey ground squirrel	T
		Sciurus, p. 155		Tree squirrels	T
			griseus, p. 156	Western gray squirrel	T
		Tamiasciurus, p. 158		Red squirrels and chickarees	T
			douglasi, p. 159	Chickaree	T
		Glaucomys, p. 163		North American flying squirrels	J
			sabrinus, p. 164	Northern flying squirrel	J
	Geomyidae, p. 168			Pocket gophers	T
		Thomomys, p. 169		Western pocket gophers	T
			bottae, p. 170	Botta pocket gopher	T
			mazama, p. 171	Mazama pocket gopher	J
	Castoridae, p. 175			True beavers	J
		Castor, p. 176		True beaver	T
			canadensis, p. 176	North American beaver	T
	Cricetidae, p. 181			New World rats and mice	T
		Peromyscus, p. 181		Deer mice and white-footed mice	T
			maniculatus, p. 182	Deer mouse	T
		Neotoma, p. 184		Woodrats	T
			fuscipes, p. 185	Dusky-footed woodrat	T
			cinerea, p. 190	Bushy-tailed woodrat	T

Orders, families, genera, and species in chapter 3 (continued)

Order	Family	Genus	Species	Common Name	Terrestrial (T) or Marina(M)
	Microtidae, p. 194			Voles	T
		Clethrionomys, p. 195		Red-backed voles	T
			californicus, p. 195	California red-backed vole	T
		Arborimus, p. 199		White-footed vole and tree voles	T
			albipes, p. *199*	White-footed vole	T
			longicaudus, p. 201	Red tree vole	T
		Microtus, p. 206		Small-eared voles	T
			townsendi, p. 207	Townsend vole	T
			longicaudus, p. 201	Long-tailed vole	T
			oregoni, p. 212	Oregon or creeping vole	T
		Ondatra, p. 215		Muskrats	T
			zibethicus, p. 216	Muskrat	T
	Muridae, p. 219			Old World rats and mice	T
		Rattus, p. 220		Old World rats	T
			rattus, p. 220	Black rat	T
			norvegicus, p. 222	Norway rat	T
		Mus, p. 226		House mice	T
			musculus, p. 226	House mouse	T
	Zapodidae, p. 229			Birch mice and jumping mice	T
		Zapus, p. 230		North American jumping mice	T
			trinotatus, p. 231	Pacific jumping mice	T
	Erethizontidae, p. 235			New World porcupines	T
		Erethizon, p. 236		North American porcupine	T
			dorsatum., p. *236*	North American porcupine	T

Orders, families, genera, and species in chapter 3 (continued)

Order	Family	Genus	Species	Common Name	Terrestrial (T) or Marine(M)
	Myocastoridae, p. 240			Coypu of nutria	T
		Myocastor, p. 241		Coypu or nutria	T
			coypus, p. 241	Coypu or nutria	T
Carnivora, p. 247				Flesh eaters	T and M
	Canidae, p. 250			Dogs and foxes	T
		Canis, p. 252		Dogs, coyotes, wolves	T
			latrans, p. 252	Coyote	T
		Vulpes, p. 257		Red foxes	T
			vulpes, p. 258	Red fox	T
		Urocyon, p. 262		Gray foxes	T
			cinereoargenteus, p. 263	Gray fox	T
	Ursidae, p. 267			Bears	T
		Euarctos, p. 266		North American black bear	T
			americanus, p. 269	North American black bear	T
	Procyonidae, p. 274			Ringtails, raccoons, and allies	T
		Bassariscus, p. 275		Ringtail	T
			astutus, p. 275	Ringtail	T
		Procyon, p. 280		Raccoons	T
			lotor, p. 280	Raccoon	T
	Mustelidae, p. 287			Martens, weasels, skunks, otters, and allies	T and M
		Martes, p. 288		Martens and fishers	T
			americana, p. 289	North American marten	T
			pennanti, p. 294	Fisher	T

Orders, families, genera, and species in chapter 3 (continued)

Order	Family	Genus	Species	Common Name	Terrestrial (T) or Marine(M)
		Mustela, p. 300		Weasels, minks, and allies	T
			erminea, p. 300	Short-tailed weasel	T
			frenata, p. 307	Long-tailed weasel	T
			vison, p. 314	North American mink	T
		Spilogale, p. 319		Spotted skunks	T
			putorius, p. 320	Spotted skunk	T
		Mephitis, p. 326		Striped and hooded skunks	T
			mephitis, p. 327	Striped skunk	T
		Lutra, p. 332		River otters	T
			canadensis, p. 333	Canadian river otter	T
	Felidae, p. 338			Cats, lynxes, and allies	T
		Felis, p. 339		True cats	T
			concolor, p. 340	Puma or mountain lion	T
		Lynx, p. 346		Lynxes, bobcats, and caracals	T
			rufus, p. 347	Bobcat	T
Artiodactyla, p. 352				Even-toed hoofed animals	T
	Cervidae, p. 353			North American elk, deer, and allies	T
		Cervus, p. 355		North American elk and allies	T
			elaphus, p. 355	North American elk	T
		Odocoileus, p. 364		Mule deer and white-tailed deer	T
			hemionus, p. 365	Mule deer	T

Orders, families, genera, and species in chapter 4

Orders, families, genera, and species in chapter 4 (continued)

Order	Family	Genus	Species	Common Name	Terrestrial (T) or Marine(M)
	Ziphiidae, p. 406			Beaked whales	M
		Mesoplodon, p. 488		Middle toothed beaked whales	M
			stejnegeri, p. 487	North Pacific beaked whale	M
			carlhubbsi, p. 407	Hubb's beaked whale or arch-beaked whale	M
		Ziphius, p. 408		Cuvier's beaked whale	M
			ca viros tris, p. 488	Cuvier's beaked whale or goose-beaked whale	M
		Berardius, p. 409		Giant bottlenose whale	M
			bairdii, p. 409	Giant bottlenose whale or Baird's beaked whale	M
	Delphinidae, p. 410			Dolphins	M
		Globicephala, p. 411		Pilot whale	M
			macrorhynchus, p. 411	Short-finned pilot whale, pothead whale, or pilot whale	M
		Grampus, p. 413		Grampus dolphin	M
			griseus, p. 413	Grampus or Risso's dolphin	M
		Orcinus, p. 414		Killer whale	M
			orca, p. 414	Killer whale or orca	M
		Pseudorca, p. 418		False killer whale	M
			crassidens, p. 417	False killer whale	M
		Delphinus, p. 418		Common dolphin	M
			delphis, p. 418	Common dolphin, white-bellied porpoise, or saddleback dolphin	M
		Lissodelphis, p. 421		Northern right whale dolphin	M
			borealis, p. 421	Northern right whale dolphin	M

Orders, families, genera, and species in chapter 4 (continued)

Order	Family	Genus	Species	Common Name	Terrestrial (T) or Marine(M)
		Stenella, p. 422		No common name	M
			coeruleoalba, p. 422	Striped dolphin	M
		Lagenorhynchus, p. 424		White-sided dolphins	M
			obliquidens, p. 424	Pacific white-sided dolphin	M
	Phocoenidae, p. 425			Porpoises	M
		Phocoenoides, p. 426		No common name	M
			dalli, p. 426	Dall's porpoise	M
		Phocoena, p. 427		Harbor porpoise	M
			phocoena, p. 427	Harbor porpoise or common porpoise	M
Carnivora, p. 429				Flesh eaters	T and M
	Mustelidae, p. 429			Martens, weasels, skunks, otters, and allies	T and M
		Enhydra, p. 429		Sea otter	M
			lutris, p. 429	Sea otter	M
Pinnipedia, p. 433				True seals and eared seals	M
	Phocidae, p. 436			True seals	M
		Phoca, p. 437		Northern hemisphere hair seals	M
			vitulina, p. 438	Harbor seal, hair seal, spotted seal, or common seal	M
			hispida, p. 440	Ringed seal	M
			fasciata, p. 442	Ribbon seal	M
		Mirounga, p. 442		Elephant seals	M
			angustirostris, p. 443	Northern elephant seal	M

Orders, families, genera, and species in chapter 4 (continued)

Order	Family	Genus	Species	Common Name	Terrestrial (T) or Marine (M)
	Otariidae, p. 446			Eared seals	M
		Eumetopias, p. 448		Steller sea lion or northern sea lion	M
			jubatus, p. 448	Steller sea lion or northern sea lion	M
		Zalophus, p. 451		California sea lion or circus seal	M
			californianus, p. 4.51	California sea lion or circus seal	M
		Callorhinus, p. 455		Fur seal	M
			ursinus, p. 455	Northern fur seal	M

1. Geology and Soils

C. T. Dyrness

The characteristics of all biological communities, both aquatic and terrestrial, are controlled by their physical environment. Although each community is made up of many interacting organisms dependent on each other, each organism owes its existence to the fact that it is adapted to its particular physical environment. In terrestrial communities, the physical environment has two basic parts-above ground and below ground. Above ground, climatic factors-such as temperature, precipitation, and wind-are most important. Below ground, the soil and underlying rock layers from which it was developed are most important. This chapter is mainly about the belowground portion of the environment.

I not only will describe rock and soil types but also will discuss how geologic and soil forming processes have interacted over eons to result in the extensive array of landscapes present today on the Oregon coast.

The importance of soil in the habitat of land-dwelling mammals cannot be overemphasized. Soil controls the production of vegetation essential for cover and food. In addition, groups of mammals, such as moles and gophers, live in the soil and are dependent on the soil profile for their food supply.

YAQUINA **HEAD**

Landscapes of the Oregon Coast

The Oregon coast is probably most noted for its spectacular rocky headlands and offshore rock formations that are highlighted by the silvery, pounding surf on picture post cards. This coastal region, however, has a wide variety of landscapes, ranging from expansive ocean beaches to precipitous mountain slopes (fig. 1). It is this variety that makes the area so attractive to visitors.

The northern two-thirds of the Oregon coast is interrupted by bays of various sizes and characteristics. With few exceptions (e.g., Depoe Bay) these bays are the western terminus of major streams draining the mountains of the Oregon Coast Ranges. Some of the more prominent bays from north to south are Nehalem, Tillamook, Yaquina, Alsea, Winchester, and Coos. With the exception of Winchester Bay which is fed by the Umpqua River, each bears the name of its principal river. Sloughs, salt marshes, and mudflats are conspicuous features resulting from fluctuations of tides. These habitats support an amazing quantity and variety of animal life, ranging from ducks to clams. Adding to the diversity is the variation in salinity of the bay water because of the mingling of fresh water and seawater.
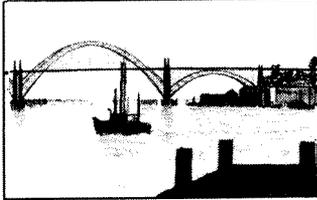
COASTAL BAY

Figure 1.—Coastal regions often contain a complex of habitats and communities. South from Cascade Head, a few kilometers north of Lincoln City, can be seen headland prairie (foreground), mixed alder and conifer forest (left center and background), vegetated and unvegetated sand dunes, beach, salt marsh (left background), Salmon River, and Pacific Ocean (Cascade Head Scenic Research Area).

Fort Stevens

Seaside

Tillamook Head

Cape Falcon

Manzanita

CLATSOP

TILLAMOOK

Tillamook

Cape Meares

Cape Lookout

Cascade Head

Gleneden Beach

Depoe Bay

Cape Foulweather

LINCOLN

Waldport

Yachats

Hece ta Head

Florence

LANE

Reedsport

DOUGLAS

Coos Bay

Bandon

COOS

Blacklock Point

Cape Blanco

Humbug Mountain

Gold Beach

Bt-ookings

CURRY

MAP
AREA

Oregon
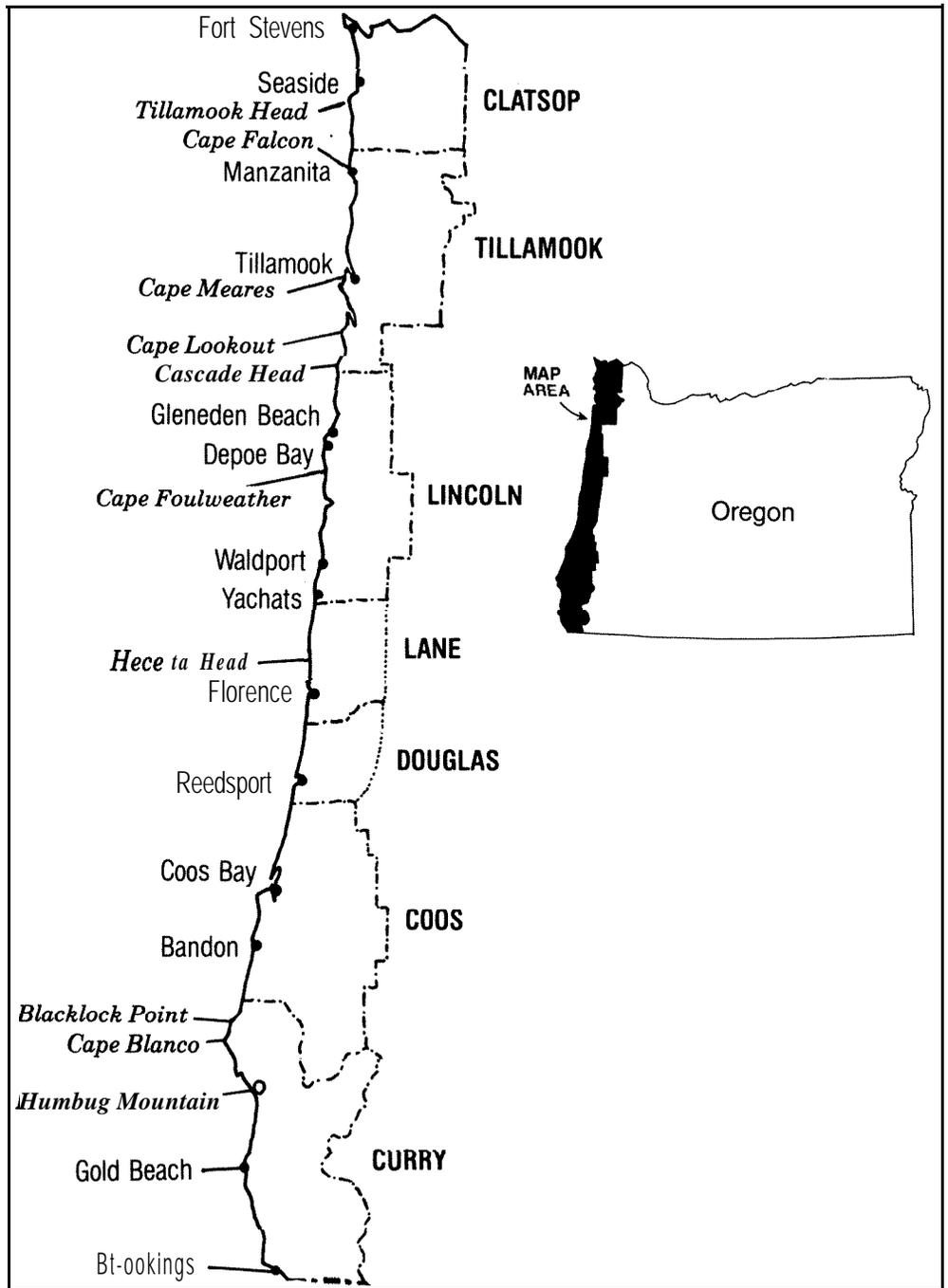
Counties and places mentioned in the text.

3

The coastal bays are sometimes termed "drowned" river mouths. They owe their existence to an abrupt rise in sea level that occurred at the end of the last glacial period (late Pleistocene). Melting glaciers supplied large amounts of additional water, inundating the lower portions of coastal river valleys, creating the forerunners of the bays seen today. Large coastal lakes, such as Siltcoos, Tahkenitch, Tenmile, and Eel, were formed in much the same way. They are in "drowned" valleys that contain small streams carrying insufficient sediments to fill the lakes, so the lakes remain.

Many processes have combined to fill coastal bays with sediment. None of the bays contain very deep water, and dredging is required to keep them navigable. Streams entering the bays are a constant source of alluvial (waterborne) sediments as they excavate valleys in the Coast Ranges. In addition, the ceaseless attack of the sea erodes coastal headlands, and the products of this erosion also fill the bays. These sediments are generally the size of sand and are especially visible near the mouths of bays where they form such features as spits and bars.

The rising sea level along the Oregon coast since the Pleistocene is also reflected in the characteristics of the coastal streams. Along the southern coast, fast-flowing streams transported sediment efficiently, generally flushing it beyond river mouths despite the rise in sea level. As a result, tidal flats are not nearly as extensive at the mouths of bays, and the tide does not extend far upstream. From Coos Bay north, tidal flats and marshes are common, however, and tidal effects in streams extend as far as 48 kilometers inland. Here, sediment deposits created by rising sea levels take the form of extensive, level flood plains and terraces adjacent to major river channels. These recent alluvial deposits provide the majority of the area used for agriculture along the coast and in the Oregon Coast Ranges.
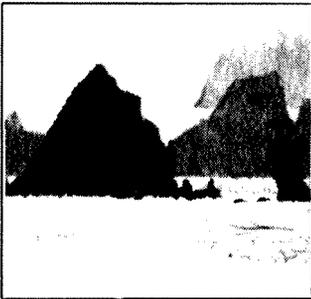
SEA STACKS

Ocean front features in Oregon are closely related to characteristics of the bedrock. Rock types most resistant to the pounding action of the surf, such as basalt, generally make up the principal headlands and capes (fig. 2). These precipitous promontories jutting boldly into the ocean are perhaps the most spectacular scenic feature of the coast. Tillamook Head, Cape Lookout, and Cape Foulweather are good examples of basaltic headlands. Small offshore islands and rocks, which for centuries have withstood the erosive power of the sea, are also generally made up of basaltic rock. Because they are often.rounded and resemble haystacks, these features have been given the name "sea stacks."

The portions of the coast underlain by more easily weatherable rocks, such as sandstone, are generally characterized by gentle slopes and broad sandy beaches. The Gleneden Beach and Waldport areas are typical of this type of terrain.

A

Figure P.-Typical coastal
headland showing the basalt
flows which, because they are
more resistant to erosion than
adjacent sedimentary forma-
tions, are responsible for
these prominent features
along the Oregon coast
(Cascade Head).

The effects of constant changes of sea level over many thousands of years are
reflected in distinct, nearly level landforms along the coastline. These are marine
terraces cut by waves, and each terrace level represents a period when the sea
level remained constant for a long enough interval for significant erosion to occur.
Surprisingly, geologists have found marine terraces along the southern Oregon
coast (between Coos Bay and Cape Blanco) as high as 457 meters above present
sea level! Such a dramatic change has been caused not only by frequent shifts in
sea level but also by a gradual uplift of the Oregon coastline which has been
occurring over the past several million years.

In many locations-for example, the Yaquina Bay and Cape Blanco areas-ter-
races are now covered by unconsolidated sediments. Most deposits are mainly
sand; in fact, most prominent areas of sand dunes are thought to be underlain by
old marine terraces.

Figure 3.-Live sand dunes, such as these at Tahkenitch Lake, are a prominent feature of the Oregon Dunes National Recreational Area. (USDA Forest Service photograph by Don Busch.)

A unique feature of the Oregon coast is its sand dunes (fig. 3). The best examples are located in the Coos Bay dune sheet which extends from Coos Bay to Winchester Bay (Reedsport), about 32 kilometers. The unique nature of this area was recognized in 1972 when Congress designated most of the area as the Oregon Dunes National Recreational Area. Within its boundaries are included most of the common, actively moving dune forms and a variety of deflation plains (moist, level areas swept clear of loose sand) (fig. 4). Interspersed among the active dunes are islands with various types of vegetation, ranging from recently stabilized areas covered with beach grass to mature spruce forest (fig. 5).

Such areas offer an excellent opportunity to study changes in plant and animal populations as dunes become vegetated and eventually stabilize. Because of this, these areas have been favorite haunts for plant and animal scientists and amateur naturalists.

Figure 4.--Deflation plains are moist, level areas, within actively moving sand dunes, that are swept clear of loose sand by the wind. (USDA Forest Service photograph by Don Busch.)

Figure 5.—Stabilized areas, such as the Sitka spruce-dominated island, are interspersed among the active sand dunes. (USDA Forest Service photograph by Don Busch.)

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Figure 6.-Typical landscape in the Oregon Coast Ranges showing the accordant ridge crests and extensive stream dissection. (USDA Forest Service photograph by Don Busch.)

Along the entire Oregon coast, mountain slopes and peaks provide a backdrop to the coastal strand (fig. 6). The Oregon Coast Ranges extend south from the Columbia River to Coos Bay and the Siskiyou Mountains from just south of Coos Bay to the California border. Of the two ranges, the Siskiyou Mountains have the highest peaks (up to 2 295 meters) and steepest slopes. This southern section of the coastline frequently lacks any gently sloping to level "coastal plain," and precipitous mountain slopes plunge uninterrupted into the ocean. Mountain slopes in the Oregon Coast Ranges, on the other hand, are more gentle and, for the most part, not as immediately adjacent to the sea.

Geology

The Oregon coast has a rich and interesting variety of rock; igneous, sedimentary, and metamorphic types are all well represented. Bedrock age is also diverse, ranging from only a few thousand years to some of the oldest rocks in the State (approximately 180 million years). For descriptive purposes, the coastline can be separated into three subregions: (1) the southern, or Siskiyou Mountain, area; (2) the central coast; and (3) the northern coast.

Southern Coast
The southern portion, extending from **Bandon** to the California border, includes the Siskiyou Mountains. The rocks in this part of the coastline are generally much older than those to the north and include the oldest in western Oregon, and perhaps in the State. Strongly folded and faulted metamorphic rocks predominate. At intervals, these rocks are intruded by either granitic or serpentinized ultrabasic rocks.

The southern coast has less total area of beach sand than do the central and northern portions. The only extensive wide sandy beaches extend from just south of **Bandon** to Blacklock Point. In this same general area and also south to Cape **Blanco,** the surfaces at slightly higher elevations (15 to 61 meters) are covered by marine terrace deposits. These are generally sandy but in some places are mixed with silt and contain layers of gravel.

For the most part, the southward beach and terrace deposits are either absent or extremely restricted in occurrence. There, coastal rock types are mostly very old (135 to 160 million years) metamorphic and sedimentary rocks. Partially metamorphosed sandstones and siltstones are the most abundant types.

Slopes in this region are often quite steep. In addition, several metamorphic rock types, such as serpentine, give rise to slopes that are very unstable when saturated with water. As a result, massive landslides are common during the winter rainy season and frequently block Highway 101. A good example of such unstable terrain is located just south of Humbug Mountain.

Central   Oregon   Coast
The central portion of the coast extends from Coos Bay north to Depoe Bay. This is an area of broad beaches and extensive sand dunes interspersed with bold, basaltic headlands. Just to the east of the coastal plain are the gentle hills and mountains of the Oregon Coast Ranges. This section is geologically simple-only a few rock types are found there and all are of intermediate age (Tertiary).

Broad expanses of beach and sand dunes extend north from Coos Bay to a point north of Florence. The slopes of the Coast Ranges adjacent to these extensive sand deposits have uniformly developed in a soft marine sandstone. Beginning just south of Heceta Head and extending north to Yachats, however, there is an abrupt change in coastline characteristics. Here, sandy beaches are lacking and most of the shoreline is high, rocky cliffs that are resistant to the pounding of the waves. This is an area of erosion-resistant basalt that provides an interesting contrast to the soft, easily weatherable sandstone to the north and south.

North of Yachats, sandy beaches are again common, especially near the mouths of **Alsea** and Yaquina Bays. The adjacent, rather gentle slopes are also underlain by sandstone with small amounts of siltstone. An exception to this general pattern is an area of dark gray to black, highly organic mudstone, both to the north and south of Yaquina Bay. Just north of this, in the vicinity of Depoe Bay, basalt constitutes the coastal bedrock.

Northern Coast

The sandstone of the central Oregon coast has an unusual mineral composition. Instead of very hard, almost indestructible quartz, the dominant mineral is feldspar which is easily weatherable. Thus, the soils derived from sandstone in western Oregon are not the coarse textured sandy loams ordinarily expected but are fine textured silt loams or silty clay loams. In addition, landforms reflect a rock prone to fast chemical weathering-streams are deeply entrenched and slumps and landslides common.

The area from Depoe Bay to the Columbia River is diverse in both geology and topography. There, as in the central section, rocks are of Tertiary age, but the geologic pattern is considerably more complex with more formations represented. It is an area of spectacular scenery highlighted by a series of basaltic headlands alternating with bays and sandy beaches.

Basaltic headlands are much more common there than in other sections of the coast. The most prominent headlands, generally called capes or heads, are from north to south: Tillamook Head, Cape Falcon, Cape Meares, Cape Lookout, and Cascade Head. Some, like Cape Lookout, extend a considerable distance into the ocean, producing a coastline substantially different from the straight coastline to the south.
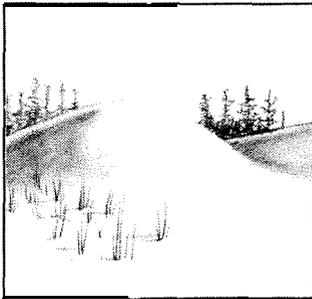
SAND DUNES

Sandy beaches are present between most of the rocky headland areas. The only extensive area where sand deposits are scarce is the stretch northward from Manzanita to Tillamook Head. From Seaside to the north, however, the strip of sandy beach and dune land is especially wide. North of Fort Stevens, a sand spit extends for several miles into the mouth of the Columbia River.

Inland from the coastal plain, lower slopes of the Coast Ranges are made up of approximately equal amounts of igneous and sedimentary rocks. As in areas to the south, the main igneous rock type is basalt, and sedimentary rocks are predominantly sandstone with smaller amounts of siltstone. A number of geologic formations are present, however, and their distribution pattern is much more complex than in the central coast.

Soils

Soil scientists have identified at least 150 distinct kinds of soils (called "soil series") in the coastal region of Oregon. That there should be so many types of soils is not too surprising because of the extensive area involved and the topographic and geologic diversity encompassed. Such a multiplicity of soil types, however, poses a problem to anyone attempting to briefly describe the soils of the Oregon coast, so my descriptions will be general.

Soils are not simply dead extensions of the outermost rock layer of the earth's crust. They are dynamic, constantly developing bodies that are dependent on living organisms (both plant and animal) for their existence. Processes of soil formation result in discrete soil layers, or "horizons," that in cross section make up the entire soil "profile." Scientists classify soil into the most appropriate series according to the sequence and properties of horizons in each profile. All the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Features that soil scientists pay close attention to

are color, texture (amounts of sand, silt, and clay), structure (how individual soil particles are grouped together), and other characteristics (such as organic matter content), pH (relative acidity), pore space arrangement, and stone content.

Five factors are crucial in the soil formation process: time, climate, parent material, topography, and organisms.

Time refers to the period in which soil has been forming. Like any other growing, developing body, soils pass from youth, through immaturity, to maturity. It is in mature soils that horizons are most pronounced and easily recognized.

Climate is extremely important in controlling the rate of soil formation. For example, chemical weathering of rocks and minerals proceeds at a much faster rate in a warm, moist climate than under cold, dry conditions.

Soil parent material refers to the rock or mineral deposit from which the soil was derived. It may be hard (for example, granite), or loose and unconsolidated (such as dune sand). In effect, mineral particles, sometimes in a weathered form, make up the "skeleton" of the soil. The characteristics of a very young, poorly developed soil are mainly those of its parent material. With maturity, however, effects of the biological community and climate assume greatest importance, and soils from different parent materials may appear almost identical.

Topographic position of a soil is important in determining its characteristics. Soils on steep slopes most often have perpetually young, poorly developed profiles because products of weathering are eroded away almost as quickly as they are formed. Soils on level terrain, on the other hand, develop much more quickly as percolating water is more effective and all products of weathering and soil formation remain on the site.

Living organisms-plants, animals, microbes, and small fauna, such as mites and worms-and their products are essential to soil formation. The microbial population is necessary for the decomposition of plant remains and the release of elements essential for plant growth. Byproducts of decomposition, as well as from root respiration, are necessary for much of the chemical weathering of mineral particles. In addition, the amount and type of organic matter in the soil greatly influence such physical aspects as color and structure.

Of these five soil forming factors, two are relatively constant along the Oregon coast-climate and time. Consequently, in the following discussion emphasis is on differences in parent material, topography, and organisms (mainly differences in vegetation type under which the soil was formed).

The soils are described under three main topographic-geologic headings: soils of the coastal strand, soils along major streams, and soils on uplands. Coastal strand soils include those in sand deposits, in tidal flats, and on marine terraces. Soils along streams are derived from alluvial deposits in both flood plain and terrace positions. Soils of the uplands are on slopes of the Coast Ranges and Siskiyou Mountains derived from either sedimentary or igneous rocks and mainly formed under forest vegetation.

Soils of the Coastal Strand

The coastal strand is the gently sloping to almost level terrain that extends from coastline to the mountain slopes. It is generally narrow and in only a few places over 8 kilometers wide. Except where alluvial or marine sediments are present, parent materials are coarse textured.

Sand deposits form an important group of parent materials, especially north of Coos Bay. Probably most abundant are dune deposits. Where the dunes are active, as in the Reedsport-Florence areas, there is little in the way of soil development. Once the dunes are vegetatively stabilized, however, soil forming processes begin and relatively mature soils are found on dunes that have been stable for a long time.

The Netarts soil series is most typical of stabilized dunes. It is a well-drained, sandy loam soil generally formed under Sitka spruce-Douglas-fir forest vegetation. It has a dark surface horizon high in organic matter and about 25 centimeters thick. The subsoil is marked by narrow red and yellow bands (lenses) of iron, aluminum, and organic matter. These bands are often slightly cemented.

On concave slopes of old dunes or in wet areas, the poorly drained Blacklock soil series occurs. These soils generally support stands of stunted lodgepole pine, which in some locations are termed "pygmy forests." This sandy loam soil is characterized by a 25- to 30-centimeter-thick leached, white horizon beneath an 18- to 20-centimeter dark surface layer. The subsoil contains humus and brightly colored iron deposits that may be cemented. All in all, the Blacklock soil has a colorful, interesting profile that makes up, at least in part, for its low productivity.

Extensive tidal flats are found adjacent to coastal bays and on stream deltas that are subject to tidal overflow. These are areas of deep deposits of alluvial and tidewater sediments that have washed from sedimentary and igneous bedrock. Because of their low elevation and tidal influence, such soils are almost continuously saturated.

Although a variety of soil series occurs in tidal flats, the poorly drained Coquille soil is perhaps most representative and extensive. It is found in areas where the vegetation consists mainly of rushes, sedges, and marsh grasses. The surface soil is a highly mottled, very dark grayish-brown silt loam. The subsoil is also strongly mottled because of poor drainage and is silty clay loam in texture. The Coquille soil is underlain at a depth of 0.76 to 1 meter by massive, bluish-gray, silty clay marine sediments. Layers of peat and sand may also occur.

Wave-cut marine terraces are another important landscape type on the coastal plain. It is, however, difficult to give a general description of soils on marine terraces because they are mantled with a wide variety of materials, ranging from coarse sand to fine sediment. Since marine terrace soils on sand closely resemble soils on old dunes, I will concentrate on describing soils derived from finer terrace deposits.

MARINE TERRACE

Marine terraces in the Waldport area are mantled by both fine and coarse sediments. The most representative soil formed on fine-textured parent material is the Lint Series, and on the coarse sediments a typical soil is the Ferrelo. The Lint is a moderately well-drained soil developed under Sitka spruce and hemlock forest. The surface layer is about 51 centimeters thick and consists of very dark brown silty clay loam. The subsoil is a dark brown silty clay loam about 64 centimeters thick. The Ferrelo is a well-drained soil formed under Douglas-fir forest. The surface layer consists of dark brown sandy loam about 25 centimeters thick, underlain by a brown fine sandy loam subsoil.

To the south, near Gold Beach, the Winchuk soil series has been described on fine-textured marine terrace deposits. The Winchuk is a deep, well-drained soil formed under stands of Douglas-fir, California laurel, and red alder. In a typical profile, the surface layer is dark brown, very friable silt loam about 20 centimeters thick. The subsoil is a dark reddish-brown silty clay.

Soils Along Major Streams

The almost level terrain adjoining the larger coastal streams may be divided into two landforms: flood plain and terrace. Flood plains occur at lowest elevations immediately adjacent to streams and are subject to periodic inundation. Alluvial terraces are at slightly higher elevations but parallel to the flood plain. In many stream valleys, several terrace levels are present. The soils developed on these landforms are very important to the economy of the region; virtually all agricultural development has taken place on these soils.

Although all flood plain and terrace soils are developed from alluvial deposits, characteristics are highly variable. First, age of the alluvium varies, from very recent deposits of silty sediments on flood plains, to old, thoroughly weathered deposits on higher terraces. Second, soil texture varies, depending mainly on the source of the sediments. For example, granitic sediments are much coarser than sediments originating from areas dominated by more easily weathered sandstone and siltstone. And third, soils range from well drained to very poorly drained, depending on their topographic position. Because of their low-lying position, however, many coastal alluvial soils are wet and poorly drained. This poor drainage is reflected in the soil profile by gray "gleyed" colors and frequent mottling.

Probably the best example of a well-drained soil on alluvial terraces along the Oregon coast is the Knappa. The Knappa series occupies older terraces immediately adjacent to the foothills and is widely distributed wherever large stream valleys are present. Although much of the land has not been cleared for agriculture, the Knappa soil was developed under an original cover of Douglas-fir or red alder forest. It is a deep, productive soil that is irrigated by sprinklers in some areas to increase yields of hay and silage. The surface soil is 30 to 36 centimeters thick and is generally a very dark brown, friable silt loam. The subsoil is a dark brown to dark yellowish-brown silty clay loam that may be relatively free of stones to a depth of 1.5 meters.

In more poorly drained stream terrace positions, the Chitwood (imperfectly drained) and Hebo (poorly drained) soils are typical. Like the Knappa, the Chitwood was formed under forest vegetation, and surface soil characteristics and horizon textures are almost identical. Differences in drainage show up primarily in the subsoil of the Chitwood where periodic high water tables have caused strong brown mottles in a dark yellowish-brown matrix.

The Hebo soils are so poorly drained that they are characteristically saturated most of the winter. Most areas with this soil have been cleared for agriculture, and some have been drained through tiles or open ditches. Native vegetation consists mainly of sedges, skunkcabbage, willow, and Sitka spruce. The surface horizon of Hebo soil is usually granular, very dark brown to black silty clay or silty clay loam. This is underlain by a firm blocky clay that is gray and highly mottled with brown and gray. Because of poor aeration, the Hebo soil is strongly acid and low in fertility.

The most common flood plain soils along the Oregon coast are, from well drained to poorly drained: Nehalem, Nestucca, and Brenner.

Nehalem soils occupy the best-drained flood plain positions and are probably the most productive of all bottom-land soils. Although most of the land is now cleared, these soils developed under forest vegetation. In a representative Nehalem profile, the surface layer, about 38 centimeters thick, is very dark grayish-brown silt loam. The subsoil is dark brown silt loam about 38 centimeters thick, underlain by a gravelly silt loam extending to a depth of about 1.5 meters.

Nestucca soils occupy slight swales and concave depressions in flood plain surfaces. These soils formed under western hemlock, red alder, and Sitka spruce forest and are slightly finer textured than the Nehalem. The surface layer is generally about 18 centimeters thick and consists of mottled, dark brown silty clay loam that contains distinct strong brown mottles.

Poorly drained Brenner soils represent the wet end of the flood plain series. They occupy enclosed depressions and must be drained before they can be effectively used for agriculture. The surface soil is a very dark grayish-brown silt loam or silty clay loam with distinct brown and yellowish-red mottles and is about 38 centimeters thick. The subsoil is usually a dark gray silty clay loam with common, distinct yellowish-brown mottles. The water table is at depths of less than 1 meter most of the growing season.

Soils on Uplands

The term "uplands" refers to the slopes of the foothills and mountains of the Coast Ranges along the northern two-thirds of the coast and the slopes of the Siskiyou Mountains along the southern one-third of the coast. These upland areas receive abundant precipitation (usually at least 254 centimeters per year), and most soils developed under dense stands of Douglas-fir and western hemlock. Deep and well-developed soils found here rank among the most productive forest soils in the world.

In the Oregon Coast Ranges, the two main classes of upland soils are derived from sedimentary parent materials (largely sandstone, but some siltstone) and soils developed in igneous parent materials (largely basalt). These soils range from deep and well-developed profiles on broad ridgetops and gentle slopes to shallow and stony profiles in extremely steep areas. In the following discussion, I will concentrate on moderately well-developed to well-developed soils.

Perhaps the best known and most widely distributed soil from sedimentary rocks in the Oregon Coast Ranges is the Astoria. This is a deep fine-textured soil showing considerable profile development. It is usually located on gentle to moderate slopes, although it has been mapped on slopes up to 50 percent. The Astoria has a thick (51 centimeters), very dark grayish-brown silt loam surface layer of granular structure. The subsoil is a dark yellowish-brown silty clay that may extend as deep as 1.5 meters where weathered parent material is encountered.

The Coast Ranges along the central Oregon coast is almost entirely underlain by the very extensive Tyee sandstone formation. There, the two principal soil series are the Slickrock soil on benchy slopes and landslide deposits and the Bohannon soil on steep, smooth mountain slopes. A typical profile of the well-drained Slickrock soil shows a very dark brown gravelly loam surface layer about 18 centimeters thick. The subsoil is comprised of a dark brown stony clay loam and grades into weathered sandstone parent material at a depth of about 1.2 meters. The stony nature of the Slickrock profile is a result of the unstable land and frequent soil and rock slides.

The Bohannon soil, showing less profile development, is found in the proximity of the Slickrock soil but usually occupies steeper (50 to 90 percent), smoother slopes. The 25- to 31-centimeter-thick surface layer is a dark brown gravelly loam and is underlain by a brown gravelly loam subsoil, only about 31 centimeters thick. Fractured sandstone bedrock is usually encountered at a depth of about 0.6 meter. Despite its shallow profile, the Bohannon is still a productive soil for tree growth, mainly because of abundant precipitation.

Basaltic parent materials in the Coast Ranges give rise to well-drained, generally fine-textured soils that are redder and less prone to mass movement than soils derived from sedimentary rocks. A widespread, representative soil on basalt is the Hembre series-a deep, well-developed soil. The Hembre soil typically has a 38- to 51-centimeter surface layer that is a dark reddish-brown, granular clay loam. The subsoil is generally a reddish-brown clay loam that may extend to depths of 1.8 meters or more before weathered basalt is encountered.

Soils in the Siskiyou Mountains differ considerably from those in the Coast Ranges to the north. Probably most of these differences can be attributed to the abrupt shift in types of parent material. Certainly, a whole new set of soils would be expected to develop on the much older, metamorphosed rock types of the Siskiyous. The influence of several small climatic changes on soil properties cannot be discounted, however. Probably most important are the warmer, drier summers characteristic of southwestern Oregon. These warmer, drier summers are also effective along the coast, although they are ameliorated to a certain extent by the ocean.

Soils from sedimentary parent materials are noticeably finer textured in the Siskiyou Mountains than are comparable soils in the Coast Ranges. This is borne out by characteristics of the Orford soil-probably the most widespread soil series in Curry County. This deep, well-drained soil is developed from siltstone and sandstone under forest vegetation (mainly Douglas-fir, western hemlock, tanoak, and madrone). A typical Orford soil profile has about a 36-centimeter-thick surface layer of very dark brown granular silty clay loam. The subsoil is dark brown to yellowish-brown silty clay which is free of stones. Weathered parent material is not encountered above depths of 1.4 meters.

One of the most unusual soils of the western Siskiyous is the Sebastian. It is developed on serpentinite bedrock under dominantly grassland vegetation. The Sebastian is very shallow and stony and is very infertile because of excessive amounts of magnesium relative to calcium. It typically has only a 3-centimeter, dark reddish-brown stony loam surface layer underlain by a dark reddish-brown, very stony, clay loam subsoil. Serpentinite bedrock is generally within 0.3 to 0.5 meter of the surface. The Sebastian soil is singularly unproductive, and its occurrence is invariably indicated by very scattered and stunted tree growth.

STUNTED TREE GROWTH

Selected references:

Geology-Baldwin (1964), Wells and Peck (1961).
Soils-Bowlsby and Swanson (1964), Buzzard and Bowlsby (1970), Corliss (1973).

2. Vegetation and Habitats

Jerry F. Franklin

The diverse and unusually luxuriant plant communities of Oregon's coastal region provide essential habitat for terrestrial mammals. Most native terrestrial species can survive only if the plant communities they require are available and in the proper mix. Therefore, an understanding of habitat requirements of mammals is the foundation of management to conserve them.

The Oregon coast provides a rich array of lush vegetation. Few regions of the world, outside the tropics, have vegetation that grows as fast, dense, and tall.

The mix of species and structure of plant communities vary considerably even over short distances. This variation is the result of differences in temperature, moisture, and nutrient availability from site to site. In general, average temperatures are higher at lower elevations and lower at higher elevations than temperatures farther inland; however, temperature differences can be found between north- and south-facing aspects of a single hill. Drought is not a problem along a creek drainage where the soil is constantly wet and air humidity high, but it may be on a sun-warmed hillside in midsummer. Few nutrients are available in sand dunes, but many of the soils developed from sedimentary rocks are rich in nutrients.

The second factor that results in a varied landscape is disturbance. Before the Oregon coast was settled (even before any human had visited it), disturbances periodically altered the landscape. Floods and landslides are part of the natural geological aging of coastal mountains. Wildfires set by lightning and windstorms presumably destroyed vast tracts of forest. People are inclined to think of such events as unusual and catastrophic, but they are, in fact, very much a part of the natural cycle of events.

Settlement resulted in additional massive changes in the vegetation. Wildfires caused by humans were frequent, and large areas were converted to agriculture and urban uses. Large areas are still being logged.

Table I-Relation of physiographic features, soil series, and habitats along the Oregon coast

Physiographic feature	Soil series	Habitat
Estuaries and bays	Coquille	Tideland river'
	Coquille	Wet pastureland
Beaches		Beach
Sand dunes		Foredunes
		Moving dunes
		Deflation plains
	Netarts, Blacklock	Stabilized dunes
	Netarts	Sitka spruce/salal
	Netarts	Lodgepole pine/rhododendron
	Netarts	Lodgepole pine/salal
	Blacklock	Willow/sedge marshes
		Coastal lake
Coastal plain	Ferrelo, Winchuk, Nehalem	Mature conifer
	Ferrelo, Winchuk, Nehalem	Immature conifer
	Knappa, Chitwood	Alderlsalmonberry
	Knappa, Chitwood	Riparian alder
	Knappa, Chitwood	Riparian hardwood
		Headland prairie
		Headland shrub
	Hebo	Cedar swamp
	Hebo	Willow/sedge marshes
	Hebo	Skunkcabbage marshes
		Coastal lake
	Hebo, Coquille	Wet pastureland
Basaltic headland	Hembre	Mature conifer
	Astoria[2]	Immature conifer
		Alder/salmonberry
		Riparian alder
		Headland shrub
		Headland prairie
		Skunkcabbage marshes
		Mountain river
Coast Ranges	Astoria	Mature conifer
	Slickrock, Bohannon	Mature conifer, Douglas-fir variant
	Slickrock, Bohannon	Immature conifer
	Chitwood, Knappa	Alderlsalmonberry
	Chitwood, Knappa	Riparian alder
	Chitwood, Knappa	Riparian hardwood
	Hebo	Cedar swamp
	Hebo	Willow/sedge marshes
	Hebo	Skunkcabbage marshes
		Mountain river

'Includes salt marshes.
[2]A cap of sedimentary rock is over the basalt

Table 1 -continued

Physiographic feature	Soil series	Habitat
Siskiyou Mountains	Orford	Mature conifer
	Sebastian	Mature conifer, both Douglas-fir and redwood variants
		Immature conifer
		Tanoak
		Riparian hardwood
		Headland shrub
		Headland prairie
		Willow/sedge marshes
		Mountain river

It is important to understand that nature rarely stands still. Plant communities are constantly growing and changing in form and composition. The process of change from one plant community into another is known as succession. Vegetation passes through orderly stages in its regrowth and, as each stage changes, it becomes suitable for some animals while becoming unsuitable for others. There are many familiar examples of succession on the Oregon coast. A clearcut is colonized by shrubs and herbs, which are replaced, in turn, by Douglas-fir. This species may ultimately be replaced by western hemlock, a more shade-tolerant species that can reproduce on the forest floor. A moving sand dune, for example, is stabilized first by beach grass, which is replaced in turn, by shrubs and lodgepole pine.

Changes in the basic conditions of light, temperature, moisture, and nutrients determine which species will grow in sequence on a particular site. Thus, not many sand dune plants appear in clearcuts, nor is skunkcabbage found in drier portions of the landscape. Changes in light conditions have a major effect on plant composition and succession, since many plants need sun and the open conditions of early successional stages to survive. As a forest develops, these plants die and shade-loving species become prominent.

The basic environment determines the growing potential of a site, but disturbances of various types help destroy plant communities and initiate successional sequences. For example, the old-growth forests seen today are the result of fires and windstorms in the distant past.

Another important factor in variation of vegetation along the Oregon coast is latitude. Along the southern coast, from about the Coquille River south, the appearance and distribution of plant communities are distinctively different from the north coast. These are the result of differences in climate, geology, and soils described in chapter 1 (table 1). North-south differences in plant communities make a substantial difference in the character and extent of habitats available for mammals. For example, nonforested ocean-facing prairies and shrub fields are common along the southern Oregon coast, whereas in the north they are mainly confined to steep headland areas. The southern coast has fewer rivers with extensive estuaries.

Along the northern coast, the vegetation is composed mainly of species found in the coastal vegetation of Washington, British Columbia, and Alaska. Species these areas have in common include Sitka spruce, western hemlock, huckleberry, salmonberry, and salal. The flora of the southern Oregon coast is much richer-the "northern" species mix with more typically California plants growing at or near their northern limits: redwood, tanoak, California laurel, western azalea, and blueblossom. The Klamath-Siskiyou Mountain region of the southern Oregon and northern California coast supports still other species, Port-Orford-cedar being a good example.

Habitats and Their Important Plant Communities

Most of the habitats significant to mammals can be characterized by plant communities of varying structure and composition. I will describe and illustrate important plant communities and other habitats. My classification is designed to recognize major categories important to mammal species. I have not attempted the type of comprehensive or detailed breakdown usually made by plant ecologists; for this kind of treatment, see "Vegetation of Oregon and Washington" (Franklin and Dyrness 1973). The principal categories used here are coniferous forests; hardwood forests; prairies and shrub fields; sand dune and strand; wetlands, rivers, and lakes; and cultivated land. These habitats often form a mosaic in the topographically and geologically complex coastal region (see fig. 1 in chapter 1).

Coniferous Forests

Coniferous forests are dominated primarily by evergreen trees, such as Sitka spruce, western hemlock, and Douglas-fir. Note that these are called coniferous forests, not simply evergreen forests; the tanoak growing on the southern Oregon coast is also evergreen but is not coniferous. Tanoak is a broad-leaved hardwood whereas conifers are needle-leaved softwood species.

The most conspicuous vegetation on the Oregon coast is the mature conifer forest (fig. 1). These forests are known for giant trees and dense, shady environment. Although the original forests have been greatly reduced by wildfire and logging, they are still conspicuous and important. The principal trees in these mature conifer forests are Sitka spruce, western hemlock, and Douglas-fir. The spruce is abundant on the slopes and headlands close to the ocean and along tidal reaches of streams. It rapidly becomes less abundant farther from the ocean. Douglas-fir does the reverse. It is less abundant close to the ocean and more abundant farther inland. Western hemlock is common everywhere except the ocean front. Undergrowth in mature conifer forests is well developed, consisting of shrubs (such as fools-huckleberry or rusty menziesia), evergreen and red huckleberries, and vine maple. A luxuriant growth of ferns and herbs (such as swordfern and Oregon oxalis) is common on the forest floor. Some of the finest examples of this habitat are found in the Cascade Head Scenic Research Area.
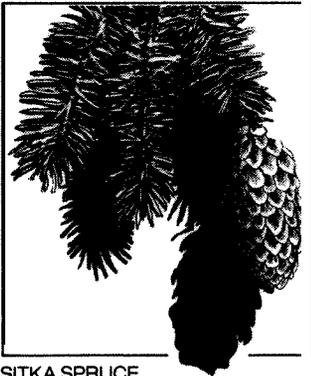
SITKA SPRUCE

Figure I.-Mature forest of
Sitka spruce and western
hemlock (Neskowin Crest
Research Natural Area).

If the "typical" mature conifer forest of the coastal regions is defined as Sitka spruce-western hemlock/swordfern-oxalis, there are several important variants. I will call the most conspicuous of these the Douglas-fir variant (fig. 2). These forests are dominated by Douglas-fir and are typically inland from the spruce-hemlock forests, although there are exceptions. Much of the inland mature conifer forest dominated by Douglas-fir has western hemlock as a secondary component. Shrubs and herbs form a rich understory in many of these forests. Sites may be considerably drier on some of the southerly exposed slopes of the Coast Ranges. Understory species may therefore vary considerably from site to site.
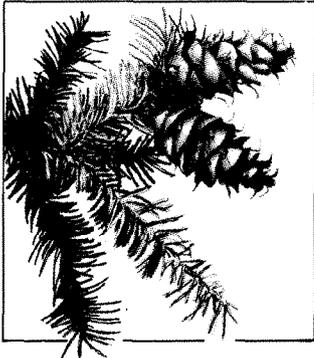
DOUGLAS-FIR

Figure 2.-Douglas-fir variant of coastal mature conifer forest (Coquille River Falls Research Natural Area).

Figure X-Redwood variant of coastal mature conifer forest (Wheeler Creek Research Natural Area).
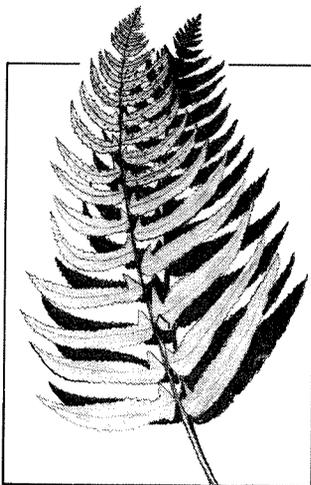
SWORDFERN

A second variant ot the mature conifer forest is the redwood variant. This community type is found along the southern Oregon coast, generally 8 to 16 kilometers inland. Coast redwood is the major distinguishing feature (fig. 3); Douglas-fir is the most common companion species, but western hemlock and hardwoods are also associates. Understories in this variant may be dominated by herbs (such as swordfern and oxalis on lower slopes and in valleys) but are often quite shrubby, particularly on drier slopes where rhododendron, salal, and huckleberries are common.

Immature conifer forests are the youthful stands of conifers common on older burns and logged-over areas. When regeneration is good after such disturbances, dense stands are established that develop closed canopies in 15 to 20 years. A classical immature conifer stand has many small stems (size depending on age of the stand and growing conditions), an open forest floor with relatively few shrubs or herbs (because of dense shade), and an abundance of small standing dead stems and logs and other woody debris on the ground (fig. 4). Some of the material on the ground is left from older stands, but much of it is the result of high mortality of young trees that compete intensely for light, moisture, and nutrients.

Figure 4.—Immature conifer forest is characteristically dense along the Pacific coast. (Photo by Lawrence Hudeitz.)

The exact composition of immature conifer forests varies widely with geographic location (north or south coast, ocean front or inland), the species that were available to seed into the disturbed site, and, in some cases, the species planted. Douglas-fir, Sitka spruce, and western hemlock dominate singly or in mixtures. On the south coast, other species-such as Port-Orford-cedar-may be mixed in; and on sandy soils near the coast, lodgepole pine. From the standpoint of habitat for small mammals, the abundance of small stems, heavy shade, and woody debris are probably more important than forest composition. Excellent examples of this habitat can be found in the Coos County Forest.

The reader should be aware that not all immature conifer forests fit this descrip tion. They may be more open because of poor forest regeneration and thereby retain some characteristics of clearcut habitat, with an abundance of shrubs, blackberries, and weedy herbs. Or they may have mixtures of hardwoods, including especially red alder. If both conifers and red alder are abundant, it is a mixed red alder-conifer community that has features similar to the alder com-munities described next (see fig. 1 in chapter 1).

Hardwood Forests

The four major hardwood communities on the Oregon coast are: Alder/salmonberry, riparian aider, riparian hardwoods, and tanoak. The alderlsalmonberry community is mainly a creation of people. It is the typical red alder forest that grows on hillsides after disturbances, such as logging or fire, or on abandoned agricultural land. Ecologists suspect that originally red alder was much more restricted than it is now, occurring mostly along streams and in other wet areas. Continual disturbance in historic times provided an abundance of open areas with bare mineral soil which this aggressive species has colonized. Red alder produces an abundance of small seeds that fly long distances. It grows extremely fast along the Oregon coast. These characteristics enable alder seed to get to logged or burned areas rapidly and seedlings to compete with conifer seedlings and often overtop them.

Upland communities dominated by red alder, with varying amounts of associated conifers, are now widespread along the Oregon coast; these are called the alderlsalmonberry community. Early in the development of this community, when the alder is dense and young, there is often little understory and most of that consists of herbs. Red alder matures quickly, however, and stand canopies begin to open up in 15 to 25 years as individual trees die. Dense understories of salmonberry, elderberry, and other deciduous shrubs then develop, forming the typical alder/salmonberry type (fig. 5).

Ecologists and foresters are unsure of the successional sequel to alderlsalmonberry communities. Red alder does not reproduce itself in these communities and slowly disappears. In some cases, conifer seedlings, especially Sitka spruce or western hemlock, appear to take advantage of the increased light and take over the site; these seedlings often were established about the same time as the alder but were suppressed in growth. In other cases, it appears that salmonberry and other shrubs take possession of the site when the alder is gone if few conifers are present and none are becoming established under the dense brush cover. As more alder stands become overmature, it will be possible to observe what really happens.
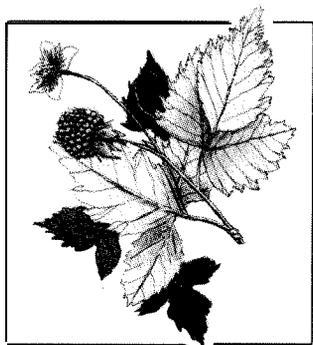
SALMONBERRY

Figure 5.—Typical community of mature red alder with a dense salmonbenry understory.
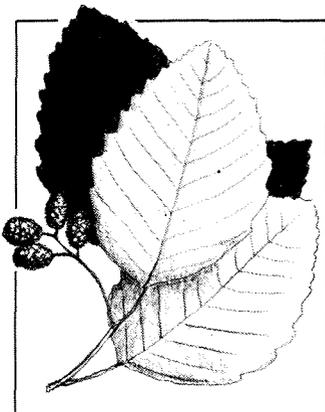
RED ALDER

Riparian alder communities are similar to those on the uplands, except that they are found on lower slopes and terraces next to streams (fig. 6). Originally, red alder was probably more common on riparian sites than uplands, and it generally grows larger along streams. Brush is also denser and taller in these wet, cool habitats than in upland alder/salmonberry communities. For mammals, the most significant feature is perennial (year-round) streams and associated sand and gravel bars-all adjacent to a dense cover of vegetation that furnishes food and shelter. Not only is the presence of a rivulet or stream important to mammals but size of stream also makes a difference. Consequently, I distinguish between riparian alder/small stream and riparian alder/large stream habitats because of differences in the fauna species that utilize them.

Large rivers, particularly along the southern Oregon coast, often are lined by flood plain and riverbank forests with a diverse mixture of hardwoods. The numerous variants of this community are called riparian hardwood habitat. Dominant trees are typically bigleaf maple, red alder, Oregon ash, and willows. In some areas, black cottonwood is common, and in southern Oregon, California laurel may be a major component. Epiphytes-mosses, lichens, and ferns growing on tree trunks and limbs-are common. These streamside hardwood forests may be dense early in their development but more typically consist of relatively few large trees and a dense understory of small trees and shrubs.

On hillsides inland from the southern Oregon coast, an evergreen hardwood community, the tanoak type, is found. These stands are often dense, with leaf litter that decomposes slowly and an open forest floor. Tanoak, though a major dominant, is often mixed with other hardwoods (such as Pacific madrone) and Douglas-fir. Many of these evergreen hardwood forests probably originated after wildfire, but some stands occupy sites that cannot support conifer forests. These forests are the northern extension of a major forest formation that is widespread in the interior of the Siskiyou Mountains and northern California.

Prairies and Shrub Fields

Plant communities dominated by herbs or shrubs or both existed within the forest matrix before white people settled here, often occupying habitats poorly suited to trees or periodically swept bare by disturbances. They continue to exist and provide distinctive and important habitats for certain mammals. They also help provide a diverse and esthetically pleasing landscape for humans. Headland prairie is a general term for the meadowlike areas found on many of the coastal headlands along the northern half of the coast (see fig. 1 in chapter 1). The factors that led to their presence are not known; soils may have been unsuited for forest, or there may have been wildfire or other destructive occurrence. Headland prairies are characteristic of exposed portions of headlands. Typically, these communities have dense ground covers of grasses, flowering herbs, bracken fern, and scattered shrubs-such as thimbleberry and rose. Some good examples of this community are found in the Cascade Head Scenic Research Area and in several State parks.

Nonforested herb and shrub communities are more widespread along the southern Oregon coast. Although these herbaceous communities along the southern coast differ markedly in composition from those on the northern headlands, they are similar in appearance, with a dense sward of grasses and flowering herbs (fig. 7). One of the most conspicuous southern coast shrub communities is called the headland shrub type (fig. 8). It is dominated by dense stands

Figure 6.—Riparian communities are especially important to animals. Red alder often dominates coastal riparian habitat, but other hardwoods, such as California laurel, are more important along this stream (Cherry Creek Research Natural Area).
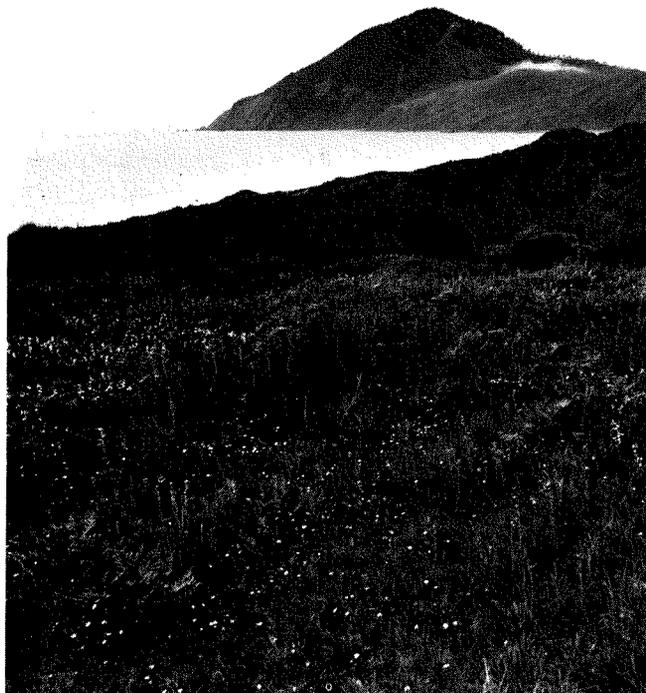
Figure 7.-Prairie along the southern Oregon coast with typical mix of grasses and forbs.

Figure 8.-Shrub community on headland along the southern Oregon coast manzanita, ceanothus, salal, evergreen huckleberry, and characteristic species.

of evergreen and deciduous shrubs. Typical species are hairy manzanita, silk tassel bush, deerbrush, western azalea, Sitka aider, evergreen huckleberry, and bracken fern. Another distinctive, and unpleasant, plant community is the gorse thicket. This spiny evergreen shrub was introduced from Scotland and has taken over many hectares along the southern Oregon coast, forming nearly pure, impenetrable thickets.

Sand Dune and Strand Habitats

Several distinctive habitats are associated with the beaches and extensive dune lands along the central and northern Oregon coast. Wiedemann et al. (1974) provide excellent descriptions of the varied communities that occur on the dune lands which are used here in simplified form. The beach habitat cannot be characterized as a plant community since few higher plants are found on these sandy or stony areas between high tide line and the first permanent terrestrial communities.
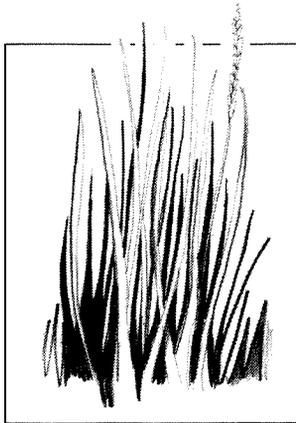
The first plant community inland from the beach is the foredune community or habitat. This habitat is mostly created by humans. Before 1930, the foredune was relatively uncommon; it has resulted from the introduction of European beach grass to stabilize sand dunes in the late 1800's. This beach grass found the coastal climate of Oregon much to its liking, became naturalized, and now occurs widely. This introduced plant is primarily responsible for the formation of the foredunes so common today but rare before 1930. The key is the ability of European beach grass to become established along the high tide line and catch and hold sand blown off the beach. As sand accumulates, growth of beach grass keeps up with it and, eventually, a dune is formed.

Extensive areas of live sand dunes occur along the central Oregon coast and, to a lesser extent, in other locations. This "live" or moving dune habitat is characterized by open expanses of sand with little vegetation (see fig. 3 in chapter 1). Within the dunes are areas where sand has been blown away nearly down to the permanent water table. Plants become established on these deflation plain habitats, and grasses and broad-leaved herbs bind the sand and form meadowlike communities (see fig. 4 in chapter 1). Gradually, these are invaded by shrubs, and some eventually become thickets of salal, evergreen huckleberry, and Pacific rhododendron (fig. 9).

Figure 9.-Vegetation within a deflation plain (Oregon Dunes Natural Resource Area). (USDA Forest Service photograph by Don Busch.)

As sands are stabilized by grasses, herbs, and shrubs-whether on a deflation plain or an upland dune surface-a stabilized dune habitat with a forest cover develops. The forest may be lodgepole pine, Sitka spruce, or both. A dense understory of evergreen shrubs—such as salal, evergreen huckleberry, and/or rhododendron-is typical (fig. 10). Several distinctive types of forest and shrub communities can be identified on stabilized dunes, depending on whether the habitat is wet or dry, the surface relatively young or very old, and so forth. Two very common communities are the Sitka spruce/salal and the lodgepole pine/rhododendron types. Another variant, one that may not be confined exclusively to sand, is the lodgepole pine/salal community.
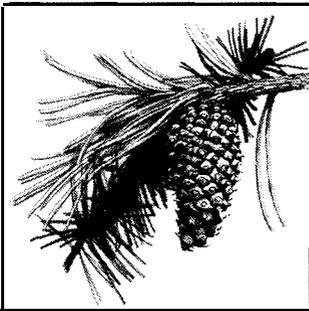
LODGEPOLE   PINE

Figure 10.—Lodgepole pine forest on stabilized dune with typical understory of dense evergreeri shrubs.

Sitka spruce/salal community

This community consists of dense, often impenetrable stands of Sitka spruce and salal on stabilized dune surfaces and some exposed slopes near the ocean.

Lodgepole pine/rhododendron community

This community consists of forests on stabilized dune surfaces, often relatively open with understories of evergreen shrubs. Lodgepole pine is the major tree species, but it has several other associates (such as Douglas-fir). In addition to rhododendron, the understory may include evergreen huckleberry, salal, manzanita, and other shrubs. The lodgepole pine/rhododendron community is particularly well represented on some of the older dune surfaces near Florence.

Lodgepole pine/salal community

This community consists of forests on stabilized dune surfaces, often older than those typical of the lodgepole pine/rhododendron community. Salal is the major understory associate. This community can be viewed on some of the coastal terraces around Bandon.

Wetlands, Rivers, and Lakes

Many local areas have high water tables all or part of the year, producing distinctive plant communities and mammalian habitats. Swamps are typified by scattered trees. Most commonly, swamps along the Oregon coast have conifers so this habitat was named the cedar swamp after one of the typical tree species. Lodgepole pine and Sitka spruce, however, are also common swamp conifers, and red alder and Oregon ash are typical hardwood trees found in swamps. A shrubby understory of willows and a dense herb layer of rushes, bulrushes, slough sedge, grasses, broad-leaved herbs, and ferns dominates the ground cover in swamps. Close to the coast, shrubby species may include wax myrtle and bog labradortea.
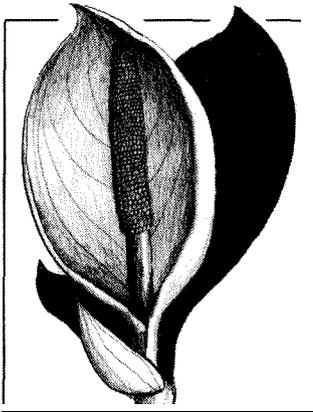
Open marshy areas (outside tidelands) may also occur in areas of high water table. The nonforested plant communities they support include the willow/sedge marshes so common near the southern end of the Coos Bay dune land and skunkcabbage marshes. The willow/sedge marshes are dominated by willow and sedge and occur in areas of high (fresh) water tables. Standing water is usually present, along with a variety of shrubs and herbs. Skunkcabbage marshes are the most conspicuous type. They occur in wet depressions and are often scattered as small islands through forests or over larger areas of valley bottoms.

YELLOW SKUNKCABBAGE

Tideland river is a habitat that occupies large portions of tidal flats. It is characterized by extensive estuarine salt marshes, mudbanks, and slow-moving streams with numerous sloughs. The salt-marsh communities are influenced by periodic inundations of saltwater or brackish water. Dense swards of rushes, bulrushes, salt grass, arrowgrass, sedges, and other grasses and grasslike plants are characteristic. There are large variations in the character of salt marshes, depending on the depth and salinity of water that affects them and the degree of human influence-dike construction, for example.

The tideland river habitat contrasts sharply with the mountain river habitat where the river or large stream is swift and often rocky. Tideland rivers may flow directly into the ocean without an estuary. Streamside vegetation is typically riparian hardwood and mature conifer types, but, in some cases, only the latter are present.

The coastal lake habitat refers to the freshwater lakes associated with coastal sand dunes. Many of these lakes were formed when drainage systems were blocked by movement of dunes. Steep sand dunes, marshes, and various types of forest can often be found along the shores of a single lake.

Cultivated   Habitats
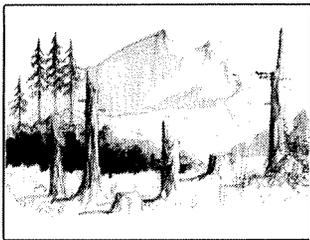
STUMP   RANCH

By clearing land of timber, people have created at least two major habitats that are now important animal habitats-agricultural or pasturelands (fig. 11) and clearcuts. The character of these is highly variable, depending on the basic environment of the site cleared, the time since the original vegetation was cleared, and the care and use since clearing. For example, it makes a significant difference whether pastureland is on a diked salt marsh or on an inland river terrace or hillside, and whether spraying, seeding, or other improvements have been undertaken. Pastureland is usually characterized by a continuous, often low, grassy sward that includes a mixture of native and exotic plants. Pastureland that has not been well cared for may include patches of shrubs and blackberries, which provide considerably more habitat diversity for mammals than more intensively cultivated pastures. "Stump ranches" often include extensive mosaics of grass sward, blackberries, bushes, stumps, and snags.

Figure 11.—Coastal pasture-
land of the type developed
from marshes, wetlands, and
low-lying forests. (USDA Forest
Service photograph by Don Busch.)

In this book, the only cultivated habitat recognized is wet pastureland. Most often this consists of low-lying, nearly flat estuarine sites that have been converted to pasture. Salt marsh species provided the original vegetation on most of these sites, but diking and grazing have given rise to a sod of grasses, sedges, rushes, and forbs. Clumps of spike rushes often stand out above the low sward of other herbs, and patches of skunkcabbage may also be conspicuous in spring.

Clearcuts vary greatly in vegetative cover, depending on their location (coastal plain or inland), logging method, intensity of any burning, and time since logging. In general, it takes about 5 years for shrubs to become dominant. Before that, herbs-such as horseweed, fireweed, and ragweed-often dominate. Despite the highly varied nature of young clearcuts, some mammals find them important for food and shelter.

Glossary of Habitats
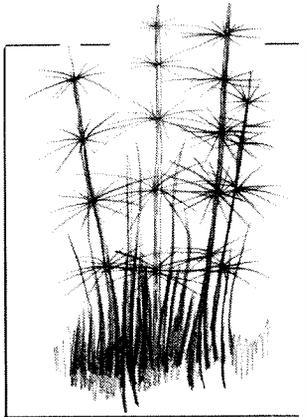
HORSETAIL

alder/salmonberry forests dominated by red alder and, in older (15 to 20 years or more) stands, with dense shrubby understory of salmonberry and other deciduous shrubs.

beach sandy or stony areas between high tide line and first permanent terrestrial communities.

cedar swamp low-lying areas (depressions) with seasonal or year-round high water tables. Scattered trees over a dense herbaceous cover of sedges, ferns, skunkcabbage, horsetails, and other herbs in varying mixtures. Tree species typically western redcedar, lodgepole pine, red alder, and Sitka spruce.

coastal lake freshwater lakes, most commonly associated with drainages blocked by sand dunes.

deflation plains areas in sand dunes where sand has been removed by wind to the point that moist sand near the water table has been reached and effective sand movement has ceased. The stability of deflation plains makes them favorable habitats for development of vegetation.

foredunes vegetated dunes immediately inland from the beach, typically dominated by European beach grass, which is responsible for their formation.

headland prairie grassy or meadowlike areas found on many exposed headlands. They are typically composed of a variety of grasses, sedges, flowering plants, and scattered shrubs.

headland shrub communities composed mainly of evergreen shrubs found on ocean-facing slopes and cliffs. Manzanitas, evergreen huckleberry, salal, and deerbrush are common species.

immature conifer typically, dense stands of small trees with sparsely vegetated, heavily shaded forest floors and abundant woody debris. Variable tree composition.

lodgepole pine/rhododendron forests on stabilized dune surfaces, often relatively open with understories of evergreen shrubs. Lodgepole pine major tree species but with several other possible associates, such as Douglas-fir. In addition to rhododendron, understory may include evergreen huckleberry, salal, manzanitas, and other shrubs.

lodgepole pine/salal forests on stabilized dune surfaces, often older than those typical of the previous community. Salal major understory associate in these forest stands.
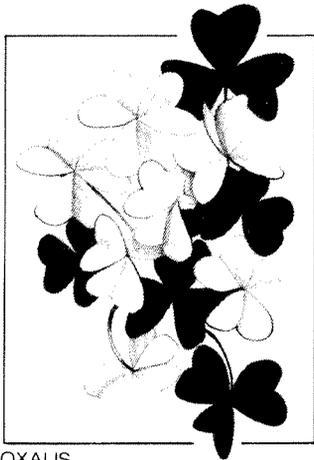
OXALIS

mature conifer evergreen, coniferous forests dominated by relatively large, older trees. Highly variable in composition, but characteristic tree species are Sitka spruce and western hemlock. Shrubs common and luxuriant ground cover of ferns (e.g., swordfern) and herbs (e.g., oxalis).

mature conifer, Douglas-fir variant generally found inland from the coast. Dominated by Douglas-fir and western hemlock. Understory variable in composition; e.g., dominants of rhododendron and/or vine maple, abundant herbs, ferns, and shrubs.

mature conifer, redwood variant extreme southern Oregon coast, 8 to 16 kilometers inland. Distinguished by presence of coast redwood with Douglas-fir, western hemlock, and hardwoods as associates. Variable understory, depending on site conditions; e.g., rich herbaceous cover on lower slopes and in valleys, evergreen shrubs on drier hillsides.

mountain river large, fast-moving (high gradient) streams, some of which drain directly into the ocean without estuary development. Streamside vegetation typically riparian hardwood or mature conifer types.

moving dunes live or unstabilized areas of sand inland from the beach and foredune areas. The dunes take a variety of forms (dune types), but all are characterized by a near absence of permanent vegetation. Forests are sometimes buried by moving dunes and later exposed as dead skeletons.

riparian alder alder forests found on streamside terraces and banks. Similar to alder/salmonberry in structure and composition but associated with a permanent flowing water course. Subdivided into **/small stream** and **/large stream** variants.

riparian hardwood mixed hardwood forests found along major rivers. Typically composed of large individuals of bigleaf maple, red alder, California laurel, and black cottonwood in varying amounts. Well-developed shrubby understory.

Sitka spruce/salal dense, often impenetrable stands of Sitka spruce and salal found on stabilized dune surfaces and some exposed slopes near the ocean.

skunkcabbage marshes wet depressions often found scattered as small islands through forests or over larger areas on some valley bottoms. Skunkcabbage conspicuous dominant. This community grades into both **cedar swamp** and **willow/sedge marshes.**

stabilized dunes sand dune surfaces that have been stabilized by either planting or encroachment of natural vegetation. Typically covered by trees or evergreen shrubs or both.

tanoak mixed hardwood forests found just inland from **riparian hardwood.** Composed primarily of tanoak, madrone, and California laurel. Understory varies from dense to open.

tideland river estuarine habitats occurring along slow-moving rivers close to the coast. Salt marsh and mudbank communities are a primary feature, along with various sloughs and drainage channels in the tidal flats.

wet pastureland pastureland on major river terraces and, especially, in estuaries where it has developed from heavy grazing and other domestic use of natural salt marsh or other estuary communities. Dense sward of grasses. sedges, rushes, and forbs in which clumps of spike rush and skunkcabbage are often conspicuous.

willow/sedge marshes nonforested communities dominated by willow and sedge in areas of high (fresh) water tables. Standing water usually present along with a variety of associated shrubs and herbs.

3. Land Mammals

Chris Maser

Introduction
Definition of Mammals

In 1758, Swedish naturalist Carolus Linnaeus proposed a classification of living organisms, both plant and animal. He took the Latin word mamma, meaning "the breast," and created the term "*Mammalia*" for animals that produce milk and nurse or suckle their young; "mammal" is English for the Latin *Mammalia.*

Mammals have characteristics that separate them from other living organisms. For example, baby mammals are initially nurtured by their mothers' milk, and mammals have hair on their bodies during some stage of their lives.

Worldwide, there are 19 major groups or orders of living mammals. Nine of these orders and 31 families (smaller, more closely related groups) are represented by mammals that live along the Oregon coast. A total of 96 species, representing 65 land and 31 marine mammals, inhabit the coast. Of these, five of the land species have been introduced, and one species of marine mammals has been reintroduced.

A Dichotomous Key

The purpose of a key is to enable you to identify an organism or object with which you are not familiar. A dichotomous key is an arrangement of characteristics, or groups of characters, into couplets of alternatives. Each animal, at any level of classification-order, family, genus, species, subspecies-theoretically has distinctive characteristics that either place it with or distinguish it from other individuals. To identify an unknown animal, therefore, read the character descriptions in the key, a couplet at a time. Start with the first couplet, la and lb. The character discussed in the first part of each couplet is a positive statement (for example, forelimbs developed into leathery wings). The same character is discussed in the second part of the couplet, but an alternative is given (for example, forelimbs not developed into wings). You must decide which character best fits the animal you are trying to identify. When the best choice is made, continue to the next couplet that is designated at the conclusion of either part one or part two of the first couplet. For example, if the animal fits the description given in la, then it has keyed out to the order Chiroptera (bats). If, on the other hand, the animal does not fit the description in la, you read the alternative, lb. In turn, lb directs you to couplet 2. If the animal fits the description given in 2a, then you have the order Cetacea (whales, porpoises, and dolphins). If the animal does not fit 2a, read

2b which, in turn, directs you to couplet 3. Continue the procedure until, by choice and elimination, you arrive at a conclusion designated in the key by a scientific name, a common name, and a page number. Turn to the correct page and scientific name. Under the name is a description of the animal (order, family, genus, or species). Read the description critically and determine whether or not the animal fits the description. If it does, you have probably identified it correctly; if not, try to key it out again.

In rekeying an animal, be particularly critical of any couplet of characters in which the character choice was not clear about the particular animal you are trying to identify. In such a case, try keying the animal by using the alternative characters.

If you think you recognize an animal before you attempt to key it, however, try the following short cut. Turn to the species description that you expect to be correct. Read it carefully. If, after reading the description, you are still not sure whether your tentative identification is correct, find the name you think the animal will key out to and use the key backwards.

Animals are not identical; they have individual variations. Weigh the evidence; do not guess. There is enough variation among animals, even of the same species, that you must be careful not to read into the key what is not there. But do not be discouraged if you cannot identify a particular animal because, regardless of how good a key is, a few animals (particularly young ones) just do not fit.

**Key for identifying the orders of mammals
along the Oregon coast**

la Forelimbs developed into leathery wings-CHIROPTERA (bats), page 79

1 b Forelimbs not developed into wings   2

2a Front limbs developed into paddlelike flippers; hind limbs absent; body ending in a horizontal, expanded fluke; blowhole (consisting of one or two nostrils) opening on top of head; body hairless or nearly so-CETACEA (whales, dolphins, and porpoises), page 373
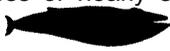
2b Front and hind limbs present; body not ending in a horizontal, expanded fluke; nostrils not on top of head; body covered with hair   3

3a Front and hind limbs developed into flippers for swimming— PINNIPEDIA (true seals and eared seals), page 433

3b Front and hind limbs not developed into flippers for swimming.   4

4a Toes terminating in hooves; four toes on each foot (two middle toes large, two upper toes small)-ARTIODACTYLA (even-toed hoofed mammals), page 352

4b Toes usually terminating in claws, not hooves.   5

5a Ears prominent, round, naked, extremely thin, leathery, black-frequently with white tip; tail long, tapering, scaly, naked (except at base and for a few scattered hairs), prehensile; first (inside) toes of hind feet large, lack claws, are more or less opposable to other toes-MARSUPIALIA (pouched mammals), page 38

5b Ears-if prominent, covered with hair; if nearly naked, concealed in body hair. Tail usually well haired; if naked, not prehensile. Claws on all toes   6

 6a Snout highly flexible, protruding conspicuously beyond mouth; eyes minute, sometimes hidden by hair—INSECTIVORA (insect eaters), page 43

 6b Snout normal, neither highly flexible nor protruding conspicuously beyond mouth. Eyes usually large; if small, readily visible.   7

  7a Fangs (canines) well developed, adapted for seizing prey, projecting far beyond other teeth-CARNIVORA (flesh eaters), page 247

  7b Fangs absent; front (incisor) teeth well developed, long and chisel shaped, and separated from the molars by a wide gap   8

   8a Ears proportionately long and narrow. Hind feet long, narrow, and soles covered with dense, woolly hair; movement is characteristic hop of a rabbit. Upper front teeth white, each with a deep, longitudinal groove-LAGOMORPHA (hares, rabbits, and allies): page 121

   8b Ears proportionately normal or small. Hind feet variously shaped but soles naked or nearly so; movements varied, but not the characteristic hop of a rabbit. Upper front teeth usually orange or yellow; if whitish, deep, longitudinal grooves absent—RODENTIA (rodents), page 132

Order Marsupialia: Pouched Mammals

Derivation: The ordinal name Marsupialia is derived from the Latin word *marsupium* (bag or pouch), and refers to the abdominal pouch that is characteristic of females of most species in this order.

General description: Marsupials as a group are the oldest, most primitive, living mammals of the New World. Sometimes referred to as "living fossils," they have survived relatively unchanged for at least 50 million years. In many respects, marsupials are intermediate between the most primitive of all living mammals, the egg-laying monotremes of Australia and New Guinea, and the more highly evolved placental mammals.

The gestation period in marsupials is short, 12 to 13 days, and the tiny young are born in a very immature condition. The young move to the mother's pouch, find and grasp a nipple which then expands in its mouth so the baby is well attached. When more mature, the young can release the nipple at will but remain within the pouch for a considerable time before venturing out. Before they are completely independent, the young usually return quickly to the safety of the pouch when danger threatens.

Marsupials are a diverse group of mammals. Some are arboreal (tree-dwelling); others live among rocks or on the ground; still others are fossorial (burrowing); and one species is semiaquatic. The diet of marsupials is equally varied; some are insectivorous (insect eaters); some are herbivorous (plant eaters); some are carnivorous (flesh eaters); and some are omnivorous (eat both plants and animals).

World distribution: Marsupials occur in the region of Australia that includes New Guinea and Indonesia, as well as in North America and South America. The opossum is the only marsupial native to the United States.

Fossil record: The oldest known marsupials occurred in North America and date to the late Cretaceous Period. They were closely related to the modern opossum.

Number of species along the Oregon coast: One, introduced.

General references Anderson and Jones (1967), Walker et al. (1968).

Key:

A single species of marsupial is represented along the Oregon coast—*DIDELPHIS VIRGINIANUS* (opossum), page 40.

Family Didelphiidae: Opossums

Derivation: The familial name Didelphiidae is derived from the Greek words *di* (two or double) and *delphys* (womb) and the Latin suffix *idae* (family). The family name refers to the structure of the female reproductive organs.

General description: Opossums are small to medium, ranging in length from 16 to 102 centimeters. They have elongated muzzles and well-developed external ears. The tail is usually long, scaly, almost naked, and prehensile. In some species, however, the tail is somewhat hairy. The hind legs are slightly longer than the front legs. All four feet have five digits (toes). The first digit or thumb lacks a claw and is opposable to the other digits. Although members of several genera have distinct pouches, some have only two longitudinal folds of skin enclosing the teats located near the midline of the abdomen; others have no pouch.

Primarily tropical mammals, most members of this family live in trees or on the ground, but one genus is semiaquatic. Opossums are insectivorous, carnivorous, or omnivorous. They are mainly active in the evening and at night.

The statement that female opossums copulate through the noses and blow their babies into the pouch is false. The idea probably arose from discoveries of newly born young in pouches after mothers were seen investigating their pouches with their noses.

World distribution: Opossums are restricted to the Western Hemisphere. They occur from southeastern Canada south through the Eastern and Central United States, Mexico, Central America, and into South America to about 47" south latitude in Argentina.

Fossil record: In North America the record dates from the late Cretaceous to the early Miocene, after which there is no known record from North America until the Pleistocene.

Number of species along the Oregon coast: One.

General references: Anderson and Jones (1967), Walker et al. (1968).

Photo courtesy Oregon Department of Fish and Wildlife.

Genus Didelphis: Opossum

Derivation: The meaning of the generic name *Didelphis* is the same as for the family.

General description: The two species in this genus are the largest of the opossums. They weigh from 2 to 5.5 kilograms. Their pelage, composed of under-fur and many guard hairs, is unique within the family. Other opossums have few guard hairs. Opossums vary from gray to black, or occasionally white. Sometimes there are three dark streaks on the head, one through each eye and another down the middle of the head.

World distribution: Distribution of the genus is the same as that of the family. In North America, however, *Didelphis virginianus* has extended its geographical range hundreds of miles north. During the fall it accumulates fat and, in the northern part of its distribution, becomes inactive during inclement weather; occasionally, an opossum may lose part of its ears and tail from frostbite.

General reference: Walker et al. (1968).

Species *Didelphis virginianus:* Opossum

Derivation: The specific name *virginianus* is a proper name. The opossum was named after the State of Virginia.

Specific description: Total length, 645 to 1017 mm; tail, 255 to 535 mm; hind foot, 48 to 80 mm; ear, 50 to 55 mm; weight 4 to 6 kg.

OPOSSUM

The opossum is about the size of a house cat but has a heavier body, shorter legs, and a pointed snout. The face is white. The ears are relatively large, naked, very thin, and black-frequently with white tips. The long, scaly tail is prehensile. The basal one-third to one-half of the tail is black; the rest is whitish. The first toe of the hind foot is opposable to the others and lacks a claw. Long, whitish hairs that overlie the black-tipped, woolly underfur give the animal a grizzled appearance.

Distribution along the Oregon coast: The opossum is a native mammal of the Southeastern United States. Opossums were introduced into Oregon as pets between 1910 and 1921 and subsequently escaped or were released (Jewett and Dobyns 1929). Over the years, opossums spread throughout Oregon, especially the western part. Along the coast, they occur as far south as Reedsport, Douglas County, and are gradually extending their range.

Habitat: Within their distribution along the Oregon coast, opossums occupy all habitats except those at higher elevations.

Habits: Opossums are not social animals. Primarily nocturnal, they are seldom seen except in the headlights of an automobile or dead along a road. Their eyeshine is dull orange.
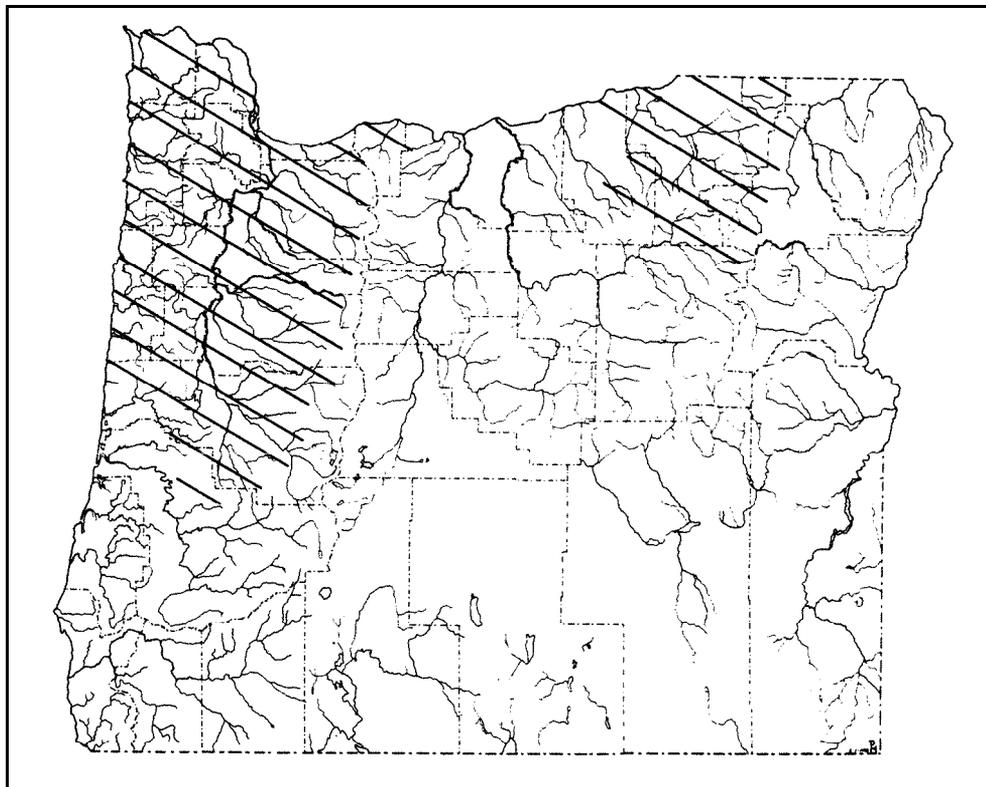
KNOWN DISTRIBUTION OF OPOSSUM

Opossums build their nests in a variety of places. They may enlarge abandoned burrows of other animals or take refuge in hollow trees or logs, under buildings, in brush piles, or in rock piles. Nest cavities are frequently lined with dry grass and leaves. In gathering material for its nest, an opossum collects a mouthful of litter and places it between the forelegs. The tail is drawn forward under the body between the hind legs. Using the forefeet, the animal passes the litter back under the body and places it on the tail. The hind legs are then used to press the litter into the curve of the tail which wraps tightly around the material. The process is repeated with five or six mouthfuls of litter before the material is carried to the nest. When an opossum transports the nest material, the tail is held out from the body with as much as three-fourths of the tail holding the material (McManus 1970).

One aspect of opossum behavior that has become a common phrase in our language refers to their attitude of passive defense or pretending to be dead-" playing 'possum." An opossum's first reaction to danger, however, is a bluff-a display of intimidation not usually followed by an attack. Such a display consists of crouching, baring the teeth, hissing, growling, screeching, and possibly emitting the foul-smelling secretion of the anal glands. If the bluff fails, an opossum goes into a cataleptic state, feigning death. The term "catalepsy" refers to a condition of muscular rigidity, in which the body and limbs keep any position in which they are placed, similar to a temporary paralysis. When feigning death, an opossum lies on its side in a curled position, lolls its tongue from open jaws,

and drools. Its eyes may be open or closed, and its respiration is shallow. The death-feigning pose may last from a few minutes to 6 hours. When the danger is past, an opossum slowly raises its head, sniffs, and resumes its activities (McManus 1970).

Food: The opossum is omnivorous, and nothing edible is bypassed. Its diet consists of fruits, berries, earthworms, insects, frogs, snakes, birds, birds' eggs, small mammals, and carrion.

Reproduction: The breeding season extends from about mid-January to mid-October, and females may have two litters a year. The opossum has the shortest known gestation period of any mammal, 12 to 13 days. Just before giving birth, a female becomes restless and begins cleaning the marsupium, the special pouch located on the lower abdomen in which the young are nursed. She licks the genital area as the young are born, and the moisture allows the minute embryos to travel the difficult 3 inches from the genital opening to the marsupium. If the route of travel was not moistened, the moist embryos would stick to their mother's hair and perish. During the journey to the pouch, an embryo uses an overhand stroke. It is aided by well-developed forelegs and sharp, deciduous claws; the latter drop off after the pouch is reached. Once in the marsupium, an embryo must search for and find a teat to which it can attach. There are usually 13 teats, but there may be as few as 11 or as many as 17. Litters usually range from 5 to 13; the average is 9. Although as many as 18 newly born young may reach the pouch, those that cannot find teats will starve (Asdell 1964, Hartman 1952, Jackson 1961).

At birth, an opossum is about the size of a small navy bean, 10 millimeters long and 2.5 millimeters in diameter. It weighs about 0.13 gram. A litter of 16 could easily be placed in a tablespoon (Jackson 1961).

A baby opossum grows rapidly; by the end of the 1st week its weight has increased tenfold. It remains attached to a teat for 60 to 70 days and attains the size of a small house mouse (25 grams). Shortly thereafter, it may leave the pouch occasionally but returns to it for food and protection. The young is weaned when it is between 75 and 85 days old but remains with its mother for 3 or 4 months. Once weaned, it spends little time in the pouch but rides on the mother's back, its small tail entwined around hers or partly around her body, clinging tenaciously to her with its feet (Jackson 1961).

Predation: Although not a predator, the automobile probably takes the greatest toll of opossums in Oregon. People, domestic dogs, and great horned owls also kill opossums.

Economic status: The opossum is not considered economically important. Its fur has little value; however, in the Southeastern United States, it is hunted for its meat. It kills poultry and native birds but also consumes many harmful insects. Opossums are widely used as laboratory animals in research and are occasionally kept as pets, but they become surly and cantankerous when more than a year old.

Diseases: The opossum is an occasional carrier of the parasitic roundworm *Trichinella spiralis* that causes trichinosis in humans. Therefore, opossum meat should be thoroughly cooked before it is eaten.

Selected references: Hartman (1952), Seton (1928).

Order Insectivora: Insect Eaters

Derivation: The ordinal name Insectivora is derived from the Latin words *insectum* (to cut in) and voro (to devour) and refers to the food habits of the group. The term is misleading since the food habits of this group vary widely and include fish, amphibians, mammals, plants, and invertebrates other than insects.

General description: The order Insectivora has been used as a catchall category for some fossil forms and for small, living mammals of generally primitive form, especially those with puzzling characteristics.

Some members (such as certain insectivores) of this group resemble the primitive mammalian type from which most modern mammals have descended.

Insectivores are small mammals. They have long, narrow, flexible snouts and small ears. Their eyes are usually minute and occasionally lack external openings. The body is usually covered with a short, dense pelage composed of only one kind of hair, or sometimes spines.

The teeth are generally primitive in structure. Deciduous teeth (milk or baby teeth) are normally shed early and are seldom functional.

The group is diverse in that its members are terrestrial, fossorial, or semiaquatic. With the exception of some shrews, shrew-moles, and aquatic species, they are primarily nocturnal. Several species have a reputation for consuming enormous quantities of food, but some of the food has little nutrient value.

World distribution: Insectivores occupy all continents except Australia, most of South America, Greenland, and Antarctica.

Fossil record: Insectivores constitute the oldest living group of placental mammals. The fossil record indicates that a variety of generally primitive families of insectivores evolved during the late Cretaceous to the early Cenozoic (Paleocene).

Number of species along the Oregon coast: Nine.

General references: Anderson and Jones (1967), Walker et al. (1968).

Key:

la Claws on front feet conspicuously larger and heavier than claws on hind feet; external ears (pinnae) absent, ear opening merely a hole near the front of the shoulders; tail noticeably constricted at base; teeth white—
TALPIDAE (moles) 2

lb Claws about equal in size on all feet; external ears present; tail not conspicuously constricted at base; teeth tipped with reddish brown pigment-SORICIDAE (shrews). . , ... 4

2a Front feet slightly larger than hind feet, longer than wide, can be rotated and placed under body; tail visibly scaly with scattered hairs, black—*NEÜROTRICHUS GIBBSI* (American shrew-mole), page 64

2b Front feet much larger than hind feet, about as wide as they are long, turned permanently out from the sides of the body; tail almost naked, not visibly scaly, whitish to pinkish—*SCAPANUS* (western American moles) 3

3a Total length, 198 mm or more; hind foot, 23 to 31 mm long—
SCAPANUS TOWNSEND/ (Townsend mole), page 71

3b Total length, 182 mm or less; hind foot, 19 to 23 mm long—
SCAPANUS ORARIUS (coast mole), page 77

4a Hind feet, 19 to 23 mm long, with a fringe of short, stiff hairs on the margins, including the toes; fringe wears down with age and may not be apparent in old individuals; outer edge of each nostril has small, erect, fleshy projections in both young and old individuals (fig. 1), but nasal projections may be difficult to see on museum study skins because of drying; shrew, including face and tail, dark brown, blackish brown, or blackish—*SOREX BENDIREI* (marsh shrew), page 57
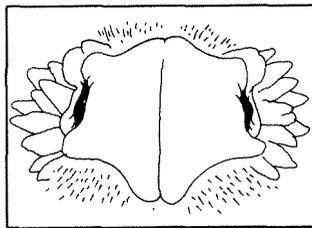
Figure I.-Marsh shrews have small, erect, fleshy projections along the outer edge of each nostril.

4b Hind feet less than 19 mm long, without a fringe of short, stiff hairs on margins; outer edges of nostrils without small, erect, fleshy projections; shrew, including face and tail, some shade of brown; if very dark gray or blackish, then tops of feet whitish or very light tan and bottom of tail whitish. 5

5a Pelage long; summer pelage brownish gray to dark gray dorsally, slightly lighter ventrally; winter pelage dark gray to blackish dorsally, slightly lighter ventrally; tail distinctly and sharply bicolored, brownish gray to blackish above, whitish below; tops of feet whitish, occasionally very light tan—*SOREX TROWBRIDGE!* (Trowbridge shrew), page 60

5b Pelage short; summer pelage light grayish brown or reddish brown dorsally, light gray or reddish brown ventrally; winter pelage dark grayish brown, reddish brown, brown, or dark brown dorsally, light gray, reddish brown, brown, or dark brown ventrally; tail brownish, not distinctly or sharply bicolored; tops of feet light tan, tan, or brown' 6

6a Pelage: dorsum light grayish brown in summer, dark grayish brown in winter, often appearing grizzled because of light-tipped guard hairs-venter light gray, sometimes with an almost silvery sheen; primary habitats are deflation plain, wet pastureland, headland prairie, headland shrub, tideland river—*SOREX VAGRANS* (wandering shrew), page 47

6b Pelage: dorsum reddish brown in summer; reddish brown, brown, or dark brown in winter, not appearing grizzled—venter reddish brown in summer, reddish brown, brown, or dark brown in winter; primary habitats are alder/salmonberry, riparian alder, skunkcabbage marsh, immature conifer, mature conifer 7

7a Occurs from the Columbia River, Clatsop County, south to the vicinity of Oceanlake, Lincoln County—*SOREX OBSCURUS* (dusky shrew), page 50

7b Occurs south of the vicinity of Oceanlake, Lincoln County. 8

8a Occurs from the vicinity of Oceanlake, Lincoln County, south to the vicinity of the Siltcoos River and Siltcoos Lake, Lane County; pigment on front teeth dark, more brown than reddish—*SOREX YAQUINAE* (Yaquina shrew), page 51

8b Occurs from the vicinity of the Siltcoos River and Siltcoos Lake, Lane County, south to Sonoma County, California; pigment on front teeth light, distinctly reddish brown—*SOREX PACIFICUS* (Pacific shrew), page 53

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[1] Because the interrelationships of some species of western shrews are not well understood, they are difficult to classify. Brown shrews are the main problem, so these shrews have been separated by geographical distribution when necessary.

Family Soricidae: Shrews

Derivation: The familial name Soricidae is derived from the Latin word *Soricis* (shrew-mouse) and the Latin suffix *idae* (family).

General description: Shrews are small, short-legged mammals with tiny eyes and long, pointed noses. In fact, the smallest mammal in the world is a species of shrew that weighs about 2 grams as an adult. Shrews cannot see well, but their senses of touch, smell, and hearing are acute. They have a short thick pelage, usually some shade of gray or brown. Some shrews have scent glands on their sides; these are most active during the breeding season. Shrews, except the semiaquatic species, do not have special feet. Semiaquatic species have fringes of short, stiff hairs along the margins of their feet, including the toes; these fringes increase the surface area of the feet, aid the shrews in swimming, and trap air bubbles so that a shrew can actually run on water without sinking. One aquatic species has webbed feet.

Shrews live mainly on the ground. Some are semiaquatic, and a few form burrows. They inhabit a wide variety of habitats from the Arctic to the desert and tropical jungle. Shrews are active throughout the year; some day and night, others only at night.

Extremely sensitive, shrews have died of fright from loud noises, even thunder. People have even tossed hats over shrews running across trails and found dead shrews when they removed the hats.
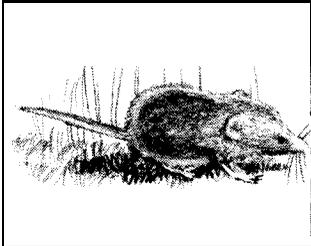
SHREW

Shrews are mainly insectivorous and carnivorous, but some eat seeds, nut meats, and other plant material. Some shrews have a poisonous substance in their salivary glands that immobilizes small prey; humans have been poisoned by the bites of shrews that, although not fatal, cause considerable pain. Shrews eat enormous amounts of food for their size, but the reports of the quantities consumed are sometimes exaggerated. It is generally true, however, that most shrews eat frequently throughout the 24-hour cycle and will starve to death in a few hours if food is not available.

Gestation periods range from 16 to 28 days; there may be one to several litters a year, each consisting of 2 to 10 young. Babies are born naked and blind in a nest loosely constructed of dried grasses or leaves in a secluded place. Deciduous teeth are shed before birth, and babies are born with a set of permanent teeth. Most shrews are weaned at 2 to 4 weeks. The bones in the cranium or skull fuse early in life, forming a more or less solid bone. The lifespan of a shrew in the wild is about 72 to 18 months but may be longer.

World distribution: Shrews inhabit all major land areas except the arctic islands, Ungava, Greenland, Iceland, the West Indies, Antarctica, Australia, Tasmania, New Zealand, and most of the Pacific islands. Shrews are found only in the most northern part of South America.

Fossil record: In North America, the fossil record of shrews dates to the early Oligocene.

Number of species along the Oregon coast: Six.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus *Sorex:* Long-tailed shrews

Derivation: The generic name *Sorex* is a Latin word meaning shrew.

General description: Shrews of the genus *Sorex* have slender, delicate bodies with long, slender, highly flexible snouts. Pelages are light in summer and dark in winter. Varying from tan to black, they may have one, two, or three colors. Tails of young animals are hairy, but those of old ones are usually naked. The length of the tail accounts for a third to more than half the total length of an animal. The eyes of shrews are minute but visible, and the ears protrude slightly beyond the fur. The teeth are tipped with a reddish brown, brown, or purplish pigment in young and middle-aged animals, but because of constant use of the teeth, old individuals frequently lack such pigment. Mature males have visible scent glands on their sides. Females have three pairs of teats. Young are born in nests-naked, blind, and helpless. Adults lead solitary lives and are active throughout the year. Shrews of the genus *Sorex* have a lifespan rarely exceeding 16 months. Most shrews die before they are 12 months old, or shortly after the breeding season (Rudd 1955). Even as adults, these shrews continue to grow slowly until they die. Many shrews lose their lives in bottles and beverage cans, discarded along roads and trails, because they are unable to crawl out of them.

World distribution: There are about 40 species of *Sorex* inhabiting the Northern Hemisphere, south to Central America in the New World, and south to Israel, Asia Minor, Kashmir, and northern Burma in the Old World.

General reference: Walker et al. (1968).

Species *Sorex vagrans:* Wandering shrew

Derivation: The specific name *vagrans* is the Latin word for "wandering" or "unsettled."

Specific description: Total length, 95 to 119 mm; tail, 34 to 51 mm; hind foot, 11 to 14 mm; ear, 8 to 11 mm; weight, 3 to 8.5 g.

Wandering shrews have relatively short fur that varies dorsally from a light grayish brown in summer to a dark grayish brown in winter. Summer pelages have light-tipped guard hairs that may make the backs of these shrews appear grizzled. The darker winter pelages usually lack these hairs. The undersides are usually light gray and sometimes have a silvery sheen, but the undersides of some are washed with light brown. The tops of the feet vary from tan to brown. The hairy tails of young animals are indistinctly bicolored, brownish above and tannish below, darker at the tips. The naked tails of old animals are brown, indistinctly bicolored, and darkest at the tips. Pigment on the incisors is dark reddish brown.

Distribution along the Oregon coast: Wandering shrews occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Wandering shrews occupy the deflation plain, wet pastureland, headland prairie, headland shrub, and tideland river habitats.

Habits: Wandering shrews are active day and night. Along the Oregon coast they mainly travel the runways of other small animals, especially microtus voles ("meadow mice"). These shrews appear to be intolerant of one another, except when they breed. They usually avoid each other. I have, however, heard squeaking under the grasses and observed one shrew chasing another in a meadow. Mutual avoidance and defense of nests may facilitate spacing of individuals in the wild, and such spacing may be a function of the frequency of an individual's contact with strangers (Eisenberg 1964). When contacts are frequent, an animal tends to shift its area of activity. Home ranges of 11 wandering shrews varied from 24 to 834 square meters, whereas the average size was calculated to be 372 square meters (Ingles 1961a). Home ranges of wandering shrews appear stable. Some spacing of individuals is achieved even though their home ranges greatly overlap (Eisenberg 1964).

Wandering shrews build their nests in burrows or under logs, boards, or large pieces of bark. Nests are usually composed of dry grasses, leaves, or mosses. These nests appear to be balls of whatever materials were used in their construction. Nests used as nurseries are usually made of finer materials than those used only as sleeping quarters by adults. When a wandering shrew builds its nest, it collects material with its mouth and transports the material to the chosen site. If the material is dropped, the shrew continues empty mouthed directly to the nest before seeking more. When a pile of material has been accumulated, the shrew rapidly arranges the litter around itself by grasping pieces with its mouth and tucking them under and alongside its body. Periodically, the animal may dig into the floor of the nest, forcing material to the rear or side. The shrew turns constantly and thereby forms a cup, the sides of which may eventually meet and create a roof over the animal (Eisenberg 1964).

Food: Wandering shrews eat primarily invertebrates, but they also feed on small amphibians and dead mammals and birds when available. These shrews exhibit relatively consistent behavioral patterns during feeding. For example, when confronting an earthworm a shrew usually explores the worm, then suddenly and viciously attacks it, biting the worm several times along its body. The writhing of the injured worm may elicit another attack, or the shrew may wait until the worm tries to crawl away, then renew its attack. After several attacks, the worm's reactions slow and the shrew starts eating one end of the worm, biting and pulling off small pieces. At times a worm may be chewed into three or four pieces of about equal length to be stored for a future meal. A shrew uses the same general tactics when attacking a small slug. After biting a slug, however, the shrew moves away, pats its forepaws on the soil, and wipes its snout with the forepaws to remove the mucus obtained from contact with the slug. Once a slug is immobilized, the shrew drags it to a selected site and eats it. Grasshoppers, on the other hand, are bitten in the neck. A grasshopper is then chewed open along its underside and the soft body parts eaten; the hard external skeleton of the insect is left as refuse. Shrews eat dead birds and mammals by biting and chewing and pushing with the forefeet

against the carcass while tossing the head up and down and from side to side. If a wandering shrew drops its food on the way to a storage site, it continues to the site before returning to locate the dropped food (Eisenberg 1964, Maser 1966a).

Since wandering shrews have high energy requirements, they spend most of their active time searching for food. Broadbooks (1939) wrote about the amount of food consumed by a wandering shrew in 24 hours:

> The average weight of food taken. . . for a period of eight days was 8.36 grams per day or 1.29 times its own weight. The greatest amount consumed was 12.3 grams of food or nearly twice the body weight; the least was 4.2 grams or 0.65 times its own weight. The highest average amount eaten during. . . three days was 10.95 grams or 1.68 times the shrew's weight.

To equal the shrew's food consumption, a 68-kilogram human would have to eat 114 kilograms of food a day. The mutual avoidance behavior of these shrews therefore apears beneficial in conserving energy that might otherwise be expended in fighting (Eisenberg 1964), as well as in limiting competition for a given food supply.

Whitaker and Maser (1976) found 30 categories of food in the diet of wandering shrews, such as centipedes, spiders, snails, bugs, beetles, and subterranean fungi.

Reproduction: Reproductive activity in male wandering shrews occurs primarily from late January through early April in western Oregon. A few males with maximum size testes have been found in November. Most pregnant females were caught in March and April, but a few pregnant or lactating females were trapped in September. Litters range from two to nine (Clothier 1955), but four to six is the usual size. Most females have one litter per year. The gestation period is about 20 days. A wandering shrew weighs about 0.5 gram at birth. From birth until 1 month old, the shrew gains weight rapidly and constantly. At 1 week, wandering shrews are naked and their eyes closed. In 2 weeks their backs are furred and their eyes open, but their teeth have not erupted. Females start to wean their young at about 16 days and finish weaning them about the 25th day. The major activity of the nestlings is huddling together, which conserves body heat. They remain in the nest about 1 month (Johnson and Rudd 1957).

Predation: Owls are probably the main predators of wandering shrews. Along the Oregon coast, the remains of wandering shrews have been found in the droppings of bobcats (Nussbaum and Maser 1975). Domestic cats kill these shrews but seldom eat them. The rubber boa preys on them.

Economic status: Wandering shrews are beneficial in their destruction of large quantities of insects, slugs, and other invertebrates.

Selected reference: Hooven et al. (1975).

Species *Sorex obscurus:* Dusky shrew

Derivation: The specific name *obscurus* is the Latin word for "dusky." The first specimen of the only subspecies of dusky shrew, *bairdi*, along the Oregon coast was captured at Astoria, Clatsop County, Oregon, on August 2, 1889.

Specific description: Total length, 118 to 137 mm; tail, 48 to 63 mm; hind foot, 14 to 16 mm; ear, 9 to 11 mm; weight, 5.5 to 12.5 g.

In summer the dorsal pelage is short and reddish brown. The underside is slightly lighter and not as red. The pelage is longer in winter than in summer and varies from medium brown to dark brown. The undersides are correspondingly darker. The tops of the feet vary from tan to brown. The hairy tails of young animals are indistinctly bicolored. In summer they are brown above and slightly lighter below, whereas in winter they range from medium brown to dark brown above and slightly lighter below. The naked tails of old animals are brown, indistinctly bicolored, and darkest at the tips. Pigment on the incisors is dark reddish brown.

Distribution along the Oregon coast: The dusky shrew occurs from the mouth of the Columbia River, Clatsop County, south to Oceanlake, Lincoln County.
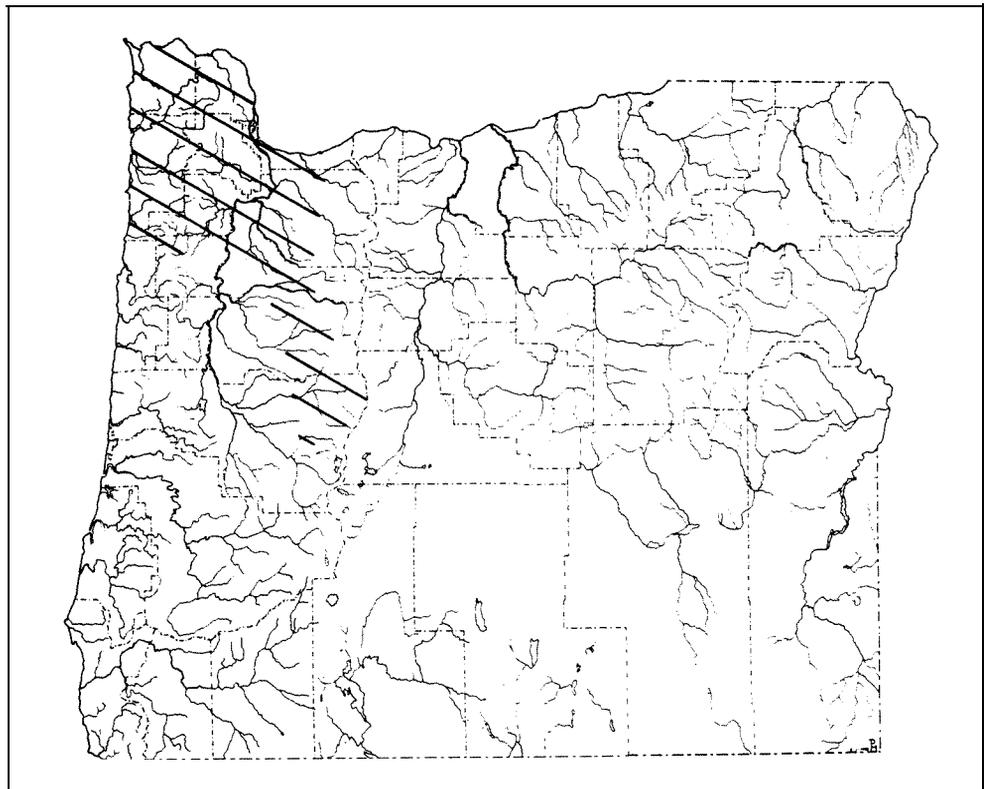
KNOWN DISTRIBUTION OF DUSKY SHREW

Habitat: The shrews occupy the mature conifer (Douglas-fir variant), immature conifer, alder/salmonberry, riparian alder, and skunkcabbage marsh habitats. Bailey (1936) said they were also found along the beach under driftwood shaded by alder trees. The fact that these shrews were captured on the beach may be attributed to the proximity of the alder/salmonberry habitat as indicated by Bailey's mention of "alder."

Habits: Little is known about the habits of these nocturnal shrews. Like other shrews inhabiting the coniferous forests of the Pacific Northwest, they are usually caught in moist areas along streams, under logs, and in thick vegetation of seepages.

Food: The food habits of the dusky shrew along the Oregon coast are probably similar to those of the Yaquina shrew that occupies the same type of habitat.

Reproduction: Not much is known about the reproduction of the dusky shrew in western Oregon. Sexually mature males have been trapped as early as February and as late as July. Sexually active females have been captured in July and September. Litters range from four to six, but four is most frequent.

Predation: Owls are probably the main predators of dusky shrews. Along the Oregon coast, domestic cats kill many of these shrews but seldom eat them. I have found that the long-tailed weasel will occasionally eat them.

Economic status: The vast number of invertebrates consumed annually by these shrews makes them beneficial.

Species *Sorex yaquinae:* Yaquina shrew

Derivation: The specific name *yaquinae* is a proper name. "Yaquina" was the name of a small tribe of Indians. The individual on which the description of the species is based was captured at Yaquina Bay, Newport, Lincoln County, Oregon, on July 18, 1895.

Specific description: Total length, 712 to 143 mm; tail, 41 to 64 mm; hind foot, 13 to 17 mm; ear, 9 to 12 mm; weight, 5.5 to 15 g.

In summer the dorsal pelages of Yaquina shrews are short and reddish brown. The undersides are slightly lighter and not as red. Pelages are longer in winter than in summer and vary from medium brown to dark brown. The undersides are correspondingly darker. The tops of the feet vary from tan to brown. The hairy tails of young animals are indistinctly bicolored. In summer they are brown above and slightly lighter below; in winter they range from medium brown to dark brown above and are slightly lighter below. The naked tails of old animals are brown, indistinctly bicolored, and are darkest at the tips. The pigment on the incisors is dark reddish brown.
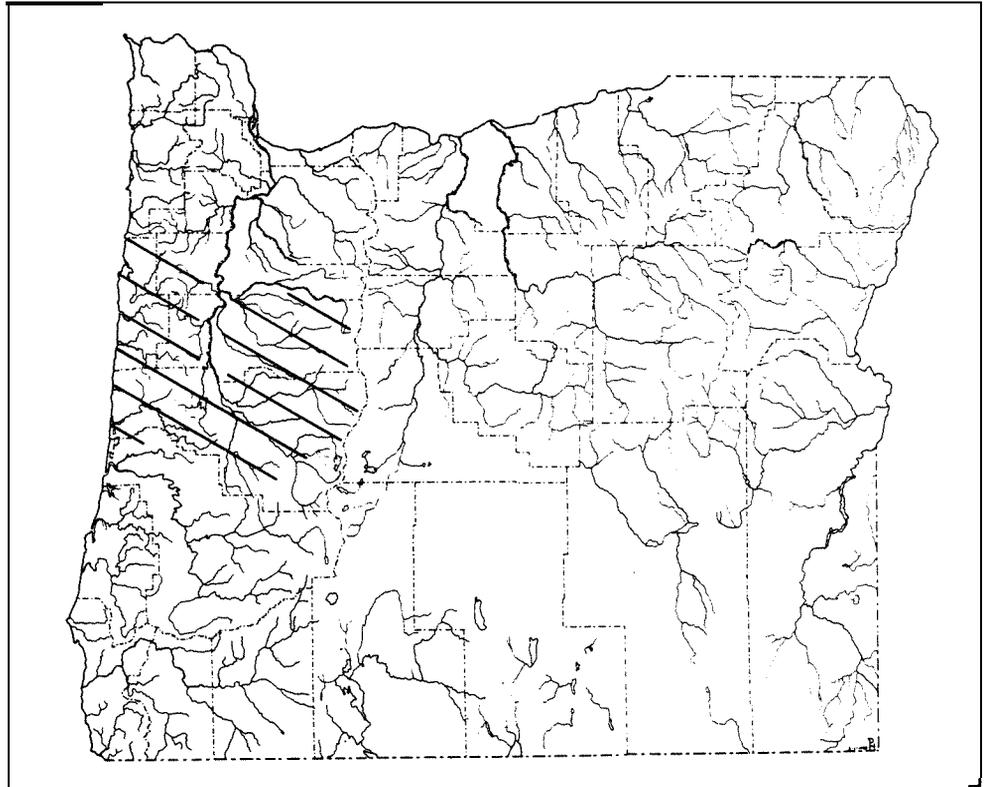
KNOWN DISTRIBUTION OF YAQUINA SHREW

Distribution along the Oregon coast: Yaquina shrews occur from the vicinity of Oceanlake, Lincoln County, south to the Siltcoos River and Siltcoos Lake, Lane County.

Habitat: Yaquina shrews occupy primarily the alder/salmonberry, riparian alder, and skunkcabbage marsh habitat; they are less often found in the mature conifer (Douglas-fir variant) and immature conifer habitats.

Habits: Little is known about Yaquina shrews. They are nocturnal and do not seem to be particularly numerous in any area.

The movements of a captive Yaquina shrew were rapid; when in motion it emitted an almost constant, high twitter. Its nest was constructed of small pieces of dead fern.

Food: The captive shrew ate earthworms, sowbugs, pillbugs, ground beetles, leaf beetles, native roaches, millipedes, centipedes, and terrestrial snails of one species. When given a freshly killed deer mouse the shrew immediately chewed the skull open and ate the brain. It also chewed a hole in the chest of a Townsend vole and ate the heart and lungs. Whitaker and Maser (1976) found 30 categories of food in the diet of the Yaquina shrew, such as beetles, bugs, larval flies, snails, and underground fungi. Moore (1942) and Kangur (1954) stated that shrews in western Oregon consume the seeds of Douglas-fir, but they failed to say which

species of shrew. Since the stomachs of live-trapped Yaquina shrews occasionally contain some rolled oats used as bait, it is possible that these shrews eat the seeds of Douglas-fir.

Reproduction: Reproductive activity in male Yaquina shrews appears to begin in late February and to last through August. Most of the males with mature testes were caught in April; however, a few were trapped in May, June, and August. Although most reproductively active females were captured in March, one was found in June and another in August. Litters range from three to four, but four is most frequent.

Predation: Owls are probably the main predators of Yaquina shrews. Along the Oregon coast, domestic cats kill many of these shrews but seldom eat them.

Economic status: Yaquina shrews may eat seeds of Douglas-fir, but the numbers of invertebrates that they annually consume makes these shrews more beneficial than detrimental.

Species *Sorex pacificus:* Pacific shrew

Derivation: The specific name *pacificus* is the Latin word for "peace making" or "peaceable." The name refers to the proximity of this species to the Pacific Ocean. The first Pacific shrew to be captured, the one on which the description of the species is based, was taken at the mouth of the Umpqua River, Douglas County, Oregon, about 1858.

Specific description: Total length, 135 to 160 mm; tail, 52 to 71 mm; hind foot, 15 to 18 mm; ear, 8 to 13 mm; weight, 10 to 18 g.

The Pacific shrew is the second largest shrew on the Oregon coast. In summer the pelages are short and distinctly reddish brown. Winter pelages are relatively long and dark reddish brown to dark brown. Pelage undersides are almost uniform in color, both in summer and in winter. The feet are noticeably pale, usually tan or light brown. The tails are also noticeably pale, both in young and old animals. Tails are either unicolored or indistinctly bicolored. Usually tan, they may be brown. There may be a slight darkening toward the tips of the naked tails of old animals. The pigment on the incisors is light and distinctly reddish brown.

Distribution along the Oregon coast: The Pacific shrew is primarily a coastal mammal and occurs from the vicinity of the Siltcoos River and Siltcoos Lake, Lane County, south into northwestern California.

Habitat: Pacific shrews occupy the alder/salmonberry, riparian alder, and skunkcabbage marsh habitats; they are less often found in the mature conifer and immature conifer habitats.
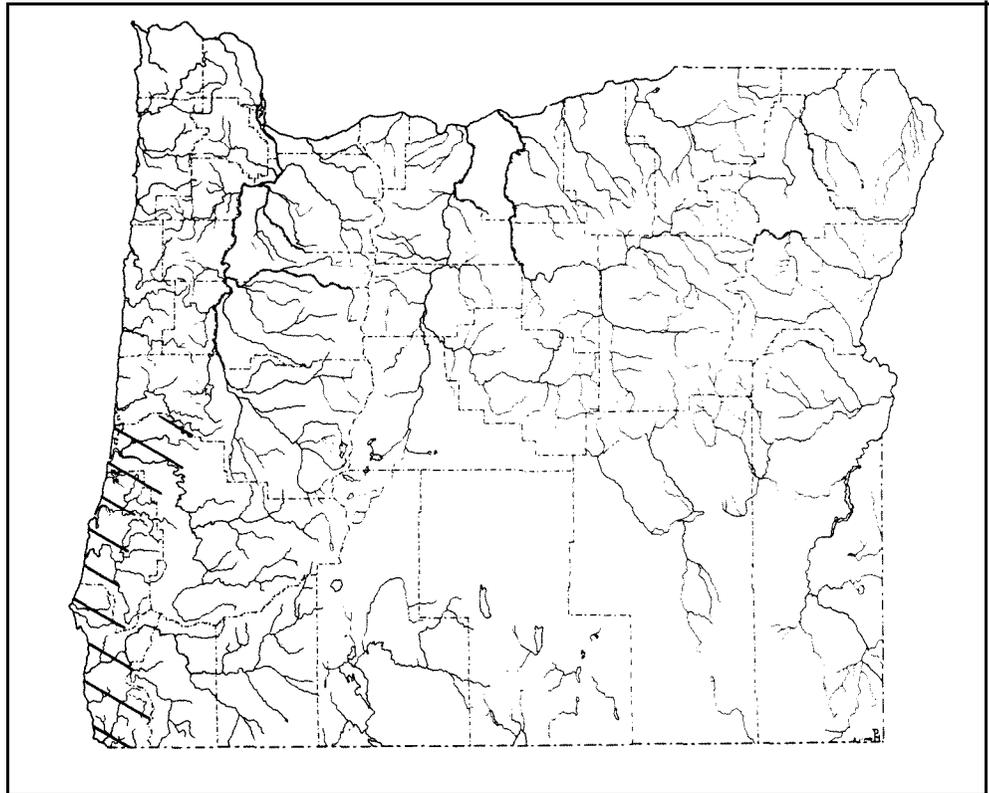
KNOWN DISTRIBUTION OF PACIFIC SHREW

Habits: Pacific shrews are nocturnal. They are quick and almost continuously twitch their noses and emit twittering sounds. As with other forest-dwelling shrews, shelter is important, and a shrew becomes disturbed when shelter is not available. In the wild, these shrews are seldom found far from protective cover, such as logs or thickets of vegetation.

Little is known about the habits of Pacific shrews in the wild. The following discussion of their habits is based on a study by Maser and Hooven (1974) of three captive animals.

In captivity, nests were composed of vegetation, such as grasses, mosses, lichens, or leaves. The shrew collected the material with its mouth, carried it to the selected site, and piled it. When the shrew could not pull a piece of vegetation free, it would tug at it and, if necessary, bite it in two and carry the free part to the nest site. After accumulating enough material, the shrew pushed its way into the middle of the pile. It used its mouth to grasp pieces of nest material and rapidly tuck them around, over, and under itself. The turning and rummaging in the nest by the shrew shaped the material into a cup and eventually also a roof as the sides of the nest were pushed up.

The shrews groomed frequently and at any time, except while hunting. The grooming was performed in a crouched position, except when the anal-genital area was cleaned. The usual grooming behavior was rapid scratching with one hind foot that was licked clean as soon as scratching ended. The tail was cleaned orally while held with the forefeet. When cleaning the anal-genital area, a shrew lies on its side, turns its head around, and licks, often for 2 minutes.

The shrews slept most of the day, waking periodically to eat food cached next to the nest. A shrew entered and arranged the nest when ready to sleep. Grooming always preceded sleeping. When sleeping, the shrew's head was curled underneath its body, nose close to the anus. The hind feet rested on the shoulders, and the tail was either curled around the body or stretched out behind. Such a sleeping position may have survival value; the exposed surface area is reduced and less body heat is lost. When disturbed, a shrew can move to another area so swiftly that the movement is difficult to see; thus, an individual may escape predators.

Urination and defecation were performed in a corner of the cage during a slight pause in other activity but were not observed while a shrew was hunting. The type of feces excreted depended on the source of food; snails and slugs caused soft feces, and earthworms caused soft and muddy feces. After a meal of earthworms, a shrew would pause, lift its tail, and squirt into a corner of the cage. When a shrew had eaten insects, centipedes, and millipedes, the feces contained much of the hard, chitinous, external skeleton of the prey; the shrew would then drag its anus on the ground after defecation which may have aided cleaning.

The shrews developed a habit of licking the corner of the cage in which they defecated and urinated. During such activity, some of the feces were undoubtedly reingested which, according to Walker et al. (1968), may be how they obtain vitamins B and K.

Food: The following account of the hunting and feeding behavior of Pacific shrews is from Maser and Hooven (1974). A captive shrew hunted by odor, or sound or both. Nonflying prey was hunted primarily by odor. When the shrew came across the fresh trail of a beetle, it followed every twist and turn that the beetle had made-much like a hunting dog tracking its quarry, with its nose to the ground. Locating the beetle, the shrew immediately attacked. If the beetle had burrowed into the substrate, the shrew would usually force its way, head first, after the beetle until the prey was captured. Less often, the shrew dug out the prey; it dug with the forefeet and kicked excess debris out of the way with the hind feet. If there was no evidence of prey on the surface of the substrate, the shrew searched within the substrate, usually by forcing its way into the litter to investigate. When it located the prey, the shrew usually shoved its way through the substrate, following the prey until it was captured. Occasionally, a shrew reverted to digging or used both methods to capture the prey.

When flying prey, such as dragonflies, crane flies, moths, or butterflies, were put into the cage, the shrew apparently found them through its acute sense of hearing. Except for a bee or wasp, the shrew chased the prey around the cage with incredible quickness and often jumped into the air, occasionally capturing the prey in flight. Frequently, it jumped and grabbed the alighted prey from the sides of the cage and fell back with the prey in its mouth. If the prey landed on the substrate, the shrew simply pounced on it and usually pinned it down by placing the forefeet on the prey's wings.

A shrew either ate the prey at the site of capture or buried it in a cache next to, within, or under the nest. To bury the prey, the shrew pulled nest material over the prey with its mouth and pushed the material into place with its nose. Whether the prey was eaten immediately or stored, it seldom was killed outright but rather was immobilized. The more dangerous types of prey, such as scorpions, bees, and wasps, were usually killed immediately.

The number of individual prey that were immobilized and stored at any given time varied greatly. For example, a shrew was given 16 flightless tiger beetles; it immobilized and cached 2 or 3 and then repeated the procedure with 2 or 3 more. When 20 crickets were placed into the cage, however, the shrew immobilized and cached them all. If a shrew had just eaten and was not hungry, it often ignored prey that wandered past its nose. Since Pacific shrews are nocturnal, immobilizing and storing prey allows a shrew to have a supply of fresh food available during the day.

The shrews ate a wide variety of invertebrates; the only invertebrate that they would neither touch nor eat was the blister beetle (family Meolidae). In addition to invertebrates, the captive animals ate freshly killed frogs, small birds, and mice. Whitaker and Maser (1976) found that wild Pacific shrews ate 29 types of food, including slugs, snails, centipedes, small amphibians, subterranean fungi, and some vegetation.

Reproduction: Sexually mature male Pacific shrews have been trapped throughout the year. Sexually active females have been trapped as early as April and as late as November; most were caught in June, July, and August. Litters range from two to six, but four or five is the usual size.

Predation: Owls are probably the main predators of Pacific shrews. Along the Oregon coast, domestic cats kill many of these shrews but seldom eat them. In addition, the Pacific giant salamander captures and consumes these shrews.

Economic status: Even though Pacific shrews may eat seeds of Douglas-fir, the numerous invertebrates that they destroy make these shrews more beneficial than detrimental.

Species *Sorex bendirei:* Marsh shrew

Derivation: The specific name *bendirei* is a proper name; this species was named in honor of Army Major Charles E. Bendire who captured the first specimen on August 1, 1882, about 1.6 kilometers from the Williamson River, 28.8 kilometers southeast of Fort Klamath, Klamath County, Oregon. The first specimen of the subspecies of marsh shrew, *palmeri,* the only subspecies along the Oregon coast, was collected at Astoria, Clatsop County, Oregon, on July 29, 1889.

Specific description: Total length, 145 to 185 mm; tail, 62 to 84 mm; hind foot, 19 to 23 mm; ear, 7 to 15 mm; weight, 14 to 25 g.

MARSH SHREW

Marsh shrews are the largest species of the genus *Sorex* in North America. Dorsally they are dark brown, blackish brown, or blackish and their undersides only slightly lighter; there is little difference in color between summer and winter pelages. The tops of their feet vary from brown to dark brown. The hairy tails of young animals are unicolored, almost the same color as the pelage. Although the naked tails of old shrews are also unicolored, they are a lighter shade of brown. In addition to their large size, marsh shrews can be distinguished from other shrews along the Oregon coast by the fringe of short, stiff hairs on the margins of the feet, including the toes.

The fringe, usually called "swimming fringe," is most noticeable on young animals. It appears to sustain much wear during the life of the animal and is not replaced by new hair in old animals (Borowski 1964). The swimming fringe, therefore, is not so apparent on old marsh shrews. Another characteristic of marsh shrews is the small, erect, fleshy projections along the outer edge of each nostril (fig. 1). These projections remain conspicuous even in old animals. The pigment on the incisors is dark reddish brown.

Distribution along the Oregon coast: The marsh shrew occurs along the entire coast.

Habitat: Along the Oregon coast, marsh shrews occupy the riparian alder/small stream and skunkcabbage marsh habitats. During the wet winter, there is a tendency for marsh shrews, particularly the young of the year, to disperse.

Habits: The marsh shrew is one of the least studied shrews of the genus in North America. These shrews appear to be primarily crepuscular and nocturnal, but they are occasionally seen and trapped during the day.

Little is known about their habits in the wild, so the following discussion is based on a study by Pattie (1969) of two captive animals. The shrews usually entered the water from a sloping surface. In the water, they would scull quickly around the surface. Their submergence was rapid; under water they used their snouts and whiskers to explore. The longest swimming period observed was 3% minutes. While swimming, the shrews' hind legs were in almost constant motion, except when the animals paused to surface. Under water, most of the propulsion was provided by the hind legs that were used alternately, not simultaneously like a
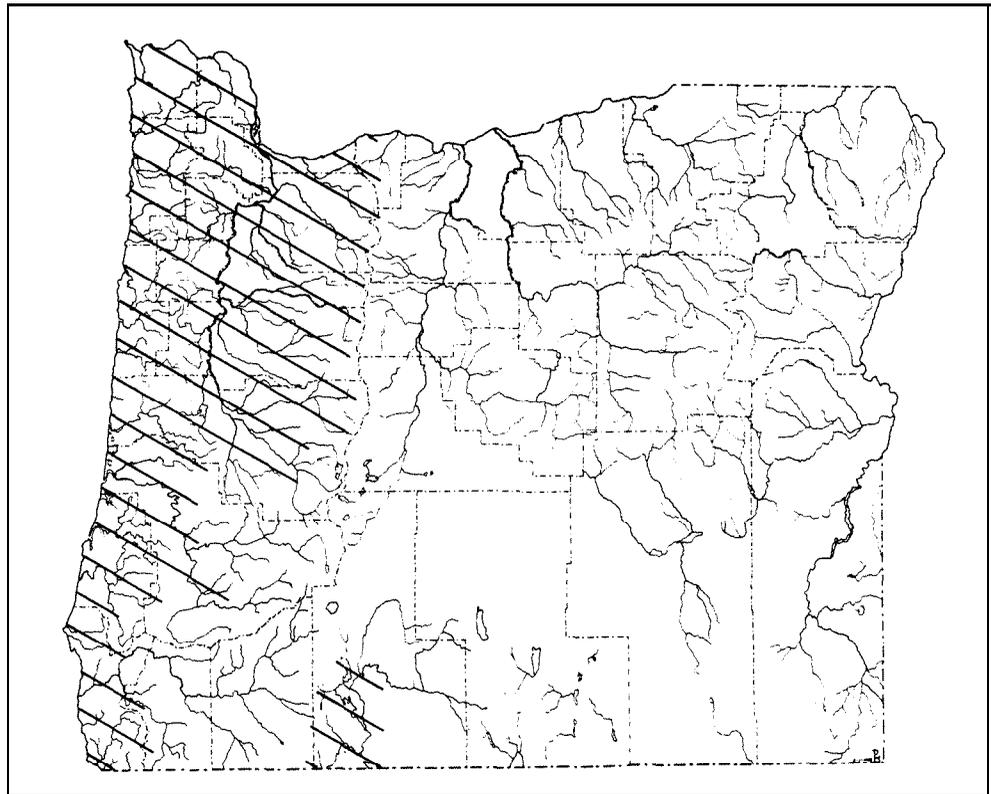
KNOWN DISTRIBUTION OF MARSH SHREW

frog's The front legs were occasionally used when the shrews were submerged, but they were more frequently used when the shrews' heads and backs were above the surface. Occasionally, the shrews actually ran on the water for as long as 5 seconds with their venters above or barely touching the surface. The shrews' fur trapped air that gave them not only buoyancy but also a silvery appearance. Their progress under water could be followed by the small bubbles that rose in their wake. To leave the water, the shrews would spring 5 to 7.5 centimeters from the surface, grasp solid substrate with their claws, and climb out. Marsh shrews apparently spend much time in the water.

As with other shrews, marsh shrews appear to deposit their feces on smooth surfaces if any are available. Defecation occurred infrequently and during short pauses from other activity. The feces had a tarlike consistency.

The nest of a marsh shrew was found under the loose bark of a fallen Douglas-fir tree that spanned a stream. It was composed of shredded bark fibers.

Food: In the wild, marsh shrews consumed 26 types of food. They fed on aquatic insects, such as nymphal stoneflies, mayflies, and alderflies. Other prey taken along the water's edge included phantom crane flies, ground beetles, snails, slugs, spiders, and harvestmen or daddy-longlegs (Whitaker and Maser 1976).

The following account of the food habits of two marsh shrews is from Pattie (1969). Marsh shrews attacked earthworms viciously with swift series of bites along their bodies. Large worms were usually eaten from the posterior to the anterior; small worms were consumed from either end. Worms encountered under water were attacked, seized with the jaws, and carried to land before they were eaten. They were the only prey observed to be stored. They were immobilized by rapid series of bites along their bodies and carried to the storage area. The worms were always moved out of water and away from the place of encounter, but when stored, they were neither covered nor concealed.

The captive marsh shrews also ate sowbugs, spiders, centipedes, and termites. About termites, Pattie (1969, p. 30) stated:

> Pieces of rotten wood with occupied termite galleries were torn apart by the use of the teeth. No manipulation with the paws other than serving to brace against the wood was observed. The long nose was pushed far into termite tunnels and both shrews worked at a frenzied pace extracting termites.

Normal swimming was greatly accelerated when the nose or whiskers contacted living prey. When prey was located, normal submergence time was often doubled. Not all aquatic animals were eaten, however; small crayfish were ignored, and a small goldfish was pursued, bitten, and killed but not eaten.

When the two shrews fed on opposite ends of the same worm and their noses met, a quick, short scuffle resulted, accompanied by twittering. These short scuffles over food were the only type of antagonism noted between captives. A feeding shrew ignored the cage mate, but when the feeding shrew was contacted, the cage mate inserted its snout into the feeding shrew's mouth in what appeared to be an effort to take away the food.

Reproduction: Information on the reproduction of marsh shrews is scarce. Sexually active males have been collected as early as February and as late as August. One litter was found in March (Pattie 1969), and sexually active females have been trapped in May, June, and July. Available data on litter size indicate a range of three to four; four is most frequent.

Predation: Nothing is known about the predation of marsh shrews, but some likely fall prey to owls, domestic cats, Pacific giant salamanders, and larger fish.

Economic status: Marsh shrews probably either are of no economic importance or are wholly beneficial because of the large number of invertebrates consumed annually.

Species *Sorex trowbridgei:* Trowbridge shrew

Derivation: The specific name *trowbridgei* is a proper name. The first specimen was caught at Astoria, Clatsop County, Oregon, on June 10, 1855. It was sent to the United States National Museum by W. P. Trowbridge, in whose honor it was named.

Specific description: Total length, 108 to 139 mm; tail, 47 to 67 mm; hind foot, 12 to 15 mm; ear, 7 to 13 mm; weight, 3 to 9 g.

Trowbridge shrews have long, lax fur. In summer their dorsal pelages are a relatively uniform brownish gray and are slightly lighter ventrally. Winter pelages vary from dark gray to blackish dorsally and are slightly lighter ventrally. During spring and fall molts, distinct areas of lighter and darker fur are readily visible on the backs and sides of these small shrews. The tops of the feet range from whitish to very light tan. The hairy tails of young animals are distinctly and sharply bicolored, brownish gray to blackish above and whitish below. The naked tails of old individuals are also distinctly and sharply bicolored; however, they are lighter than the fur, ranging from light brown to brown. The pigment on the incisors is dark reddish brown.

Distribution along the Oregon coast: Trowbridge shrews occur along the entire coast.
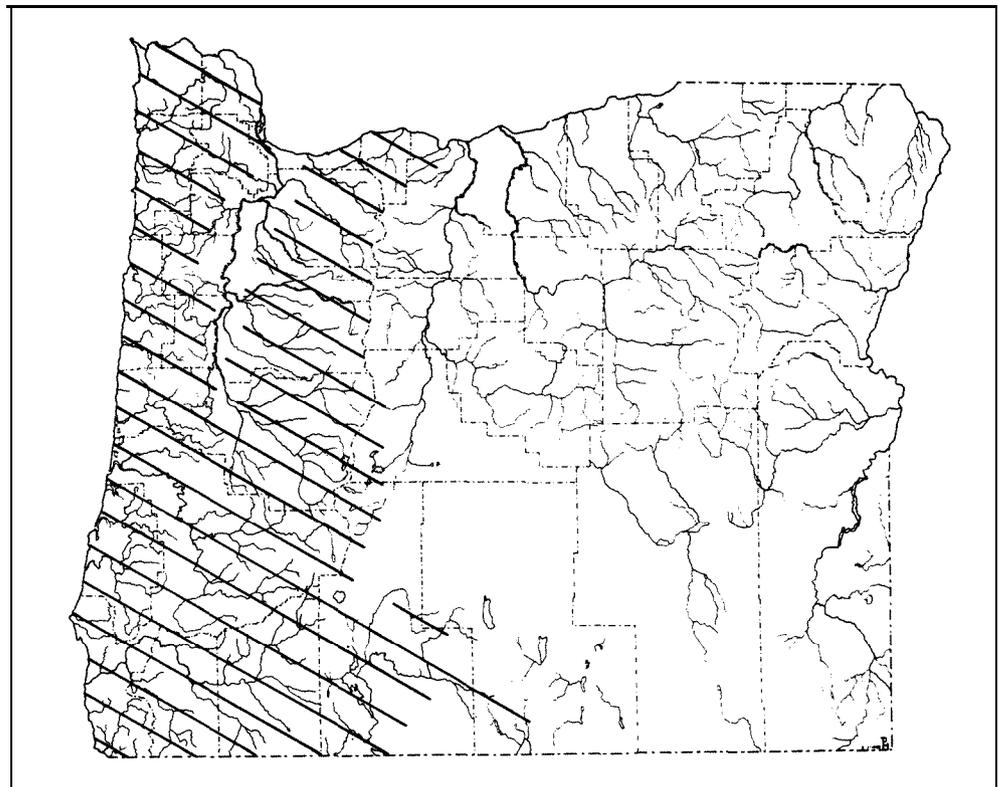
KNOWN DISTRIBUTION OF TROWBRIDGE SHREW

Habitat: These small shrews occupy the mature conifer, immature conifer, alder/salmonberry, riparian alder, riparian hardwood, lodgepole pine/rhododendron, lodgepole pine/salal, Sitka spruce/salal, cedar swamp, mountain river, and, occasionally, tanoak habitats.

Habits: Trowbridge shrews are forest dwellers and usually nocturnal. They become active on the forest floor late in the evening and are the most commonly captured species of shrew. As with other shrews, Trowbridge shrews are usually associated with some type of protective cover, such as logs or thickets of vegetation, but they are occasionally caught in unprotected areas. These shrews, when compared with other western Oregon shrews, occupy not only the greatest variety of habitat types but also habitats that range from the wettest to the driest. Dalquest (1941, 1948) stated that, to him, Trowbridge shrews appeared to be "slower-moving and less aggressive" than wandering shrews, *Sorex vagrans*. He also said that population studies showed that Trowbridge shrews were unable to compete with wandering shrews in ravines and he found them difficult to maintain in captivity. Although in recent years the maintenance of captive animals has been more successful, these little shrews are the most sensitive of the western Oregon shrews.

Food: Jameson (1955) studied the stomach contents of 73 Trowbridge shrews trapped throughout the year in California. He found that they ate a wide variety of insects during all months. Centipedes and spiders were eaten in December and earthworms in the fall and winter. In addition, two shrews had eaten planarians, a type of nonparasitic, aquatic flat worm. Whitaker and Maser (1976) found Trowbridge shrews to be the most adaptable shrews in western Oregon. These shrews consumed 47 types of food, including beetles, bugs, larval flies, centipedes, spiders, snails, and underground fungi.

Alcorn (1958, p. 40) watched a shrew, thought to be a Trowbridge shrew, pursue a bumblebee:

> The bee seemed unable to get a clear flyway for escape in the brushy ground cover and was closely pursued by the squeaking shrew. The shrew was unable or unwilling to secure a firm hold on the loudly-buzzing bee during several contacts. The battle continued perhaps for ten minutes, until at last the bee managed to find an opening in the foliage and escaped. Thereupon, the shrew ran about frantically squeaking and sniffing and finally disappeared in the brush.

Moore (1942) indicated that the stomachs of 14 Trowbridge shrews trapped in coastal Oregon contained over 60 percent plant material, and Jameson (1955) found unidentified seeds in the stomachs of 4 Trowbridge shrews trapped in winter. Of the western Oregon shrews, Trowbridge shrews are the most likely to consume coniferous tree seeds. Over several years, I caught hundreds of these shrews in western Oregon in live-traps baited with rolled oats and oatmeal. When I examined the stomach contents of the captured shrews, I found that almost all contained oatmeal. Compared with other shrews that I have trapped in western Oregon, Trowbridge shrews were the only ones consistently found to have eaten the bait.

Reproduction: In Oregon, sexually active male Trowbridge shrews have been captured from January to November; most, however, were trapped from February through April. Sexually active females have been collected from February to November, but most were caught in March and April. Litters range from one to six, but usually from three to four.

According to Jameson (1955), who studied 366 Trowbridge shrews in California, their breeding season appeared to begin and end earlier than did the breeding season of some other species of shrews. He noted that they matured rapidly in February when there was a coincidental increase in weight and sudden development of the reproductive organs. The males seemed to attain sexual maturity about 2 weeks before the females. The earliest Jameson found a pregnant shrew was February 25; all other pregnancies were observed in April or May. Breeding activity decreased the latter part of May, and reproduction ended in June for most individuals, At this time their reproductive organs shrank and became nonfunctional. One male and one female, however, were found to be reproductively active in early August.

Jameson (1955) found five embryos to be the mean offspring per female but found that litters ranged from one to six. His data indicated that more than one litter per breeding season was probably a common occurrence in Trowbridge shrews. He stated (p. 345) that "two or three litters produced successively might compensate for the rather short breeding season and general lack of reproductive activity during the summer."

After May, the proportion of adult to immature shrews dropped rapidly, and the population turnover was completed by late summer. Less than 2 percent of the 165 adult shrews were caught later than August. Perhaps the drastic decrease of adults is because their badly worn teeth make eating difficult. "Some workers have suggested that the disappearance of adults is an illusion caused by the dilution of the population with young animals, but it is quite apparent that in *trowbridgii* there is a very real and sudden decrease of adults in late spring and early summer" (Jameson 1955, p. 342).

Predation: Owls are probably the main predators of Trowbridge shrews. Along the Oregon coast, domestic cats kill many of these shrews but seldom eat them. The remains of Trowbridge shrews have also been found in stomachs of Pacific giant salamanders.

Economic status: Although Trowbridge shrews probably destroy seeds of Douglas-fir and other coniferous tree species in the Pacific Northwest, the vast number of invertebrates that they consume annually makes these shrews more beneficial than detrimental.

Family Talpidae: Moles

Derivation: The familial name Talpidae is derived from the Latin word *talpa* (mole) and the Latin suffix *idae* (family).

General description: Moles have long, tapering snouts, cylindrical bodies, and minute eyes. Their ear openings are simply holes near the shoulders concealed by dense fur. Keen senses of ground vibrations and of direction compensate for weak sight. They have broad front feet, the toes terminating in stout claws adapted for digging. The forelegs and shoulders are anatomically modified in such a way that the front feet, except those of shrew-moles, are permanently turned out. The pelages of most moles are composed of soft, flexible hairs-all about the same length. The hairs become smaller in diameter near the body, making the pelage much like velvet. Such structure allows the hairs to lie in any direction, enabling an individual to go forward or backward in small burrows. Shrew-moles, on the other hand, have pelages more like those of shrews; that is, they are composed of both guard hairs and underfur directed toward the rear of the animals, so that the animals cannot move backward in a burrow.

Unlike western shrews, which have reddish-tipped teeth, moles have white teeth. Furthermore, the first upper incisors of western North American moles are straight, flat, and relatively broad, similar to human teeth. In contrast, the first upper incisors of shrews are pointed and curved sharply down.

Most moles are well adapted for a burrowing life and normally make two types of burrows: shallow surface-tunnels, marked by visible ridges of soil that are pushed up with their backs, and deeper tunnels that can be located by the cone-shaped mounds of earth on the surface of the ground. These "molehills" are formed by earth being pushed out through a tunnel; however, when a mole compresses the soil around a deep tunnel sufficiently to provide the required space for its body, molehills are not created. One mound of primary importance is called the "fortress." The fortress is larger than other molehills, and it is under this particularly large mound of earth that a mole constructs its nest. Although moles can traverse their burrow with surprising speed, they are relatively slow on the surface of the ground. Their strength is almost incredible. Dr. Murray L. Johnson, curator of mammals, Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington, had a captive Townsend mole in the basement of his home. The mole got out of its container onto the concrete floor. Finding a small crack in the floor, it dug its way straight down through the concrete and escaped. Some species in the wild can burrow into hard soil in seconds. Other members of the mole family are active primarily in the decaying vegetative litter on the ground and under such protective cover as logs. A few moles are amphibious or semiaquatic, living in freshwater streams and ponds; these moles have fringes of short, stiff hair along the margins of the feet, called "swimming fringes," and partially webbed toes. Some moles are omnivorous, but most are insectivorous. Many moles have a strong, musky odor that probably makes them unpalatable to some potential predators.

The known gestation period ranges from 28 to 42 days, but delayed gestation has been reported in members of one genus. Moles become sexually mature from 6 to 12 months of age; they have a single litter per year.

MOLE

In the past, as many as 4 million moleskins a year were imported into the United States from England. Today, the trade in moleskins is insignificant because the fur does not wear well when made into coats and is no longer fashionable in this country.

Moles are active throughout the year, and numerous methods have been devised to rid lawns and gardens of them. One technique is to put empty bottles into the ground with the bottom in the mole's tunnel and the necks sticking above the surface at an angle. When the wind blows, it makes a "piping" noise and moles supposedly disappear almost overnight.

World distribution: Moles are found in Europe and Asia, north to the 63d parallel and south to the Mediterranean and the Himalayas. In North America, they occur from southern Canada to northern Mexico.

Fossil record: Their fossil record dates to the middle Oligocene in North America.

Number of species along the Oregon coast: Three.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus *Neürotrichus*: American shrew-mole

Derivation: The generic name *Neürotrichus* is derived from the Latin word *nervus* (sinew or tendon) and the Greek word *trichos* (hair); the reference is probably to this little mole's tail.

General description: The shrew-mole, the smallest North American mole, is often mistaken for a shrew. The common name, shrew-mole, is apt since this genus has a combination of shrewlike pelage, composed of both guard hairs and underfur and the large head and heavy dentition of a mole.

World distribution: American shrew-moles occur only in the Pacific Northwest from southern British Columbia, Canada, south to central California, and west to the eastern flank of the Cascade Range.

General reference: Walker et al. (1968).

Species *Neiirotrichus gibbsi*: American shrew-mole

Derivation: The specific name *gibbsi* is a proper name; this small mole was named in honor of George Gibbs who caught the first specimen at White River Pass, north of Mount Rainier, Pierce County, Washington, on July 15, 1854.

Specific description: Total length, 100 to 126 mm; tail, 32 to 50 mm; hind foot, 14 to 17 mm; ear, 2 to 6 mm; weight, 5.5 to 12 g.

Except for the tip, which is naked and reddish, the long, tapering nose is sparsely covered with fine hairs. The nostrils are on the sides of the reddish tip. The ears are merely holes located near the shoulders and usually are not visible because of the dense fur. Minute eyes are nearly concealed by fur. The front feet are broad with stout claws adapted for digging. The three middle claws on all feet are longer than the outer claws. Although definitely constricted at the base, the tail is relatively thick. It is encircled with rows of scales and covered with sparse, long, coarse hairs. In color, the tail resembles the pelage. The pelage is thick, relatively soft, and almost uniform in color, varying from dark brownish gray to blackish gray. In certain lights, the long, glossy guard hairs shine like metal.

Distribution along the Oregon coast: Shrew-moles occur along the entire coast.
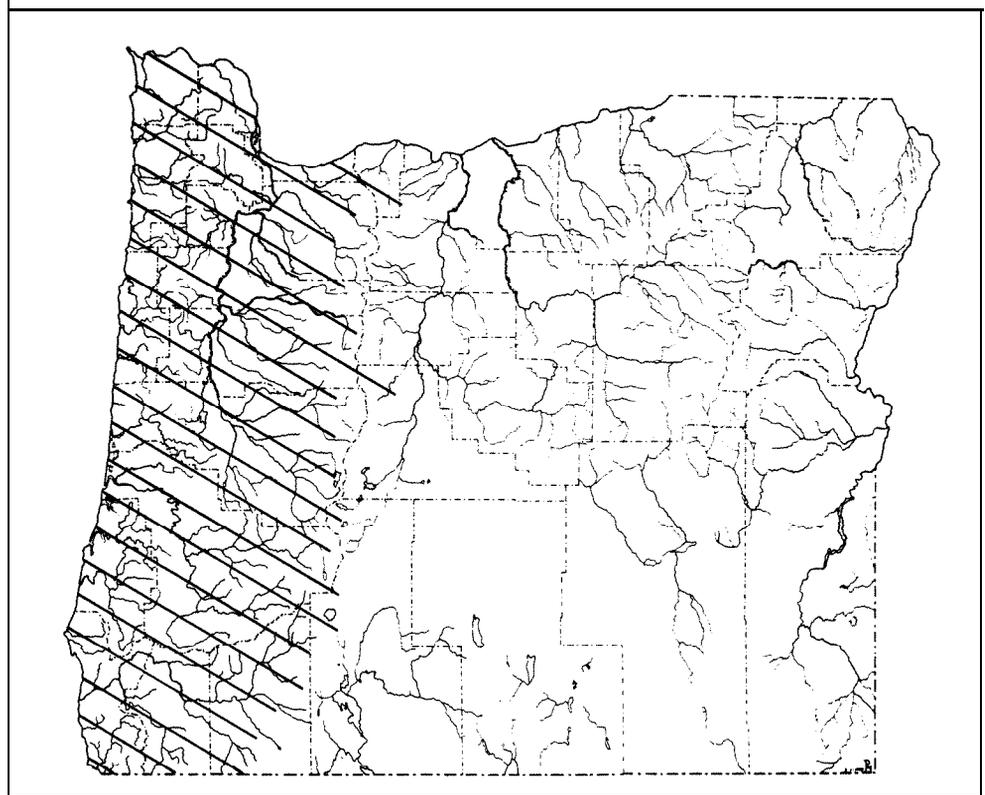
KNOWN DISTRIBUTION OF SHREW-MOLE

Habitat: Although these tiny moles seem to be most common in the alder/salmonberry and riparian alder habitats, they also occupy the mature conifer, immature conifer, riparian hardwood, Sitka spruce/salal, skunkcabbage marsh, wet pastureland, headland prairie, and headland shrub habitats.

Habits: In many respects, the habits of these tiny moles are shrewlike. They do not create burrow systems with the molehills characteristically constructed by larger moles; instead, they make relatively shallow burrows in the loose, sod-free topsoil. Active at any time of the day or night, these little moles noisily rummage in the decaying litter on the ground.

Unless otherwise stated, the following discussion of the habits of the shrew-mole is from Dalquest and Orcutt (1942). Shrew-moles make two types of burrows: shallow runways and deep burrows. The runways are 38 millimeters wide and 20 deep. Apparently constructed by shrew-moles in search of food, the shallow troughs, roofed by the decaying vegetation on the ground form a complex, intersecting network. Such runways may be regularly traveled by shrew-moles in search of invertebrates that have crawled or fallen into them. A shrew-mole constructs a tiny opening, too small to admit its body, in the roof of a shallow burrow. Immediately beneath this tiny ventilation duct is a slightly larger chamber in which the animal sleeps.

Deep burrows are not as commonly constructed as the surface runways. The deep, narrow burrows, 25 millimeters or less in diameter, branch, intersect, and cross one another at various levels but seldom go as deep as 304 millimeters beneath the surface of the soil. These burrow systems often contain a larger chamber built at the level of the water table. These chambers are about 127 millimeters in diameter, with arched ceilings about 75 millimeters high, and are constructed closely enough to the water table to have soft, level, mud floors.

SHREW-MOLE

In general, shrew-moles move more slowly than do shrews. The ordinary movements of shrew-moles on the ground consist of a slow walk and momentary pauses. When shrew-moles walk, the elongated claws of the forefeet are bent underneath the feet so that the animal actually walks on the backs of the foreclaws. When frightened, a shrew-mole makes an incredibly swift, scuttling dash for cover. Once under cover, the animal crouches and, except for rapid breathing, is absolutely still. I have observed defensive posture assumed by an animal that was disturbed in an area devoid of protective cover. If a disturbance is not too severe, the animal faces it with one forefoot raised and its mouth open. Drastic disturbance may cause the animal to turn its back and hide its head beneath its body. Regardless of how frightened the animal is, within a minute it resumes its interrupted activity.

A shrew-mole is not only graceful on the ground but also is a capable climber. A deliberate climber, the shrew-mole takes neither a step up nor down without first solidly placing its feet. It descends tail first. None has been observed to jump while climbing. The shrew-mole's ability to put the front legs under its body and place the palms flat on the ground makes it more agile than other western American moles.

When digging a burrow, a shrew-mole pushes aside the earth with lateral motions of the forefeet. Using only one foot at a time, the shrew-mole rotates the body at a 45" angle and forms the burrow by pressing aside and packing the loose, damp earth (Dalquest and Orcutt 1942). The animal makes its way through loose litter on the ground by pushing the litter sideways with its forefeet and pushing its body forward with its hind feet.

These tiny moles are good swimmers and they sometimes tackle small, swiftly flowing streams to reach islands. Dalquest and Orcutt (1942, p. 392) wrote about a test of a shrew-mole's swimming ability, "The results were astonishing! The animal simply flew through the water with powerful movements of all four feet. The forward motion was so great that the head and fully two-thirds of the body were above water." A shrew-mole uses the feet on each side of its body alternately, creating an undulating motion of the body and tail.

A shrew-mole's periods of activity are interspersed with periods of rest and sleep. These are longest and most frequent when the mole's appetite is satiated and shortest and least frequent when the mole is hungry. Rest periods range from 1 to 8 minutes at irregular intervals from 2 to 18 minutes apart. The nest in which a shrew-mole rests or sleeps is simple. The animal grasps small pieces of vegetation with its mouth and takes them to a selected site. When a sufficient pile of material is accumulated, the mole hollows out a cuplike depression in the material by moving around and tucking some of the material around itself with its mouth. To sleep, the mole places the feet fairly close together under the body and tucks the snout and head beneath the body between the forelegs. The animal's weight is borne by the top of the head and by the hindquarters. The tail is placed around one side of the body. When the shrew-mole is resting, its nose is relaxed and flat against the ground. Periods of relaxation are occasionally interrupted when the mole raises its nose and half-heartedly sniffs the air or scratches itself vigorously with a forefoot or hind foot (Dalquest and Orcutt 1942; Maser, unpublished data on file at Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington).

Touch appears to be the most developed sense of a shrew-mole. The mole's long, flexible nose guides it much like a "blind man's cane." The nose, almost constantly in motion, quickly identifies any object it contacts. The gentlest contact of an object by one of the sensitive whiskers on the nose or face causes an immediate response. Debris adhering to a whisker makes the mole almost frantic in its effort to remove the material with its forefeet. The stiff hairs that encircle the ear openings are also very sensitive, and the long, stiff hairs on the tail may also be sensitive to touch. The shrew-mole's hearing apparently is adapted to the sounds of invertebrates. Sensitivity to ground vibrations is difficult to determine. A small object dropped in the vicinity of a shrew-mole will usually cause it to jump or start, but both touch and hearing may account for the response.

A shrew-mole's sense of smell is poor and of little use in locating food or enemies. Its nose is a tactile organ and not until an object is touched is there any response. Individuals often missed a motionless bit of food during experiments even though their noses passed within a fraction of a millimeter of it. One shrew-mole blundered repeatedly into a frog, even though each contact caused it to dash for shelter. Each time a living invertebrate was encountered and touched, a shrew-mole started in surprise; there was no indication that it had been forewarned by a sense of smell. Since shrew-moles, especially reproductively active males, emit a musky odor, the sense of smell may detect only particular odors.

Shrew-moles placed in darkness did not respond to brilliant lights suddenly flashed within a few millimeters of their eyes; when placed in bright light, they did not respond to shadows suddenly passed over them. Apparently, shrew-moles are completely blind.

So far as is known, shrew-moles are silent. Dalquest and Orcutt (1942) never heard one make a vocal sound, not even very young animals or fighting males. Nor have I any record of sound from these moles. They possibly emit sounds too high for the human ear to detect.

Shrew-moles seem to be gregarious, apparently traveling in "loose bands." Traps set along a log will not catch any of these moles for several days or weeks; then several may be caught in succession. Dalquest and Orcutt (1942, p. 393) wrote:

> A band of *Neiirotrichus* may invade an area and remain there from several hours to several days. Whether the band is trapped out in this time or whether it then moves on we could not determine. Our greatest catch of *Neiirotrichus* in one place in one day included 11 individuals, taken in a line of traps set along a log 50 feet in length. No *Neürotrichus* had been taken in these traps for four days previous to this catch. In this case, at least, a band contained 11 or more individuals.

If, as trapping records indicate, shrew-moles do travel in groups, it would be interesting to know which sense or combination of senses are used by individuals of the group to communicate with one another and thereby keep the group intact.

These tiny moles are astonishingly hardy and strong. The greatest weight lifted vertically by one shrew-mole was 209 grams-20 times its own weight. These moles withstood temperature variations from 7" to 27" C with no ill effects. Likewise, they were not susceptible to shock; and repeated handling and experimentation did not bother them. One shrew-mole even fell 1½ meters onto a concrete floor without sustaining any noticeable ill effects.

The feces of shrew-moles are about 4 millimeters long and less than 1 millimeter wide. They are black, irregular, and soft, disintegrating rapidly. Unlike the western shrews, shrew-moles defecate and urinate with no visible attempt to confine such activity to a particular area (Dalquest and Orcutt 1942; Maser, unpublished data, on file at Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington).

Food: I have found that shrew-moles eat a variety of invertebrates, such as termites; sowbugs; pillbugs; earthworms; centipedes; a species of small, thin-shelled, terrestrial snail, *Haplotrema vancouverense;* and various insects. Dalquest and Orcutt (1942) examined the stomach contents of 39 shrew-moles. They found the following items (expressed in percent by volume): earthworms, 42; isopods, sowbugs, and pillbugs, 36; insect larvae and pupae, 12; springtails, 2; and unidentified material, 8. Some vegetable matter may also be eaten.

Unless otherwise stated, the following discussion of the food habits of shrew-moles is from Dalquest and Orcutt (1942, p. 393). "Probably 99 percent of a shrew-mole's active life is spent in a ceaseless quest for food. This is easily understood

when one realizes that the shrew-mole's greatest enemy is its own appetite." When hunting for food, shrew-moles rummage through decaying litter, turn leaves and debris, investigate crevices, and patrol burrows. They may also climb into low-growing vegetation and search the foliage for food. Hunting is aided by an ever-active nose that may be "thrown high in the air, twisted to one side or the other, rapped on the ground, or hooked under the body." Nose-rapping appears to be characteristic of a shrew-mole while hunting on the ground.

> In an ordinary search for food the nose is rapped first on the ground directly in front of the animal. The head is then swung 40 degrees to the right and the ground is lightly rapped again. The head is then swung to the left side and a third rap given. The animal then moves one step forward. These raps follow each other with extreme rapidity. A tapping sound often serves to locate a shrew-mole when it is hunting for food in dead leaves.

Shrew-moles consume enormous amounts of food. One shrew-mole, weighing 10 grams, ate a worm that weighed 1.26 grams in 10 minutes. Another consumed 4.7 grams of worms in 2 hours. The largest known quantity of food eaten by a single shrew-mole in a 12-hour period was 14.4 grams— 1.4 times its own weight! It is not surprising, therefore, that these tiny moles are prone to starvation.

Shrew-moles found dead in live-traps probably died of starvation and exposure rather than shock as is usually supposed. Although the stomachs of most of these dead moles are empty, some occasionally contain small quantities of trap-bait, usually oatmeal. The amount of trap-bait is probably insufficient to maintain the animal, and it may be eaten and digested with difficulty compared with normal food.

Individual shrew-moles handled earthworms differently. Some stripped them through the forefeet, presumably to clean off the earth. Some bit worms along their entire length; some merely bit from the portion that was first encountered to the worm's nearest end. Most shrew-moles simply began to eat a worm from one end or the other. One, however, always bit a worm into small pieces. Another mole bit a small piece from the tail of a living worm, then chewed and swallowed the piece before pursuing the maimed creature for another bite; consequently, an injured worm often escaped.

When insect pupae, pillbugs, and sowbugs were encountered by a shrew-mole, the mole hooked them with its nose, pulling them backward off balance. Pillbugs, which are capable of rolling into tight balls, were bitten open and consumed from their soft undersides. Insects were often struck repeated blows with the mole's forefeet or were covered with earth. Centipedes were simply grabbed by the head and eaten. While eating, shrew-moles used their forefeet not only to hold food but also to arrange the food in their mouths. Beetles, ants, terrestrial mites, and slugs were refused even though beetles, ants, and slugs are readily eaten by most western shrews. Dead frogs and salamanders were usually eaten when no other food was available, but live amphibians were not molested (Dalquest and Orcutt 1942; Maser, unpublished data on file at Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington).

The speed of digestion varied by type of food, but within 40 minutes after it was consumed, remains of food were evident in the feces.

Dalquest and Orcutt (1942) thought that shrew-moles probably obtain sufficient water from the bodies of their prey and do not need to drink water.

Reproduction: Shrew-moles appear to be reproductively active throughout the year; however, Dalquest and Orcutt (1942) stated that over 80 percent of the animals that they found in a reproductive state were caught between March 10 and May 14. Litters range from one to five; three or four is probably the usual size. There may be more than one litter annually. Although the gestation period is not known, Dalquest and Orcutt (1942) found that it is longer than 15 days.

Four newly born young ranged from 26 to 27 millimeters in length and weighed from 0.49 to 0.58 gram. At birth shrew-moles are pink, naked, and lack even whiskers. The external ear openings are not yet evident, and the eyes are merely prominent black spots under a transparent covering of skin. The broad forefeet are fleshy and paddlelike. The tops of the digits are soft and blunt, with no indication of nails (Kritzman 1972). Dalquest and Orcutt (1942, p. 396) described three young shrew-moles approximately three-fourths grown:

> Their eyes were closed and the auditory orifice (external ear opening) was represented by a shallow trench. The animals attempted to bite, although their teeth had not yet erupted. The. . . skin and fur of the upper parts were dark bluish black. The fur was soft and downlike. The fur was especially short on the upper parts, where its color was almost silver-gray. The feet and nose were pink. The skin of the anal region was much folded. The tail was relatively long, thick and. . . bluish-violet. The forefeet were turned out, with the palms away from the body.

The nest in which the three young shrew-motes were found consisted of a handful of damp willow leaves 0.6 meter above the ground in an old, rotten alder stump; a burrow, constructed within the stump, led to the nest.

Predation: Owls are probably the main enemies of shrew-moles. Dalquest and Orcutt (1942), studying the food habits of the screech owl, found that shrew-moles constituted 5 percent of the mammals eaten. They stated (p. 399), "The blind, blundering Neürotrichus makes an easy prey for almost any predator." Maser and Brodie (1966) found that shrew-moles accounted for 2.33 percent of the diet of a pair of great horned owls and 0.98 percent of the diet of a pair of barn owls. Reynolds (1970) stated that these tiny moles were eaten by long-eared owls, and Forsman and Maser (1970) found the saw-whet owl to be a predator of the shrew-mole.

The Pacific giant salamander and the rubber boa undoubtedly capture some shrew-moles. Dalquest and Orcutt (1942) found shrew-moles in the stomachs of two northwestern garter snakes. They also recovered the remains of one shrew-mole from the stomach of a raccoon. Along the Oregon coast, domestic cats kill many of these moles but seldom eat them. Many shrew-moles die in bottles and beverage cans carelessly discarded by people along roads and trails; the moles crawl in but are unable to crawl out.

Economic status: Shrew-moles are beneficial because they consume large quantities of invertebrates.

Genus Scapanus: Western American moles

WESTERN AMERICAN MOLE

Derivation: The generic name Scapanus is derived from the Greek word *skapane* (digging tool).

General description: Western American moles are robust, compact animals. Their front feet are flat, pale, and scantily haired. The palms are nearly as broad as they are long and the claws are broad, flat, and heavy. They have minute but visible eyes and long, tapering snouts. Their snouts and lower lips are pinkish and essentially devoid of hair. The tips of the noses are naked with crescent-shaped nostrils opening upward. The short, round, thick tails are slightly constricted at the bases and taper toward the ends. There are indistinct circular rows of scales and sparse, coarse hairs on the tails, although one species, Scapanus *latimanus,* has a relatively hairy tail. The dorsal pelage is brownish black to black and slightly lighter on the underside. When smoothed, the pelages have a metallic luster; they are velvety as described under the family.

World distribution: The three species of the genus *Scapanus* are confined to extreme western North America from southern British Columbia, Canada, south into the northern part of the Baja Peninsula, Mexico.

General reference: Walker et al. (1968).

Species *Scapanus townsendi:* Townsend mole

Derivation: The specific name *townsendi* is a proper name; this large mole was named in honor of J. K. Townsend who captured the first specimen on the banks of the Columbia River, probably at Old Fort Vancouver, now Vancouver, Clark County, Washington, on May 9, 1835. John Kirk Townsend, primarily a naturalist, was in charge of the hospital at Fort Vancouver the winter of 1835-36 (Johnson 1943).

Specific description: Total length, 198 to 237 mm; tail, 35 to 61 mm; hind foot, 23 to 31 mm; ear, 2 to 4 mm; weight, 64 to 171 g.

Townsend moles and coast moles are similar in appearance, but adult Townsend moles are considerably larger. These moles often occur together, and, if necessary, a museum of natural history can identify specimens.

Distribution along the Oregon coast: Townsend moles occur along the entire coast.
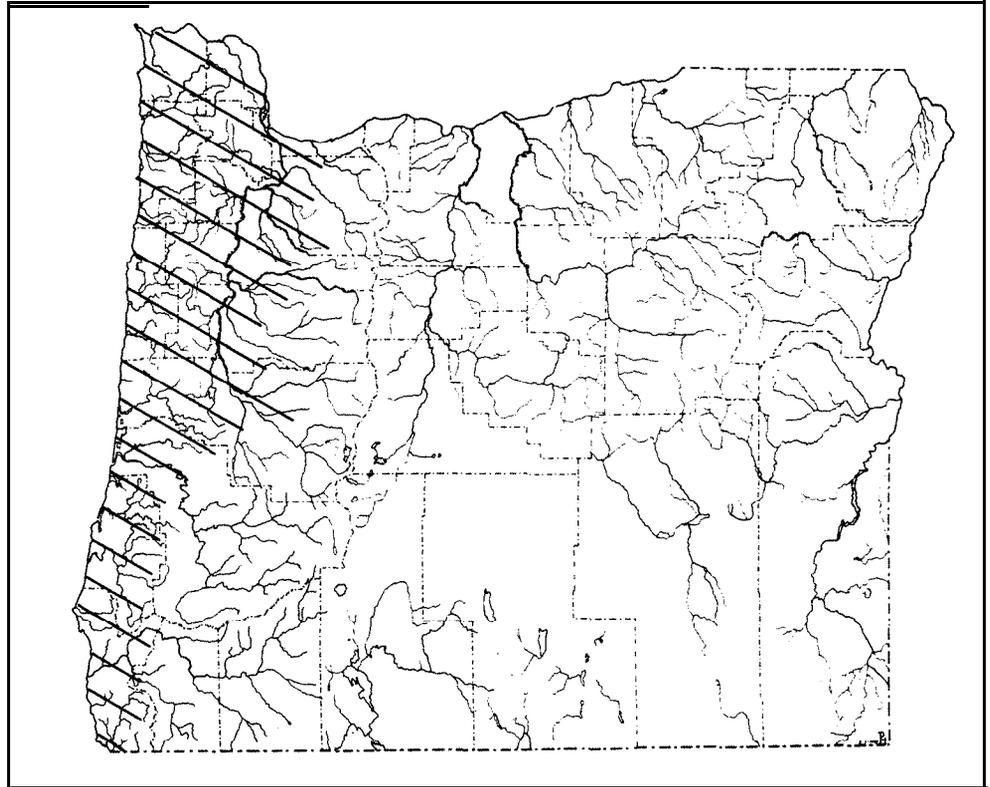
KNOWN DISTRIBUTION OF TOWNSEND MOLE

Habitat: The habitat of Townsend moles along the coast is essentially wet pastureland; occasionally they have been found in headland prairie and headland shrub habitats.

Habits: Townsend moles are primarily nocturnal, but they are occasionally active during the day. In the wet pastureland habitat, these moles usually create extensive and deep burrow systems, often in extremely wet situations; however, along the junction of the wet pastureland and alder/salmonberry habitats, Townsend moles also make shallow tunnels as evidenced by ridges of soil.

Townsend moles are almost exclusively subterranean, so little is known about their behavior in the wild. Wight (1928) and Moore (1933) both kept Townsend moles in captivity but said nothing about their general behavior. Johnson kept Townsend moles in captivity and found them exceedingly gentle.[2] They may be gentle when handled by humans, but Giger (1973) found that captive Townsend moles were antagonistic toward each other, frequently intimidating one another or fighting violently. Scheffer (1961, p. 10) witnessed a confrontation between two Townsend moles:

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[2] M. L. Johnson, curator of mammals, Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington, personal communication, 1973.

> At 9 a.m. on July 4, 1961, I saw two moles fighting (?) on the lawn of my home. . . .The sky was overcast. From evidence of a track on the grass, the moles had just moved about one meter from brushy cover to the open lawn. They were writhing and tumbling vigorously and soundlessly. I could not distinguish their respective holds, though when I seized and lifted one mole it retained in its teeth a grasp on the other one. One was a male. . . , the other a female. . . . On the basis of unworn teeth and certain unclosed sutures. . . I judged the specimens to be subadult or young adults.

Giger (1973) studied the movements of Townsend moles near Tillamook, Tillamook County, Oregon. He found that there was no overlap of movements between adult moles living within established, interconnecting burrow systems, indicating that these animals are, for the most part, solitary. He suggests (p. 657) that "The solitary habits and aggressive or defensive behavior shown by moles could be manifestations of intense efforts to retain homesites." On the other hand, when crowded onto restricted areas (such as islands and roadbanks during periods of severe flooding), individuals appeared to exhibit some tolerance for one another.

Four genera of North American moles, including *Scapanus*, have sudoriferous glands on the head, chin, wrists, venter, and anal region. The orangish material resembles the wax of the human ear "both in texture and color" (Eadie 1954). These glands apparently enlarge seasonally. The secretions produced appear to be correlated to some extent with the age and breeding condition of the individual; perhaps they are associated with the production of sex hormones. Although in some areas the hair may be intensely stained (brownish or orangish in Townsend moles) to the bases of the shafts, in other areas the stain may be visible only on the outer two-thirds of the shafts. The glandular material remains on the hair until the hair is lost during the molting process. These secretions may serve not only as a sex hormone but also as a method of marking an occupied burrow system. Furthermore, immature moles, first appearing in June, lacked any evidence of glandular secretions until August or September (Eadie 1954) when presumably they had dispersed and established their own burrow systems.

Giger (1973) found that Townsend moles inhabiting low areas of sparse popula-tions and poorly drained soil moved greater distances than did moles inhabiting higher areas with greater population densities and better drained soils. He indicated that poor drainage, coupled with a scarcity of earthworms-the moles' principal food-appeared to induce the animals to extend their movements and to seek higher terrain. Whereas the average adult movement was within 40 meters, Townsend moles in low areas traveled from 69 to 116 meters compared with 15 to 38 meters by those in higher areas. The destruction of lateral burrows by the trampling of livestock constrained some moles to long, narrow burrow systems along fence rows and ditches.

In late January 1964, heavy rainfall and snowmelt caused severe flooding, and most of the study area was inundated. Apparently reluctant to travel on the sur-face, many moles constructed shallow burrows for great distances ahead of the rising water. These burrows followed the upward contour of the land. Some moles made it to higher ground only to be forced to swim when this area also became flooded. Although they are good swimmers, the moles seemed unable to orient toward higher terrain. Those that succeeded in reaching land appeared exhausted,

and some only buried their heads in the soil. When the flood waters subsided, 62 dead Townsend moles were found in the piles of debris on the study area (Giger 1973).

Four moles, compelled by rising water, moved about 112 to 149 meters from their dwellings; however, signs of activity from individuals displaced by flooding indicated that they returned to their original burrow systems almost as rapidly as the water receded. Near Tillamook (and in other coastal areas) Townsend moles are displaced, almost annually in some areas, by winter floods; rapid reoccupation typically follows when floodwaters subside.

> Homing behavior explains the apparently orderly mass redistribution of moles. The speed with which areas are reinhabited suggests that it is comparatively easy for survivors among those displaced to return if the distances are not greater nor the terrain too difficult. Such activity must make the periodic process of reestablishment more efficient and aid survival.

(Giger 1973, p. 657)

Food: Wight (1928) studied the stomach contents of 306 Townsend moles from December through May in the Willamette Valley, presumably near Corvallis, Benton County, Oregon. He found that the moles feed on earthworms, earthworm coccoons, insects (larvae, pupae, and adults), centipedes, and slugs, but earthworms comprised an average of 72.5 percent of their diet. Moore (1933) examined the stomach contents of 42 Townsend moles, primarily from the Oregon coast, and found that earthworms comprised an average of 76.1 percent of the diet; flies (probably larvae), butterflies and moths (probably larvae), centipedes, beetles, bees, wasps, and ants (probably larvae), crickets, grasshoppers, and spiders were represented in much smaller amounts.

There has been a controversy over the food habits of Townsend moles for many years. Wight (1928) found a negligible amount of plant material in 8 of the 306 stomachs he examined, but Moore (1933) found a trace to 100 percent (an average of 15.9 percent) in 24 of the 42 stomachs he studied. The controversy stems from the belief that Townsend moles do extensive damage to flowers and crops by eating the underground portions of the plants. Wight (1928) indicated that the damage was done by Townsend voles. He trapped 72 moles and discovered that the voles (often called "meadow mice") occupied 50 percent of the abandoned burrows within a month of their vacancy. Moreover, he found that the crops (a portion of an earthworm's digestive tract) of the earthworms eaten by the moles contained enough plant material to account for that found in the moles' stomachs. Moore (1933) found that Townsend moles may do a considerable amount of damage to crops by eating the underground portions of certain plants. The controversy has not been settled among farmers and gardeners.

Wight (1928) maintained three moles for 45 days. They consumed an average of 57 grams of food in 24 hours. They also drank "long and repeatedly each day."

Reproduction: Male Townsend moles with enlarged testes have been trapped in December, February, and June. Females with embryos have been trapped from February through April; they apparently have only one litter per year. Litters range from one to four, usually two or three.

The following discussion of the reproduction of Townsend moles, unless otherwise stated, is from Kuhn et al. (1966). Ninety-four nests containing young Townsend moles were dug out and examined: 1 nest contained a single young; 23 nests had two young; 57 nests, three young; and 13 nests, four young. Likewise, 18 pregnant females were examined: 1 (5 percent) had one embryo; 7 (39 percent), two embryos; 10 (56 percent), three embryos; none had four.

Moles are about 50 millimeters long and weigh about 5 grams at birth; they are hairless and their skin is whitish to pink. At about 10 days, they are about 75 millimeters long and weigh about 20 grams; they are still hairless, but their skin is becoming bluish to blackish from developing hair. At 22 days, they are about 115 millimeters long and weigh about 40 grams; they still may be hairless but some may have short hair. By the time they are 36 days old, they are longer than 115 millimeters and weigh about 80 grams; they are covered with short, soft hair. At this age or shortly after, they leave the nest.

Because of the high average winter rainfall along the Oegon coast, the habitat of Townsend moles is normally saturated (often flooded) during the reproductive season. Nursery nests, therefore, are typically located in slightly elevated areas. Such areas vary from a few centimeters to several meters above the surrounding land. Nests are often situated under well-established fences that protect the soil from farm machinery and trampling livestock. Ridges of loose, well-drained soil are thus formed and maintained.

Nests are usually situated under, or within 1 meter of, a single, large mound of earth (75125 cm in diameter and 30-45 cm high) called a "fortress," but they may also be located near the center of clusters of several normal size mounds concentrated within a 1.8- to 3-meter area.

Nest cavities are constructed from 7.5 to 50 centimeters below the surface. They are spherical, averaging 23 centimeters in diameter and 15 centimeters in height. Three to eleven lateral tunnels enter the cavities. Many cavities have a burrow ("bolt-hole") leading several centimeters straight down from the floor of the cavity, then turning up and joining an upper-level tunnel. In addition to allowing a quick escape, the bolt-hole provides drainage.

Nursery nests are usually constructed several days before birth of the young. They are composed of two layers. The inner layer, forming about 25 percent of the nest, is usually made with fine, dry grasses, but occasionally with mosses or leaves. The outer layer is made with coarse grasses that are still green and frequently wet. Since the coarse grasses sometimes have their root systems intact, it is thought that a mole may gather the nest material in shallow tunnels by grasping the roots of the grass with its mouth and pulling the whole plant underground. The coarse grasses are matted or interwoven to form a compact, protective shell about 5 centimeters thick around the dry, inner nest. Green grasses are added to the outer layer several times during the months the nest is occupied by the young.

As the wet grasses decay, they generate a considerable amount of heat that is largely retained in the nest cavities because there is no rapid air movement. Thus, the nestlings are kept warm even when the mothers are absent. Nursery nests are clean; no accumulation of feces or other waste materials was found in any nest examined.

In the wet pastureland habitat, cattle cause relatively high mortality among nestling moles. Cattle apparently are attracted to the nest site of moles; whether the attractant is the abundance of loose soil or the odor of the outer layer of the nests is not known. In some instances, cattle paw large depressions in the soil near nest sites, suggesting that they are attracted by the odor of the nests. Particularly when the water table is high and the ground wet and spongy, grazing cattle often break through the shallow layer of soil and sod covering a mole's nest and crush the nestlings. Nursery nests under fences are somewhat protected.

Giger (1973) found that young Townsend moles disperse at night during the month after weaning. Areas chosen by the dispersing young as homesites appeared to depend more on the suitability of the habitat than on the number of moles already residing in the area. Forty-four juveniles were recaptured from 4 to 6 months after weaning. Of these, 38 (87 percent) had moved less than 305 meters and 27 (61 percent) had moved less than 152 meters from the birthsite when recaptured after the middle of September. The distances traveled ranged from 13 to 854 meters. Movements of females averaged 181 meters, whereas those of males averaged 765. Three (7 percent) of the young crossed paved roads; one of these traveled 720 meters. Twelve (27 percent) were recaptured within 40 meters, possibly having established residence adjacent to that of their mothers.

Predation: The rubber boa appears to be an important predator of nestling Townsend moles. These snakes capture the baby moles in their nursery nests. Owls are probably the major natural predators of Townsend moles over most of their geographical distribution once they leave the nursery nests. Giger (1965) studied the food habits of barn owls at the Tillamook Naval Air Station, 4.8 kilometers southeast of Tillamook. He found the remains of 13 juvenile Townsend moles in the regurgitated pellets of the barn owls in May and June. He stated (p. 36) that "13 or 14 road-killed moles recovered in June were juveniles." The remains of only one adult Townsend mole were recovered from the pellet of a barn own in December, indicating that most of the surface activity of these moles is probably due to the dispersal of the young. Along the southern Oregon coast, on the other hand, domestic dogs and cats seem to be the main predators of Townsend moles. Dogs dig out and kill moles the entire year. Although cats primarily kill juveniles that are active on the ground during the summer, they occasionally kill adults. Neither dogs nor cats have been observed to eat the moles they kill. Humans probably kill the greatest number of Townsend moles with poisons, traps, and "mole-guns." The latter (now illegal) are pipes fitted with shotgun shells and are triggered when a mole passes through its tunnel under the gun.

Economic status: As indicated by their food habits, Townsend moles are largely beneficial, but in some instances, they may damage crops by eating the underground portions of the plants and by covering the aboveground portions with their earth mounds. More detailed studies of their food habits are necessary, however, to determine the extensiveness of such damage. Their mounds of earth

on lawns, golf courses, fields, and pastures annoy many people. According to Wick (1961, in Kuhn et al. 1966), dairymen in Tillamook County, Oregon, estimated losses exceeding $100,000 annually caused by the burrowing activities of Townsend moles.

Species *Scapanus orarius*: Coast mole

Derivation: The specific name *orarius* is a Latin word meaning "belonging to the coast."

Specific description: Total length, 148 to 182 mm; tail, 34 to 46 mm; hind foot, 19 to 23 mm; ear, 1.5 to 3 mm; weight, 38 to 67 g.

Coast moles and Townsend moles are similar in appearance, but coast moles are considerably smaller. These moles often occur together and, if necessary, a museum of natural history can identify specimens.

Distribution along the Oregon coast: Coast moles occur along the entire coast.
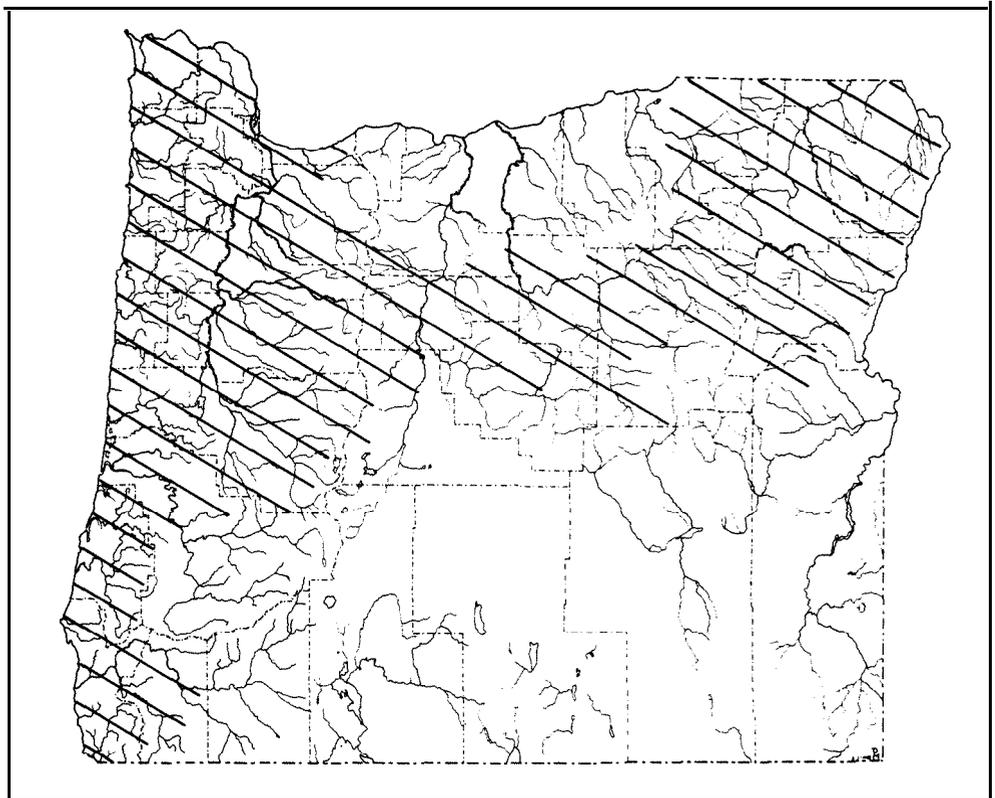
KNOWN DISTRIBUTION OF COAST MOLE

Habitat: These moles occupy a variety of habitats. Along the Oregon coast they have been found in all habitats except the beach, coastal lake, and tideland river. They are regularly trapped in sand and were even occasionally discovered in the peripheral areas of the moving dunes habitat.

Habits: Although coast moles are primarily nocturnal, they are also active during the day. I have occasionally seen them on the ground in the early morning, late afternoon, and early evening. Concerning a coast mole that he caught in a mousetrap on the ground, Dalquest (1948, p. 129) stated, "This is the only case known to me of a coast mole appearing voluntarily on the surface of the ground." He further wrote, "Never have I found coast moles crushed on the highway; several Townsend moles so killed have been found." I have, however, caught several coast moles in mousetraps set along logs in forested areas, and in small, steel traps set in large, open burrows of mountain beaver.

Compared with Townsend moles, coast moles along the Oregon coast appear to have a much greater adaptability to different habitats. It is not uncommon for coast moles to cohabit meadows with Townsend moles, but Townsend moles have not been found to penetrate forested areas and cohabit with coast moles even where meadow and forest grade into each other.

Coast moles characteristically inhabit soils that are better drained than those in which Townsend moles normally occur. Dalquest (1948, p. 128) stated that "The coast mole seems to live deeper in the ground. . . than the Townsend mole." In western Oregon, coast moles are usually found in burrows that are shallower than those of Townsend moles. Contrary to Dalquest's observations in Washington, coast moles construct ridges in the soil by burrowing just under the surface more commonly than do Townsend moles. In addition, molehills created by coast moles are smaller, less conspicuous, and appear to be less numerous than those of Townsend moles.

Food: Moore (1933) examined the stomach contents of eight coast moles trapped intern Oregon. He identified the following, expressed as averages: earthworms, 69.9 percent; flies (probably larvae), 25.1 percent; butterflies and moths (probably larvae), 1.6 percent; beetles, 0.9 percent; centipedes, 0.6 percent; Orthoptera (roaches, crickets, grasshoppers), 0.3 percent; Hymenoptera (ants, bees, wasps), 0.2 percent; and vegetable matter, 1.2 percent.

Reproduction: Male coast moles with mature, descended testes have been trapped from December through March, but most records are from February. Kuhn et al. (1966) stated that the only nest of a coast mole that they examined contained three young; they gave no further details. Dalquest (1948) wrote that four young, born from late March to early April, constituted an average litter. A mature female probably has a single litter per year.

Predation: The rubber boa is probably the most important predator of nestling moles. Once the moles have left their nursery nests, owls are most likely their main, natural predators. Giger (1965) studied the food habits of barn owls at the Tillamook Naval Air Station. He found the remains of 28 coast moles in the regurgitated pellets of the owls. Two coast moles, caught by the owls in February and March, were adults that had been active on the ground. Twenty-five coast

moles were captured from May through August (May 6, June 12, July 7, August 1); undoubtedly these moles represented young of the year dispersing from their nursery nests to establish individual dwellings. In addition, Maser and Brodie (1966) recovered the skull of a coast mole from the pellets of a pair of long-eared owls.

Along the southern Oregon coast, domestic dogs and cats kill many of these moles. Dogs dig out and kill fewer coast moles than they do Townsend moles because coast moles, being primarily forest dwellers, are not so readily available. Although cats kill primarily juvenile moles that are active on the ground during the summer, they also kill many adults. In many areas, cats kill more coast moles than they do Townsend moles because coast moles are more readily available in the brushy, forested areas where most cats do their hunting. Neither dogs nor cats, however, have been observed to eat the moles that they killed. Humans probably take a far greater toll of Townsend moles than of coast moles since the latter have less direct contact with people.

Economic status: The food habits of coast moles, their limited, direct contact with humans, and their less extensive construction of molehills, make them less annoying to people than Townsend moles.

Order Chiroptera: Bats

Derivation: The ordinal name Chiroptera is derived from the Greek words *cheir* (hand) and *pteron* (wing) and refers to the four greatly elongated, slender digits or fingers of the forelimbs, between which are stretched thin, delicate membranes. The membranes, composed of a double layer of body integument, are also attached to the sides of the body, the legs, and the tail-forming wings. Bats are unique among mammals in that only they have true powers of flight. Other mammals, such as "flying squirrels," can only glide in a descending path from a higher to a lower elevation.

General description: Because bats are primarily nocturnal, little understood, ugly by most human standards, and known to carry some dangerous diseases, they have probably evoked more superstition, prejudice, and misinformation than any other group of mammals. Yet among mammals, only rodents exceed bats in numbers of species. The great diversity to which bats have evolved is shown in the spectrum summarized by Walker et al. (1968) according to feeding habits, rather than the recognized scientific classification. Insectivorous bats feed mainly on insects that they catch in flight. Fruit-eating bats depend almost exclusively on fruit and some green vegetation for food. Flower-feeding bats, aided by long tongues with brushlike tips, eat primarily pollen and nectar. True vampire bats make small incisions in the skins of sleeping animals and lap the blood that flows freely from the wounds. Carnivorous bats usually prey on other small mammals, birds, lizards, and frogs. Fish-eating bats catch fish at or near the water's surface with large, powerful feet armed with sharply hooked claws.

Bats, birds, and airplanes share the same basic aerodynamic characteristics. Among bats, the structural differences and the resultant aerodynamic characteristics of their wings are extremely important. The wings of bats are directly related to the efficiency with which various sources of food can be exploited. The aerodynamic evolution of the flight of bats is described by Findley et al. (1972), Lawlor (1973), Quay (1970), and Vaughan (1970a, 1970b, 197Oc).

Coupled with aerodynamic characteristics are the time, location, and altitude of flight. These factors interact to maximize the efficiency with which bats can exploit a given source of food. At the same time, variations in these factors minimize direct confrontation between species. The result is that competition is being constantly reduced through evolution between species (interspecific) and between individuals of the same species (intraspecific). For example, along the Oregon coast there are 10 species of insectivorous bats, yet confrontations between species are minimal because they feed in different habitats and at different altitudes. In this way confrontations between individuals of the same species may be minimized by the establishment of and adherence to relatively discrete territories while feeding.

The ear is a specialized organ adapted not only for hearing but also for maintaining balance or equilibrium. Although it is true that bats that depend on echolocation (sonar) for guidance have acute hearing ability, they are not blind, as implied by the phrase "blind as a bat." In fact, the predominant senses used by the Old World fruit bats are vision and smell. Furthermore, it has become apparent through research that many echolocating species also depend on vision and smell (Henson 1970, Suthers 1970).

Reliance on vision and smell in no way detracts from the remarkable feats of bats using echolocation. Bats flying at speeds of 2¾ to 3% meters per second can maneuver unhindered through an array of wires or can select and capture several individual insects in a swarm in a few seconds. Some bats routinely detect and capture insects or small vertebrates resting on vegetation, the ground, or the surface of water. In laboratory studies, certain species have even distinguished between real insects and fake ones. To account for the extremely accurate directional-focusing system of bats, one must assume that their sense of hearing is highly directional in both horizontal and vertical planes. Sonar signals emitted by bats are brief and must be perceived and interpreted within milliseconds. Within a species, different signals indicate that prey is being sought, pursued, or captured. Some species emit sonar signals through their mouths; others, through their noses.

The external ears (pinnae) of bats exhibit great differences in size, shape, and elaboration of accessory structures. Insectivorous bats, such as the western big-eared bat, that can hunt insects which rest on vegetation or solid objects, usually emit faint sonar signals and have enormously large ears. Fast-flying bats, such as the hoary bat, emit loud sonar signals with high frequencies and have relatively small ears (Henson 1970).

Compared with most small mammals, bats have long gestation periods, ranging from slightly less than 2 months to 8 months. Many rodents, for example, have gestation periods of 21 to 28 days. Bats are helpless and essentially naked at birth. They develop slowly; however, they have well-developed thumbs and hind feet and are capable of climbing shortly after birth. Depending on species, bats may be able to fly in 3 to 10 weeks (Orr 1970). The deciduous teeth of most bats are partially developed at birth. There are fewer deciduous than permanent teeth. Deciduous teeth vary in structure by species but are usually slender, pointed, and directed toward the rear of the mouth. Such hooklike teeth apparently aid young bats in clinging firmly to their mothers' teats. Deciduous teeth are rapidly replaced by permanent ones (Vaughan 1970a).

Bat guano (feces) was used for many years as a source of the saltpeter needed to produce gunpowder (Hutchinson 1950, cited in Constantine 1970). it was used for this purpose by the United States during the War of 1812 and the Civil War (Mohr 1948, cited in Constantine 1970). During World War II, the U.S. Armed Forces considered using bats as weapons. It was proposed that large numbers of bats, fitted with small incendiary bombs, be released from airplanes over such enemy installations as ammunition dumps, industrial centers, and fleet concentrations (Mohr 1948, cited in Constantine 1970). It was expected that the bats would disperse, seek shelter in numerous obscure places, and produce many fires simultaneously (Constantine 1970).

World distribution: Bats inhabit most of the temperate and tropical regions of the world but are not found in colder areas beyond the limits of tree growth. They are also not found on certain remote, oceanic islands.

Fossil record: The earliest known bat, an almost-complete fossil, was discovered in Wyoming in the sediments of an early Eocene lake (Jepsen 1970).

Number of species along the Oregon coast: 10.

General references: Allen (1939b), Anderson and Jones (1967), Barbour and Davis (1969), Walker et al. (1968), Wimsatt (1970).

Key:

la Ears, 27 to 39 mm in length; nose with two prominent lumps, one on each
     side- *PL ECOTUS TOWNSEND/* (western long-eared bat), page 115

lb Ears, 23 mm or less in length; nose without prominent lumps 2

   2a Tail membrane well furred on topside 3

   2b Tail membrane not furred on topside (naked except for a few
       scattered hairs) 4

      3a Topside of tail membrane completely furred from body to tip; wing
          membrane conspicuously bicolored, brown to slightly reddish brown
          along forearm and part way down fingers from wrists, rest of wing
          membranes dark brown; wings with small, distinct, conspicuous
          clusters of stiff, light tan hairs on elbows and wrists—*LASIURUS
          CINEREUS* (hoary bat), page 109

      3b Topside of tail membrane well furred from body for about two-thirds of
          its length; wing membranes unicolored, dark brown to almost black;
          wings without clusters of stiff hairs on elbows and wrists—
          LASIONYCTERIS NOCTIVAGANS (silver-haired bat), page 100

4a Total length, 108 mm or more; weight, 12 g or more; wingspread (from wing tip to wing tip), greater than 310 mm—*EPTESICUS FUSCUS* (big brown bat), page 103

4b Total length, 106 mm or less; weight, 10 g or less; wingspread, less than 370 mm **5**

5a Calcars with keels (fig. 2) 6
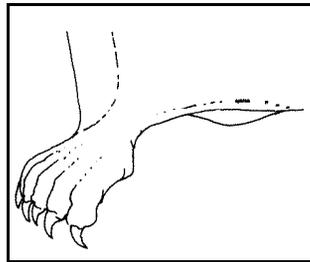
Figure P.-Some species of bats have keels-broad flat areas-on their calcars near the feet.

5b Calcars without keels (fig. 3) 7
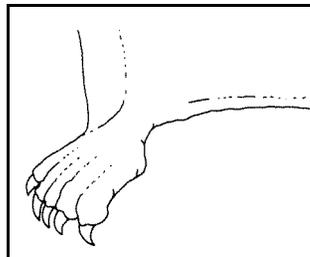
Figure J.--Some species of bats have calcars without keels or broad, flat areas near the feet.

6a Keel on calcar long and wide; total length, 90 to 106 mm; belly hair extending onto underside of wing membranes as far as elbows and knees, forming a line paralleling the body—*MYOTIS VOLANS* (long-legged or hairy-winged bat), page 95

6b Keel on calcar short and round; total length, 77 to 88 mm; belly hair does not extend onto underside of wing membranes, does not form a line paralleling the body from elbows to knees—*MYOTIS CALIFORNICUS* (California bat), page 97

7a Ears, 19 mm or longer; when laid forward, extending beyond nostrils 8

7b Ears, 16 mm or shorter; when laid forward just reaching nostrils 9

8a Tail membrane with fringe of short, stiff hairs along margin (fig. 4)—*MYOTIS THYSANODES* (fringed bat), page 93
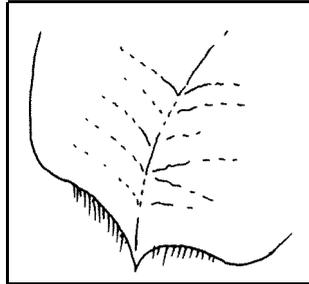
Figure 4.—The fringed bat has a fringe of short, stiff hairs along the margin of its tail membrane.

8b Tail membrane without fringe of short, stiff hairs along margin (fig. 5)—*MYOTIS EVOTIS* (long-eared bat), page 91
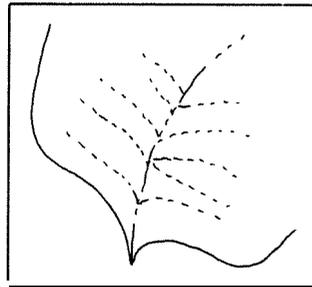
Figure 5.—The long-eared bat does not have a fringe of short, stiff hairs along the margin of its tail membrane.

9a Dorsal pelage yellowish brown, brown, or dark brown, usually with many shiny-tipped hairs that create a glossy sheen; ventral pelage pale brown with little or no sheen—*MYOTIS LUCIFUGUS* (little brown bat),[3] page 87

9b Dorsal pelage brown or dark brown, hairs dull, without shiny tips and glossy sheen; ventral pelage pale brown to almost tan; throat often whitish—*MYOTIS YUMANENSIS* (Yuma bat),[3] page 89

[3] Little brown bats may be confused with Yuma bats. The best way to differentiate the two species with certainty is to compare the cleansed skull of the bat in question with a number of cleansed skulls of both species. Little brown bats have gradually sloping foreheads, whereas Yuma bats have abruptly rising foreheads. A museum of natural history can identify doubtful specimens.

Family Vespertilionidae: Evening Bats

AT
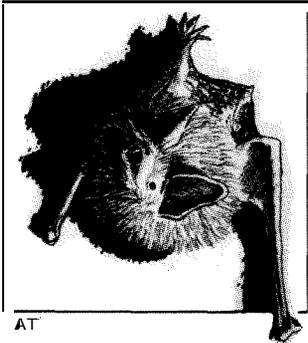
Derivation: The familial name Vespertilionidae is derived from the Latin word *vespertilio* (animal of the evening) and the Latin suffix *idae* (family).

General description: Most evening bats are blackish, gray, or some shade of brown; members of a few species are red, yellow, or orange. They have small eyes; their ears range from small to disproportionately large. Some members of this family have large glands under the skin on the snout that cause large bulges or folds in the skin.

Most evening bats dwell in caves, but they also take refuge in buildings, mine shafts and tunnels, old wells, storm sewers, culverts, rock crevices, hollow trees, the foliage of trees and bushes, hollow joints of bamboo, large tropical flowers, tall grasses, and abandoned bird nests; and under bridges, rocks, and loose bark on tree trunks. Locations where they roost may be found by the whitish stains from their urine, or the dark stains from their body secretions, or both. In addition, feces are frequently evident at entrances to roosts. Feces from bats usually are segmented and crumble easily, revealing bits of shiny exoskeleton of insects. The droppings of rodents are harder and more fibrous. The feces of bats do not contain the white, calcareous material characteristic of the droppings of birds, lizards, snakes, and toads. At times, the roosts of some species can be found by the strong odors emitted from the bats' scent glands. In addition to the supersonic sounds undetectable to human ears, bats produce sounds that are audible to human ears; this is particularly true of bats roosting in groups.

Members of this family alight initially with their heads up. Once alighted, they quickly shuffle around and hang by their toes with heads down and wings folded along their bodies. Although many hang from vertical surfaces rather than hanging freely suspended, some crawl into small crevices and others hang from limbs of trees amid the foliage. Members of most species roost in small groups or large colonies, but those roosting in foliage are solitary by nature. Colonial species normally return to the same roosting site annually. Some remain in colonies throughout the year; some congregate only in winter. Cavedwellers become torpid in winter, periodically changing locations within the cave. Members of a few species migrate south in the fall to milder climates and return in the spring. Individuals of some species can find their way back to their home colonies after being captured, transported, and released at various distances from their colonies.

Most evening bats are insectivorous and use habitats in their nocturnal feeding that are similar to those used by birds in diurnal feeding. A few evening bats, however, are fisheaters.

The thickness of a bat's wings and the weight of its body are apparently directly related; there is also a correlation between the habitat in which it feeds and the resistance of its wings to punctures. Species that feed on or near the ground or in areas of dense or thorny vegetation usually have wings that are more resistant to punctures and less elastic than wings of species that feed in more open areas (Studier 1972).

By emitting ultrasonic sounds through their mouths, evening bats avoid flying into objects and locate and pursue prey. Such echolocation brings a bat within capturing distance of its prey. A bat captures prey by "netting" it with a wingtip and immediately transferring it into the cupped tail membrane, formed by the tail curled

up under the body. The prey is then grasped with the teeth. Small prey is eaten in flight, but large prey is consumed at a resting site. The remains of large prey may occasionally be found under resting sites. Many evening bats pause during feeding to rest and allow their food to digest which accounts for the accumulation of feces under resting stations. Feeding appears to take place in definite areas and resting at definite sites.

In many colonial species, the females segregate into maternity colonies to bear and raise young. Males are not associated with rearing of offspring. In temperate climates, species that become torpid breed from August through October and frequently again in the spring. Sperm deposited in the females' reproductive tracts in the fall are stored through the winter. The combined fall and spring breeding periods produce a spring litter, because ovulation and fertilization occur only in spring. In tropical regions, however, breeding is immediately followed by fertilization and embryo development. The gestation period of most species ranges from 40 to 70 days but is 100 or more days for some species. Litters range from one to four young.

As the time of birth approaches, an expectant female that has been hanging quietly from a vertical surface suddenly becomes restless and changes position frequently. She is nervous, irritable, and reluctant to eat. She periodically grooms her underside, genitalia, and tail membrane; this behavior lasts from a few minutes to an hour. Just before onset of labor, a fetus changes from a horizontal to a vertical position. An expectant female also normally reverses position until, head up, she is suspended from the vertical surface by the thumbs and feet. The hind legs are spread, and the tail is curled forward over the vaginal opening, forming a "cup" into which the young are born. During labor, a bat cries, closes her eyes, bares her teeth, and makes chewing motions, indicating that labor is probably painful.

In normal labor there may be as few as 10 muscular contractions. The young are usually born in a breech position. Unlike most mammalian offspring, a bat starts to grope with its feet and hind legs as soon as they are freed from the birth canal. The feet grasp whatever they encounter, usually the fur or a leg of the mother. After securing a foothold, the young pulls vigorously with its legs and helps to draw its body from the vagina. In a few seconds, the body is freed up to the head, which remains momentarily in the vagina. The baby may continue to pull with its legs or may bring them forward and brace its feet against its mother's body and push vigorously. Pushing or pulling by the baby, coupled with the muscular contractions of the mother, frees the head suddenly. The mother tears the birth membrane off with her teeth. After delivery, the naked, blind young remain attached to the afterbirth (placenta) by the remarkably elastic umbilical cord. In members of some species, the expulsion of the placenta with its attached umbilical cord is delayed, and the cord functions as a "safety line" after the birth. Should a youngster fall off its mother, it remains suspended close enough to her to be able to secure a firm grip on her with its well-developed thumbs and feet. Free circulation of blood continues through the umbilical cord for 3 to 10 minutes until it blanches and circulation ceases. The delicate cord dries rapidly. If the umbilical cord ruptures too early, the baby bat bleeds to death in minutes. After its expulsion, the placenta may be eaten. A single birth is usually completed within 30 minutes; double births often take longer. During or shortly after birth, the female

resumes her normal head-down position. The mother then grooms her baby until it is clean and dry, after which she cleans herself, using her wings to shift the baby around.

Most bats probably live at least 4 to 8 years in the wild, but banding records show that individuals have exceeded 21 years of age, and captives have lived over **20** years.

World distribution: Evening bats are distributed throughout the temperate and tropical regions of the world, except some islands in the South Pacific. They range from tropical forests to deserts and from sea level to timberline.

Fossil record: In North America, the fossil record for the family dates to the middle Eocene.

Number of species along the Oregon coast: 10.

General references: Bogan (1972), Carter (1970), Greenhall and Paradiso (1968), Studier (1972), Walker et al. (1968), Wimsatt (1980).

Genus *Myotis*: Myotis bats

Derivation: The generic name *myotis* is derived from the Greek words myos (mouse) and otos (ear).

General description: Myotis bats are usually some shade of brown, darker dorsally and lighter ventrally. Dark and light phases are exhibited by members of certain species. Members of some species roost singly or in small groups; others are colonial. In cold regions, myotis bats become torpid in winter, some flying long distances to find suitable hibernation sites. Females of some species are gregarious, and their maternity colonies may number into the tens of thousands. Although females have two teats, one by each forelimb, members of most species have a single young, but some may have two offspring. Births occur in spring and early summer. By late summer, maternity colonies disintegrate. The young become sexually mature in about 1 year. Myotis bats are long lived; individuals have been known to live at least 18% years in the wild.

World distribution: Myotis bats are the most widely distributed of the bats. Except for humans, these bats probably have the most widespread, natural geographical distribution of any genus of terrestrial mammal. They are not, however, found in the arctic or antarctic regions nor on many of the oceanic islands.

General reference: Walker et al. (1988).

Species *Myotis lucifugus:* Little brown bat

Derivation: The specific name *lucifugus* is derived from the Latin word *lucis* (light) and *fugio* (to flee).

Specific description: Total length, 84 to 98 mm; tail, 33 to 41 mm; hind foot, 1 to 11 mm; ear-notch, 14 to 17 mm; ear-tragus, 7.5 to 10 mm; forearm, 33 to 40 mm; weight, 5 to 9.5 g.

Little brown bats have long, soft, thick pelages that are, according to Jackson (1961, p. 76), "reputed to have the finest hair of any mammals and the greatest number of hairs per unit area of skin surface." Their backs vary from yellowish brown, to brown, to dark brown. The dorsal hairs have shiny tips, creating a glossy sheen that is fairly characteristic. The undersides are pale brown with little or no sheen. Ears, when laid forward, reach to the nostrils. Flight membranes and ears are usually dark brown and almost devoid of hair. There are no keels on the calcars (fig. 3). Little brown bats may be confused with Yuma bats (see footnote 3, page 83).

Distribution along the Oregon coast: Little brown bats occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: As far as could be determined, little brown bats appear to be generally distributed in all habitat types along the Oregon coast, but they exhibit an affinity for the forested areas.

Habits: Little brown bats have been observed feeding along the coast as early as the middle of March. The sexes segregate during April when the females form maternity colonies. During the summer, the females usually roost in the attics of houses where they can frequently be heard during the day as they "squabble" among themselves. Stones and Wiebers (1965) found that in the laboratory these bats survived well at 33" C, but they died in a week or two at cooler temperatures when not hibernating (Barbour and Davis 1969). Some of the attics examined probably reached more than 33" C during the day. Males are frequently found alone under loose flashing around chimneys where temperatures also get very high. Occasionally males are found in attics, under shingles, or under wooden or tar-paper siding on houses. In those places, temperatures are much cooler.

By August adult bats have accumulated fat layers for winter. Females accumulate more fat than males (Ewing et al. 1970). Along the coast these bats usually disappear sometime in October. Whether they migrate inland to hibernate or hibernate on the coast is not known; in fact, no data have been found about hibernation of these bats in Oregon. Little brown bats, however, are known to migrate as far as 464 kilometers between their summer feeding areas and their winter hibernation sites (Barbour and Davis 1969).
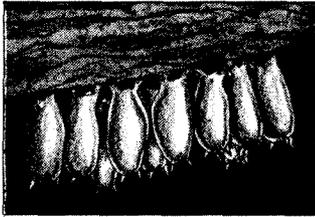
LITTLE BROWN BAT

When hibernating in northern regions, these bats form tightly packed clusters that aid in conserving body heat; in southern regions, they do not exhibit this habit. During hibernation, they select areas that remain several degrees above freezing and have high humidity (85-100 percent). The humidity is often high enough to form droplets of condensation. Bats arouse at about 2-week intervals and, if conditions have changed, move to more favorable areas (Barbour and Davis 1969). When wind blows into the hibernaculum during an extremely cold spell, exposed bats regulate their body temperatures by increasing their metabolism to maintain a body temperature a few degrees above air temperature (Davis and Reite 1967). Prolonged exposure to subfreezing temperatures is fatal, especially to young bats (Davis and Hitchcock 1965).

Food: Along the Oregon coast, these bats usually emerged about 20 to 30 minutes before dark and foraged among scattered trees, along the edges of dense timber, and over lawns and meadows. They were occasionally seen feeding in continuous circular patterns, 1.5 to 3 meters above the ground, around buildings and small patches of trees. Whitaker et al. (1977) found that little brown bats in western Oregon ate 22 types of food. The three most important food items were midges (Diptera), internal organs of large insects, and unidentified flies (Diptera). In Indiana, Whitaker (1972a) found that small moths and caddisflies were the most important prey for little brown bats from May to September; but the bats also ate such insects as beetles, ants, craneflies, crickets, and leafhoppers.

Reproduction: Little brown bats breed in the fall. Along the Oregon coast, sexually active adults were captured as early as August 1; in large hibernation colonies, however, some breeding occurs throughout the winter (Jackson 1961, Barbour and Davis 1969). Delayed fertilization takes place in the spring when the bats emerge from hibernation (Wimsatt 1944). The gestation period is 50 to 60 days (Wimsatt 1945). On the Oregon coast, maternity colonies are formed in April, in warm, dark, secluded places-such as the attic of a house around the chimney. In some parts of North America, maternity colonies are large, frequently 300 to 600 individuals (Barbour and Davis 1969) but occasionally 30,000 or more (Cockrum 1956), consisting primarily of mothers and their offspring. One maternity colony examined at the beginning of May in Bandon, Coos County, contained seven pregnant little brown bats and one pregnant Yuma bat. The colony was under the loose flashing around a chimney. A second colony, found in Lincoln City, Lincoln County, in the middle of August, consisted of 20 to 30 females and young.

There is considerable variation in birth dates within the species and within a given colony. The time of birth may be correlated with latitude to some extent. No data were found about birth dates for these bats in Oregon, but the aforementioned females secured at Bandon on May 3 had small embryos (2-5 mm), whereas two females captured on July 4 in Columbia County, Oregon, contained large embryos (16-23 mm). In King County, western Washington, four females were caught with large embryos (16-23 mm) on July 13, and a female captured on October 10 was lactating.

Little brown bats usually have a single young each year, occasionally two. Davis and Hitchcock (1965) suggested that older females give birth early; hence, later births may be from young females having their first litters.

At birth a bat is blind, almost devoid of hair, and weighs about 1.7 grams, about one-fourth the mother's weight after she has given birth. The young have disproportionately large thumbs, feet, and head. After the mother has licked its baby dry, the baby climbs about on her body until it finds one of her two teats on the chest near the forearms; the suckling baby is then wrapped in its mother's wing. Although the baby's eyes open on the 2d day, it remains wrapped in its mother's wing, firmly attached to a teat throughout its first few days of life. The mother probably leaves the baby hanging in the roost at night when she leaves to feed. When about half grown, the youngster begins to hang beside its mother during the day in the roost (Wimsatt 1966).

Young bats are capable of flight at about 3 weeks of age. They learn to fly in the home shelter, and, at about 1 month, they venture outside. At that time they weigh nearly as much as adults. Davis and Hitchcock (1965) observed that young bats flew in a continuous circular pattern near the exit of the roost. Their flight was slow and steady in contrast to the zigzag pattern characteristic of adult bats. Davis and Hitchcock thought that these young bats were not yet weaned and that they were practicing flying and perhaps orientation, rather than feeding. Once out-side, they must learn to detect and capture prey, which apparently requires time and practice. Therefore, they are probably not weaned until they become competent at capturing food. Even though young bats continue to feed after the adults are in hibernation, they are not able to accumulate as much fat as the adults which may cause some mortality their first winter. Little brown bats are not sexually mature until the next year. Several have lived 20 years.

Predation: Along the Oregon coast, domestic cats kill a number of little brown bats in and around their roosting areas. Barbour and Davis (1969) cited a record of a little brown bat recovered from the stomach of a bass and of another captured by a broad-winged hawk.

Economic status: Since they destroy millions of insects annually, these bats are beneficial. Large colonies occasionally cause problems in houses because of the accumulation of feces and odors, as well as the noises created by the bats.

Disease: Little brown bats are carriers of rabies.

Selected references: Bailey (1936), Barbour and Davis (1969).

Species *Myotis yumanensis:* Yuma bat

Derivation: The specific name *yumanensis* is a proper name. The first specimen of this species was captured at Old Fort Yuma, Imperial County, California, on the right bank of the Colorado River opposite the present town of Yuma, Arizona; hence the proper name "Yuma" plus the Latin suffix *ensis* (belonging to).

Specific description: Total length, 84 to 99 mm; tail, 32 to 45 mm; hind foot, 9 to 11 mm; ear-notch, 11 to 16 mm; ear-tragus, 8 to 9 mm; forearm, 33 to 37 mm; weight, 5 to 7 g.

Yuma bats have dull fur that varies dorsally from brown to dark brown. Their undersides are pale brown to almost tan; their throats are often whitish. When laid forward, the ears reach to the nostrils. Flight membranes are usually dark brown. There are no keels on the calcars (fig. 3). Burt and Grossenheider (1984) stated that the tail membrane is hairy nearly to the knees, but this characteristic is not reliable in western Oregon. Yuma bats may be confused with little brown bats; see footnote 3, page 83.

Distribution along the Oregon coast: Yuma bats occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Yuma bats are closely associated with water. They can be found along large streams, rivers, ponds, and lakes, but since they feed close to the surface of the water, there must be ample room to maneuver.

Habits: Yuma bats have been observed feeding along the coast as early as the middle of March. The sexes segregate in April. Although no maternity colonies were found along the coast, Yuma bats form maternity colonies in buildings, mines, and caves, and under bridges (Barbour and Davis 1989). Dalquest (1947a) estimated that one colony in Nevada contained 5,000 individuals. He found that maternity colonies would not tolerate human disturbances. Once disturbed, the colony would partially or completely abandon the original site. Maternity colonies may be formed in buildings where temperatures reach 50" C in the afternoon (Barbour and Davis 1989). Licht and Leitner (1987) studied the relationship of a maternity colony of about 2,000 Yuma bats to daily temperature differences in a barn in California. They found that the bats roosted in tight congregations at the tops of the beams adjacent to the ceiling during the cool morning. As the temperature rose to 40" C, the bats spread out and moved down the beams away from the ceiling. When the temperature exceeded 40" C on all portions of the beams, most of the bats flew to cooler areas of the barn where the temperature stayed below 30" C. The remaining bats withstood a temperature of 41° C. As the temperature decreased in the late afternoon, the bats that had remained on the beams moved closer to the ceiling, but those that had left the beams did not return to them until they finished foraging during the night.

Tar-paper and wooden siding of buildings appear to be main roosting sites used by Yuma bats along the Oregon coast. A few were located in attics and under loose flashing around chimneys. Yuma bats occasionally shared roosting sites with little brown bats, long-eared bats, or California bats. Dalquest (1947a) stated that there frequently was little evidence of use of night roosts or resting sites. On the coast, however, night roosts showed ample signs of use, such as accumulations of feces and white stains from urine. Night roosts, but not day roosts, are frequently established under bridges. Sixteen kilometers east of Brookings, Curry County, Yuma bats were observed using an exposed chimney on a house. The bats rested just under the overhang of the roof at about 15- to 20-minute intervals. At Bandon, Coos County, on the other hand, numerous Yuma bats used a low, permanently open garage for a night roost. The bats flew into the garage and rested on the beams near the ceiling. There were occasionally as many as 12 bats in the garage at one time. The garage had been used as a night roost for several years even though it was constructed under the house. The noise and movement of the human inhabitants had no apparent effect on the bats.

Yuma bats, having substantial accumulations of fat by September, disappear in late October. Whether they migrate inland or hibernate along the coast is not known. Yuma bats have been studied in California and elsewhere, but no winter hibernation sites have been found. After the maternity colonies are abandoned in the fall, the bats disappear (Barbour and Davis 1969).

Food: Along the Oregon coast Yuma bats emerge to feed 20 to 30 minutes before full darkness. They normally feed just a few centimeters over the surface of the water. They often feed within regular routes that they fly again and again. Along rivers and streams, they fly back and forth in relatively straight patterns; over ponds and small lakes, they fly in circular patterns. Yuma bats were observed flying in continuous circular patterns 1.5 to 3 meters above the ground around a house near a small river 16 kilometers east of Brookings. Barbour and Davis (1969) stated that Yuma bats are efficient feeders. Taken from resting sites 15 minutes after dusk, they already had full stomachs. Yuma bats in western Oregon ate 12 types of food, of which the 4 most important were midges and flies (Diptera), termites (Isoptera), and moths (Lepidoptera) (Whitaker et al. 1977).

Reproduction: Little is known about the reproduction of Yuma bats. Each female gives birth to a single young. The young are born from late May to July (Barbour and Davis 1969). Along the coast, four females with very early pregnancies were caught in mid-April, and one female with a small embryo (7 mm) was taken in a small maternity colony of pregnant little brown bats on May 3 at Bandon. The colony was under loose flashing around a chimney.

Breeding probably begins in the fall; four adult males with mature testes were captured in early August.

Predation: The only animal found to kill Yuma bats was a domestic cat that was extremely agile and adept at snagging them as they flew into the garage at Bandon. Although the cat leaped into the air, caught and killed three bats in 30 minutes, it did not eat them. Hunting bats in the garage was a regular activity of the cat; it probably killed many during a summer.

Economic status: Consuming millions of insects each year, these bats are beneficial.

Disease: Yuma bats are carriers of rabies.

Selected references: Bailey (1936), Barbour and Davis (1969), Dalquest (1947a).

Species *Myotis* evotis: Long-eared bat

Derivation: The specific name *evotis* is derived from the Greek words ev (good) and otos (ear); it refers to the species' large ears.

Specific description: Total length, 89 to 96 mm; tail, 37 to 43 mm; hind foot, 2 to 12 mm; ear-notch, 20 to 23 mm; ear-tragus, 9 to 12 mm; forearm, 36 to 41 mm; weight, 5 to 7 g.

Long-eared bats have dull, yellowish brown to dull, light brown backs. They have tan to light tan undersides. The hairs are dark gray at the bases, much darker than the tips. The large, black ears, when laid forward, reach about 5 to 9 millimeters beyond the nose. Flight membranes are dark brown. Sometimes long-eared bats are confused with fringed bats, but long-eared do not have a conspicuous fringe of stiff hairs along the margins of the tail membranes (fig. 5). The calcars lack keels (fig. 3).

Distribution along the Oregon coast: Long-eared bats occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: These bats are primarily inhabitants of coniferous forests. Along the Oregon coast, they occur in the mature conifer, immature conifer, lodgepole pine/rhododendron, lodgepole pine/salal, and to a lesser extent, in the alder/salmonberry habitats.

Habits: Although generally distributed throughout Oregon, long-eared bats are not abundant anywhere. There is a corresponding lack of knowledge about their life history.

Long-eared bats use buildings and slabs of loose bark attached to dead trees as day roosts along the coast. These bats most frequently use buildings as day roosts throughout their geographical distribution; they often use caves as night roosts or resting sites but seldom reside in them during the day (Barbour and Davis 1969). Albright (1959) found that long-eared bats were the most common species using the cave at Oregon Caves National Monument, especially early in August. Bats were captured in an insect net during August and most of September 1958. Most bats were taken as they returned to the cave between 1O:OO p.m. and 2:00 a.m. Of the 381 bats captured and banded, 213 were long-eared bats, 185 males and 28 females.

Fifteen adult long-eared bats were captured along the Oregon coast during August, but none had any fat deposit. On the other hand, an adult male long-eared bat caught on October 31 had a good accumulation of fat. None of these bats were seen later than October 31, and nothing is known about their hibernation.

LONG-EARED BAT

Food: Long-eared bats emerge late in the evening and feed among the trees. They were found to emerge from 10 to 40 minutes after full darkness in early August 1971. These bats ate 11 types of food, including flies, moths, beetles, and spiders (Whitaker et al. 1977).

Reproduction: Small maternity colonies are formed in late spring or early summer where each pregnant female bears a single young. Maternity colonies of 12 to 30 individuals have been found in buildings and hollow trees (Cowan and Guiguet 1965). A small maternity colony of five females in late pregnancy was found on July 15, 1950, in the attic of a small house in Clallam County, western Washington. The bats were next to the chimney of a wood cookstove. One young was visible on July 15. Four additional young were born in captivity the night of July 16, but the birth process was not seen. The mothers were observed, however,

licking the umbilical areas of the babies. The babies weighed about 1.08 to 1.36 grams at birth and were about 40 to 47 millimeters long. The wingspan, from wing tip to wing tip, of a newborn baby was about 103 millimeters whereas the wingspan of an adult was 250 millimeters. The babies were devoid of hair, but their deciduous or milk teeth were sharp. Two nonpregnant females were also captured in the attic, but they were roosting apart from the maternity colony.[4]

A maternity colony of long-eared bats was found living in the attic of a house about 1 kilometer northeast of Otis Junction, Lincoln County, Oregon. The bats, discovered on August 2, 1971, entered the house through a small hole just under the overhang of the roof. Although they could not be located within the attic, the amount of feces around the base of the chimney was ample evidence that the bats had been using the house for several years. The bats were captured in a fine, nylon net that was secured around the entrance to their roost. Two adult male Yuma bats and 19 long-eared bats were caught: 12 adult females, 2 adult males, 1 juvenile female, and 4 juvenile males. A fifth very young male was found on the ground under the entrance to the roost on the day after the capture of the only lactating female, presumably its mother. The other young, however, were old enough to fly and leave the roost. The two adult males had maturing testes.

Predation: Apparently nothing is known about the predation of long-eared bats.

Economic status: Because of their insect diet, these bats are considered beneficial.

Disease: Long-eared bats are carriers of rabies.

Selected reference: Barbour and Davis (1969).

Species *Myotis thysanodes:* Fringed bat

Derivation: The specific name *thysanodes,* derived from the Greek word *thysanos* (fringe), refers to the fringe of short, stiff hairs along the margin of the tail membrane.

Specific description: Total length, 91 to 98 mm; tail 40 to 41 mm; hind foot, 9 to 11 mm; ear-notch, 16 to 20 mm; ear-tragus, 9 to 12 mm; forearm, 38 to 46 mm; weight, 7 to 9 g.

Fringed bats are the only bats with a conspicuous fringe of short, stiff hairs along the margin of the tail membrane (fig. 4). Dorsally, they vary from dull to moderately glossy yellowish brown, slightly reddish brown, or brown. Their undersides are light tan or light grayish tan. They have black ears and dark brown flight membranes. When laid forward, the ears extend from 3 to 5 millimeters beyond the nose. There are no keels on the calcars (fig. 3).

[4] Field notes of M. L. Johnson, Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington.

Distribution along the Oregon coast: Fringed bats are rarely seen in Oregon. The first record of a fringed bat in the State was a subadult secured in Tillamook, Tillamook County, on September 13, 1928 (Walker 1942); a second specimen was captured at Tillamook on August 3, 1940 (Roest 1951). In addition, I caught three males about 1 kilometer northeast of Otis Junction, Lincoln County, on August 11, 12, and 14, 1971. Although fringed bats are rare along the Oregon coast, a few appear to regularly use the cave at Oregon Caves National Monument (Albright 1959, Roest 1951).
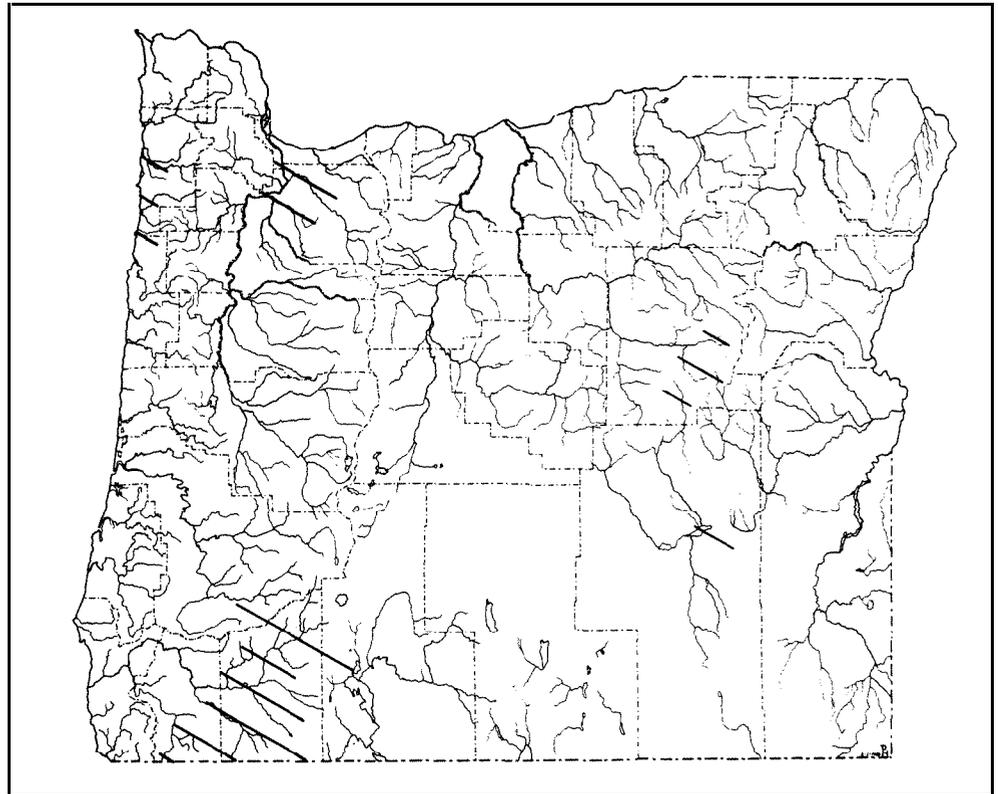
KNOWN DISTRIBUTION OF FRINGED BAT

Habitat: Nothing is known about the habitat in which fringed bats forage along the Oregon coast; however, the area in which the three specimens were caught in August 1971 can be characterized as alder/salmonberry habitat in the proximity of immature conifer habitat.

Habits: Caves, mines, rock crevices, and buildings are favored roosting sites. Such shelters are frequently used as day and night roosts; those not used during the day may be used at night, as evidenced by droppings (Barbour and Davis 1989). The three bats taken in August 1971 were captured in the early morning as they roosted under loose flashing around a chimney. None of these bats had fat accumulations. Nothing is known about their winter habits.

Food: The stomachs of four fringed bats contained the following foods, expressed in percent of the volume: moths, 46.2; harvestmen or daddy-longlegs, 26.2; crickets, 16.3; craneflies, 6.3; spiders, 5.0 (Whitaker et al. 1977).

Reproduction: Barbour and Davis (1969) wrote that almost nothing is known about reproduction in the species, except that a single young is produced from each pregnant bat annually. Fringed bats are highly colonial, and maternity colonies of several hundred individuals are common. Females containing embryos have been captured in June; young are born in July. Maternity colonies apparently break up in the fall, but nothing is known about their movements. The three male bats caught in August 1971 had maturing testes. Roest (1951) collected a male with mature testes at Oregon Caves National Monument on September 4, 1948.

Predation: Nothing is known about predation of fringed bats.

Economic status: Because of the insects consumed annually by these bats, they are considered beneficial.

Disease: Fringed bats are not known to carry rabies, but that does not mean that they are not potential carriers.

Selected reference: Barbour and Davis (1969).

Species *Myotis volans:* Long-legged or hairy-winged bat

Derivation: The specific name *volans* is the Latin word for "flight" and refers to the excellent flying capabilities of this bat.

Specific description: Total length, 90 to 106 mm; tail, 38 to 49 mm; hind foot, 8 to 10 mm; ear-notch, 13 to 15 mm; ear-tragus, 8 to 9 mm; forearm, 38 to 41 mm; weight, 7 to 9.5 g.

Long-legged bats are large and have long, soft, dark hair that is slightly glossy in some individuals. Dorsally, they vary from reddish brown, brown, to nearly black. Their undersides are slightly paler than their backs and vary from yellowish brown, reddish brown, to nearly black. The rounded ears are attached low on the head, making them appear smaller than they are. When laid forward, the ears barely reach the nostrils. The ears and flight membranes appear black. Long-legged bats are the only brown bats with belly hair extending onto the undersides of the wings, covering the membranes as far as the knees and elbows and forming a line that parallels the body. They have prominent, long, wide keels on the calcars (see fig. 2).

Distribution along the Oregon coast: Long-legged bats occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Along the coast, these bats occur in the mature conifer, immature conifer, and in some areas, alder/salmonberry habitats. They are also found in the lodgepole pine/rhododendron, lodgepole pine/salal, and Sitka spruce/salal habitats.

Habits: Even though long-legged bats are widely distributed in Oregon, almost nothing is known about their habits. The only record of a roosting long-legged bat along the coast is of a male discovered under tar paper on the side of a building 16 kilometers east of Brookings, Curry County, on April 24, 1972. The bat, found at 7:30 a.m., had not been there the day before. Albright (1959) caught a few of these bats in an insect net in the cave at Oregon Caves National Monument between 10:00 p.m. and 2:00 a.m. in August and September 1958. In other parts of their geographical range, long-legged bats have roosted in crevices in the face of a cliff (Davis 1966). Barbour and Davis (1969) stated that caves and mines are used as roosts at night but not during the day.

Barbour and Davis (1969) wrote that few long-legged bats had been banded, but none had been recovered. Almost nothing is known about their winter habits; however, two long-legged bats were beginning to accumulate fat when they were taken along the coast in August 1972.

Food: In August, long-legged bats were seen flying only on warm, overcast evenings along the coast. When the overcast was heavy, long-legged bats emerged as early as 8:00 p.m.; when the overcast was light, they emerged as late as 8:45 p.m. On cold, clear nights, however, the only *Myotis* captured feeding along the edge of the forest were little brown bats. Perhaps long-legged bats fed among the trees on such nights, because occasionally a large *Myotis* would fly out of the forest and directly back in again without paralleling the edge of the forest.

Long-legged bats did not appear to establish well-defined feeding territories along the coast. An area might be occupied by a single foraging long-legged bat one night, three the next, and none the next. On August 16, 1972, two bats were observed flying at considerable speed along a road; one appeared to be chasing the other for they were only inches apart. The second bat made every twist and turn made by the leader. It was shot and proved to be a long-legged bat. From the size and style of flight, both bats were thought to be the same species. Thus, there may be some territoriality among foraging long-legged bats.

Long-legged bats were found to eat 10 kinds of food. Moths (Lepidoptera) constituted 78.2 percent of their diet (Whitaker et al. 1977).

Reproduction: Long-legged bats form maternity colonies where each pregnant female gives birth to a single young annually. Such colonies often contain several hundred individuals (Barbour and Davis 1969). Dalquest and Ramage (1946) reported a maternity colony of about 500 long-legged bats in California. They collected 100 of the females between June 2 and 4, all in late stages of pregnancy. Numerous dates from May 31 to August 1 are given by Barbour and Davis (1969) for the capture of pregnant females.

No dates were given for pregnant or young long-legged bats found in Oregon. Two females, however, caught along the coast in August 1972 had well-developed mammary glands although they no longer showed signs of producing milk. Two males had mature testes, whereas the testes of two other males were approaching maturity. Breeding probably begins in the fall.

Predation: Apparently nothing is known about predation of long-legged bats.

Disease: Long-legged bats are carriers of rabies.

Selected references: Barbour and Davis (1969), Dalquest and Ramage (1946).

Species *Myotis californicus:* California bat

Derivation: The specific name *californicus* is a proper name; this species was named after the State of California with the Latin suffix cus, denoting possession. The name means "California's bat."

Specific description: Total length, 78 to 88 mm; tail, 33 to 42 mm; hind foot, 7 to 8 mm; ear-notch, 11 to 15 mm; ear-tragus, 5 to 9 mm; forearm, 29 to 38 mm; weight, 3 to 7 g.

California bats are the smallest bats in western Oregon; they also have the smallest hind feet. Dorsally, their soft hair ranges from reddish brown to brownish red. Their undersides are slightly lighter with a little less red. The bases of the hairs are much darker than the tips. Ears and flight membranes are dark brown. There are definite, although small, rounded keels on the calcars (see fig. 2).

Distribution along the Oregon coast: California bats occur along the entire coast. They also occur in appropriate habitats throughout the State.

Habitat: These small bats are common and generally distributed along the coast. Undoubtedly occupying a wide variety of habitats, they have been found in immature conifer, alder/salmonberry, riparian hardwoods, lodgepole pine/rhododendron, and lodgepole pine/salal.

Habits: California bats are perhaps best characterized as crevice-dwellers. As such, they probably use structures made by people as night roosts more than any other species of bat (Barbour and Davis 1969). Most such structures are constructed of wood, but in California Krutzsch (1954a) found structures of adobe and concrete to be used. These bats also roost in mines, caves, hollow trees, and beneath flakes of rock and loose bark.

Along the coast, they use structures made by people as day roosts more frequently than any other species of bat. Tar paper on the outside of buildings was most commonly used, provided it was loose, torn, or had a large enough hole for entry. Some bats were even found under loose tar paper that had been in place less than 2 weeks. They were also discovered in crevices in the roofs of attics, under window shades, in cracks around exterior moulding. Occasionally they were found hanging exposed on the ends of rafters that extended to the exterior of a building but were protected by the slight overhang of the roof.

Krutzsch (1954a, p. 539) observed that, except for occasional maternity colonies, California bats seem to "move about without regard to any particular, habitually used, hiding place. They apparently roost in the most available site when their evening foraging is completed." He found a bat, for example, in a fold of a temporary canvas shelter less than 24 hours after it was erected and two females with their young in the folds of an old rag hanging inside an abandoned building. The rag had been uninhabited when checked before. Since most retreats are used only at intervals, there are no accumulations of feces or urine stains. For the most part, these observations are also valid along the Oregon coast, but there is one exception. When the bats roost under tar paper that is fastened securely at the bottom, the accumulations of feces become great enough to cause the tar paper to bulge outward. California bats were collected occasionally in attics where they were difficult to find because there were no droppings or urine stains. A number of these bats were caught in an attic near Otis Junction, Lincoln County, in the cracks between the shingles and the rafters after droppings were noticed on the floor directly under the roosting bats. Since the bats were found in August, the droppings represented only the summer's accumulation. Such continued use of particular roosting sites other than tar paper was exceptional.

So far as is known, California bats are the only bats in Oregon that occasionally fly and feed during the day. On May 9, 1950, a California bat flying in bright sunlight in a ponderosa pine forest was shot at 9:00 a.m., 9.6 kilometers northwest of Sisters, Deschutes County, Oregon. Another of these bats was collected as it fed on "mayflies" along Fishhawk Creek near Jewell, Clatsop County, Oregon, at 11:00 a.m. on April 30, 1955. I collected a third California bat on April 10, 1971, near Otis Junction. It was shot as it flew over a lawn at 4:55 p.m., just as the sun emerged from the clouds on a predominantly cloudy day.

Although most California bats probably hibernate throughout the winter, Krutzsch (1954a) found active individuals every month of the year in southwestern California. Their activity gradually increased in the spring and gradually decreased in the fall. They were encountered most frequently from May until September, whereas the fewest individuals were encountered from November to February. In western Oregon, three hibernating California bats were found on December 3, 1969, between the inner and outer walls of an old, abandoned house. The bats; two females and one male, were extremely vocal when disturbed and became very active; they had good accumulations of fat but showed no evidence of having eaten recently. Two male bats were captured 6.4 kilometers southeast of Bandon, Coos County, on November 15 and 17, 1971. Both bats had food in their intestines that indicated that they had been feeding recently; both had good accumulations of fat. Thirteen bats were found on February 26, 1972, under tar paper on the outside of a shed 14 kilometers north of Gardiner, Lane County. Two had stomachs with some food, and all had food in their intestines that indicated recent feeding. Only two of the nine bats had any fat accumulation, and that was minimal. The shed was revisited on March 20, and 14 more bats (12 females and 2 males) were secured under the tar paper. They all had food in their stomachs. Five had no fat, but nine had moderate to heavy accumulations. On March 21, a male was found under the tar paper; it had no fat, but its stomach contained food. Two females, caught in the same place on March 23, also had food in their stomachs. One had fat; the other did not. Because there was little accumulation of fat in the bats but food in their stomachs, it appears that California bats emerge from dormancy in

late February or early March along the Oregon coast. When these bats enter dormancy is not known, but none collected in late August 1971 had accumulations of fat. The California bat appears to emerge from dormancy earlier and to enter it later than other species along the coast.

Food: California bats apparently emerge to forage at different times, depending on location. Bailey (1936) stated that these bats started to fly about 20 minutes before full darkness. Krutzsch (1954a) found that they began foraging before dark and continued until the early hours of the morning but rested periodically throughout the night. According to Barbour and Davis (1969), they did not emerge until it was too dark to shoot them. Along the coast, a single California bat was collected while foraging 16 kilometers east of Brookings, Curry County, on April 13, 1972. It was shot as it started to feed 50 minutes before full darkness.

Krutzsch (1954a, p. 544) probably best describes the foraging behavior of these bats: "Little California bats go to open water to drink soon after emerging from their diurnal retreat. These bats apparently seek water several times during the night, certain favored watering places being repeatedly utilized." While drinking, they flutter slowly over the water, their heads bent forward.

> *Myotis californicus* begins foraging in the early evening soon after sunset. They feed rapidly and fill their stomachs in a short time, often retiring to a roosting site near their foraging grounds a few minutes after darkness. Foraging is done near the ground, frequently at heights of less than 10 feet. Quite often bats stay near vegetation in their search for food. The height of the foraging flight, therefore, varies somewhat according to the vegetation level at which food material is most abundant.

Barbour and Davis (1969) stated that California bats have a slow erratic flight pattern. Dalquest (1948), on the other hand, could not distinguish them from little brown bats or Yuma bats when in flight, nor could I along the coast.

California bats are entirely insectivorous, but little is known about their specific diet. Krutzsch (1954a) watched them catching "oak moths." The individual shot while foraging 16 kilometers east of Brookings had a cranefly in its mouth. These bats ate 17 types of food (Whitaker et al. 1977). The four most important were: midges, unidentified flies, craneflies (Diptera), and moths (Lepidoptera).

Reproduction: Female California bats form maternity colonies in the spring where each gives birth to a single young. There is considerable variation in birth dates. A female in early pregnancy was collected on April 30, and two were caught on May 1. Another female captured on May 21 was in late pregnancy. Recently born bats have been found as late as June 20, whereas others were nearly as large as the adults by that time and were well able to fly. One female that had recently ceased lactating was captured on August 7 (Krutzsch 1954a). Along the Oregon coast, 2 females in early stages of pregnancy were found on February 26; 2 on March 12; 12 on March 20; 2 on March 23; 1 on April 7; 1 on April 29; 1 on May 3; and 1 on May 6.

Breeding probably begins in the fall. Krutzsch (1954a) found males with enlarged testes in September and October; two males with enlarged testes *were* captured along the Oregon coast in August.

Predation: Apparently nothing is known about predation of California bats.

Economic status: These bats are beneficial because of the large numbers of in· sects that they destroy each year.

Disease: California bats are carriers of rabies.

Selected references: Barbour and Davis (1969), Krutzsch (1954a).

Genus *Lasionycteris*: Silver-haired bat

Derivation: The generic name Lasionycteris is derived from the Greek words *lasios* (hairy) and *nykteros* (nocturnal). The name refers to the species' hairy tail membrane and to the bat's time of activity.

General description: Silver-haired bats dwell primarily in trees, so they are usually associated with wooded or forested areas. In some parts of their distribution they are permanent residents; in these areas they hibernate throughout the winter. Over most of their geographical range, however, they migrate south in the fall and north in the spring. In the mountainous regions of the Western United States, their migration is primarily elevational.

World distribution: Except for the Hawaiian Islands, silver-haired bats occur throughout most of the United States, including southeastern Alaska, and southern Canada. These bats have also been found in the Bermuda Islands, but most oceanic records are from the fall and spring, the time of migration.

General reference: Walker et al. (1968).

Species *Lasionycteris noctivagans:* Silver-haired bat

Derivation: The specific name *noctivagans* is derived from the Latin words *noctis* (night) and *vagans* (wandering).

Specific description: Total length, 92 to 112 mm; tail, 38 to 50 mm; hind foot, 9 to 11 mm; ear-notch, 15 to 18 mm; ear-tragus, 6 to 9 mm; forearm, 40 to 44 mm; weight, 8 to 14 g.

Silver-haired bats are distinctive. Their backs vary from dark brown to black; numerous white-tipped hairs give the pelage a silvery appearance. Their undersides are slightly paler and have a less pronounced silvery appearance. The ears are about as broad as they are long and are black. Wing membranes are dark brown to almost black. Tail membranes are dark brown and are well furred on the topsides from their bases to about two-thirds of their lengths. The only other bat along the Oregon coast that has a furred tail is the hoary bat. Hoary bats have small clusters of stiff, light tan hairs on the wrists and elbows and soft, yellowish

fur extending to the wrists on the undersides of the wings. Silver-haired bats have neither small clusters of stiff hairs on the wrists and elbows nor soft, yellowish fur on the undersides of the wings.

Distribution along the Oregon coast: Silver-haired bats occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Silver-haired bats were found in the mature conifer, immature conifer, and alder/salmonberry habitats. They should also be in the lodgepole pine/ rhododendron, lodgepole pine/salal, Sitka spruce/salal, and perhaps occasionally other habitats.

Habits: Usually solitary by nature, silver-haired bats are erratic in numbers and are scarce throughout much of their range. They are primarily a northern species associated with coniferous forests. They are probably most common in the central Rocky Mountains, from Wyoming and Idaho north into Canada. They are locally abundant during their brief migration north in the spring but less common during their more prolonged migration south in the fall.
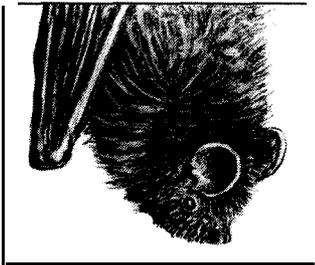
LVER-HAIRED BAT

The spaces between pieces of loose bark and the trunks of trees are probably their most typical roosting sites during the day. They also are known to roost in hollow trees, woodpecker holes, and birds' nests. Because of a scarcity of normal roosting sites during migration, however, they may be found in a wide variety of places, such as open sheds, garages, and outbuildings. They have even been discovered in piles of lumber, railroad ties, and fenceposts (Barbour and Davis 1969).

The migratory habits of silver-haired bats are not well understood. These bats are unknown in many areas in the summer but are regular and dependable visitors in spring and fall. In such areas they may be fairly abundant. At times silver-haired bats migrate in groups; there are records of weary bats descending on ships at sea off the Atlantic coast of North America. During migration, these bats have also been found on oceanic islands, but they do not occur on these islands at other times (Barbour and Davis 1969).

Silver-haired bats hibernate in hollow trees, buildings, and rock crevices. In the Midwestern and Southeastern United States they also hibernate in silica mines but rarely in limestone caves. Silica mines may be selected because the soft surface of the wails is more like the surface of hollow trees, not the hard surface of limestone caves (Barbour and Davis 1969). Several of these bats have been found hibernating under the loose bark of western redcedar trees (Cowan and Guiguet 1965). Nothing was found on their hibernation in Oregon.

I found only one record of homing for the silver-haired bat. The bat, captured on June 6, 1966, at an elevation of 2 402 meters was released on June 8 after being transported more than 160 kilometers from the site of capture. The bat was again caught on June 26 at an elevation of 2 523 meters, 1.6 kilometers southeast of its original site of capture. It had flown at least 171 kilometers from its point of release (Davis and Hardin 1967).

Food: There are differences of opinion about when silver-haired bats emerge to forage. Some authors maintain that they emerge late in the evening (Bailey 1936, Jackson 1961); others contend that they are the first bats to take wing, early in the evening (Dalquest 1948, Cowan and Guiguet 1965, Barbour and Davis 1969). Along the Oregon coast, silver-haired bats emerged fairly early in the evening; however, their time of emergence varied. One bat was shot 16 kilometers east of Brookings, Curry County, while foraging 45 minutes before full darkness on April 19, 1972. On August 2, 1972, a silver-haired bat was shot near Otis Junction, Lincoln County, as it foraged about 15 minutes before full darkness. Another individual, shot in the same location on August 6, was abroad 25 minutes before dark. Such variability may be due to the prevailing weather conditions or, as suggested by Jackson (1961), the location of the roosting site. When roosting in trees, some bats may be in areas where daylight lasts longer than it does in other areas.

Differences of opinion also exist about the speed of flight among foraging silver-haired bats. Some authors think they are fast fliers (Bailey 1936); if fact, Jackson (1961) said they are the "most rapid-flying" bats in Wisconsin. Dalquest (1948) indicated that they are relatively fast fliers. Barbour and Davis (1969) stated that, with the possible exception of one other species, silver-haired bats are the "slowest-flying" North American bats. I have collected silver-haired bats in western Oregon and considered them the slowest flying bats in that part of the State. Dalquest (1948, p. 160) described their flight, "The wings are moved with a 'fluttery' motion, and their flight is interrupted by frequent short glides." The characteristic "fluttery" wing motions are apparent to someone with experience, but the "frequent short glides" should not be construed as a readily distinguishable characteristic of their flight.

Silver-haired bats frequently hunt in sweeping circles, often more than 90 meters in diameter. Although they usually forage in and over the forest, they fly along roads through the forest. Feeding normally occurs 6 to 12 meters above the roads. Adults generally appear singly, but they may be found in pairs or in groups of three or four. Whitaker (1972a) examined the stomach contents of two silver-haired bats from Indiana. One was full of caddisflies, and the other contained 90 percent caddisflies and 10 percent Scarab beetles. In western Oregon, these bats were found to eat 22 kinds of food; the most important were moths (Lepidoptera), termites (Isoptera), and flies (Diptera) (Whitaker et al. 1977).

Reproduction: There are several reports from the late 1800's of maternity colonies of silver-haired bats. One cited 10,000 individuals; but since no reports of maternity colonies within the last 60 years have been found, the identification of the species in these earlier records is questionable (Barbour and Davis 1969).

Little is known about the breeding habits of silver-haired bats. Two young (occasionally only one) are born to each pregnant bat in June or July (Barbour and Davis 1969, Easterla and Watkins 1970). Bailey (1929) collected six reproductively active female silver-haired bats, four of which contained two embryos each. They were collected on May 20 and 28 and June 2. One female, collected on May 30, "showed signs of having bred," and a lactating female was captured on July 9. Easterla and Watkins (1970) captured 18 female silver-haired bats between June 9 and July 2, 1967. Five were lactating, seven contained two embryos, and two contained a single embryo. The reproductive status of four was not determined. On

August 2, 1972, a lactating female with one uterine scar **was** shot near Otis Junction, Lincoln County, Oregon. Males with enlarged testes have been captured in the Pacific Northwest in July, August, and September.

Predation: Silver-haired bats are occasionally captured by owls (Jackson 1961). Sperry (1933) found two of these bats in the stomach of a striped skunk.

Economic status: These bats are beneficial because they destroy millions of insects annually.

Disease: Silver-haired bats are carriers of rabies.

Selected references: Barbour and Davis (1969), Easterla and Watkins (1970).

Genus Eptesicus: Big brown bats

Derivation: The generic name *Eptesicus* is derived from the Greek words *epiēn* (to fly) and *oīkos* (house).

General description: Big brown bats are reddish brown, dark brown, or nearly black above and usually paler below. Some species in Africa have white or translucent membranes. Members of this genus weigh from 8 to 24 grams. During the summer they often roost in hollow trees or in and around buildings. In the Antilles (West Indies), these bats roost throughout the year in the "twilight zone" near the entrances of caves and do not hibernate. One species in Africa is associated with fertility by some natives and is used in religious rites.

World distribution: The genus *Eptesicus* is distributed nearly worldwide and contains about 30 species. They occur from southern Canada to Argentina and Uruguay in South America, the Antilles, Africa, Madagascar, Europe, Asia, and Australia.

General reference: Walker et al. (1968).

Species *Eptesicus fuscus:* Big brown bat

Derivation: The specific name *fuscus* is the Latin word for "brown."

Specific description: Total length, 108 to 139 mm; tail, 43 to 59 mm; hind foot, 10 to 14 mm; ear-notch, 18 to 21 mm; ear-tragus, 8 to 11 mm; weight, 12 to 28 g.

Big brown bats are large. Dorsally they vary from light reddish brown to dark reddish brown and may have glossy hairs. The undersides are paler and lack gloss. They have black faces which, at first glance, appear devoid of hair. Ear and flight membranes vary from dark brown to black. There are well-developed keels on the calcars.

Distribution along the Oregon coast: Big brown bats occur along the entire coast. They also occur in appropriate habitat throughout the State.
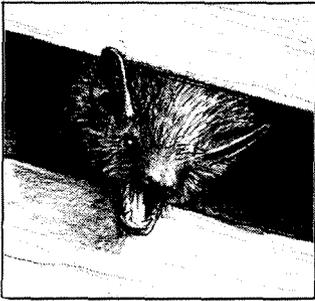
BIG BROWN BAT

Habitat: These bats occupy a wide variety of habitats. Along the Oregon coast they can be found in the mature conifer, immature conifer, alder/salmonberry, riparian hardwood, lodgepole pine/rhododendron, lodgepole pine/salal, Sitka spruce/salal, wet pastureland, headland prairie, headland shrub, mountain river, and tanoak. They probably also occur in other habitats.

Habits: Big brown bats are abundant and generally distributed throughout most of their geographical range. Their summer and winter ranges are almost the same. These bats are closely associated with humans and are probably the most familiar North American bat. Because they roost more frequently in buildings than anywhere else, they are often called "house bats" or "barn bats." Their summer roosts are usually in buildings or hollow trees or under bridges, but they hibernate in buildings, caves, mines, tunnels, and similar shelters (Barbour and Davis 1969).

These bats seek day roosts in dark places and are intolerant of disturbance. If disturbed while roosting in an exposed area of an attic, they immediately retreat to some inaccessible crevice and may not use the exposed area again that season. They may abandon the roost. On the other hand, they may become tame with repeated handling (Barbour and Davis 1969).

Even though they roost in attics, they are not as tolerant of high temperatures as are little brown bats or Yuma bats. When temperatures exceed 33" C, they may seek cooler places or even abandon their roost if the temperature becomes excessively high. They may pass the hottest part of the day in a group on an open floor. Hot spells frequently force these bats to seek cooler places within houses, bringing them into direct contact with people (Barbour and Davis 1969).

Along the coast, temperatures seldom get high enough to force these bats into direct contact with people inside houses. In fact, they appear to use hollow trees, loose flashing around chimneys, and crevices under the exterior siding of houses far more often than attics. None were found under tar paper.

Big brown bats are rather sedentary. Beer (1955) banded 3,871 of these bats in Minnesota and Wisconsin between 1940 and 1953; from the original site of capture, the bats traveled a maximum distance of 53 kilometers during the summer and 98 kilometers during the winter. Beer found that most of the movements were within a 16-kilometer radius of the point of banding. In spite of their seemingly limited movements and their familiarity with only small areas, big brown bats have remarkable homing abilities. Cope et al. (1961) released bats at various distances from their home roost. Bats released 32 kilometers away returned home the same night. It took 2 nights for bats to return from 64 kilometers away, and others arrived at the home roost 3 nights after being liberated 160 kilometers away. Bats released 400 kilometers away arrived home the 4th and 5th nights.

In late summer and early fall, big brown bats accumulate thick layers of fat. Along the Oregon coast, the accumulation of fat begins in July, and by the end of August many bats have thick layers. Big brown bats captured in September may weigh as much as 30 grams; a third of the weight is due to the enormous accumulation of fat, more fat than is needed to survive the winter (Barbour and Davis 1969).

Big brown bats are remarkably hardy. They retreat into underground shelter, such as caves and mines, only during the coldest weather, and their stay in such retreats may be short. Even though some individuals are always found in caves during hibernation, the winter quarters of the majority of these bats are not known. In the northern part of their range, most of them apparently hibernate in buildings (Barbour and Davis 1969). In Oregon, a number of these bats have been found for several years hibernating in buildings in Corvallis, Benton County. Where they pass the winter along the coast is not known since none have been found.

When big brown bats hibernate in caves, they select sites near the entrances where the temperature is low and the relative humidity below 100 percent so they never become covered with condensation. They soon die in a cold place where the humidity is too high. Although they often hang from vertical cave walls, they apparently prefer horizontal crevices and can maneuver themselves into extremely small spaces. Crevices most commonly used are those formed by the partially flaking layers of rock on the ceilings of caves (Barbour and Davis 1969).

Big brown bats arouse when the temperature is below freezing and move to more favorable locations within their shelter. During extremely cold weather big brown bats are often abroad during the day, seeking more adequate shelter (Barbour and Davis 1969). Rysgaard (1941) wrote that drifting snow from a severe storm had closed the entrance to a cave. The habitual use of this particular cave, even though nearby caves were open and accessible, apparently caused the bats to continue to try to gain entrance, resulting in their exhaustion and eventual death. Immediately after the storm, over 100 dead bats were discovered at the entrance to the cave, mostly big brown bats.

Barbour and Davis (1969, p. 128) aptly described a hibernating bat:

> A bat in hibernation is a strange creature. When found, the bat is nearly helpless. If put on the ground it extends its wings, flops onto its back, and opens its mouth, all the while making a kissing sound of apparent protest. If it has an opportunity it will bite, and once the jaws have closed the grip is extremely tenacious and it is difficult to pry the animal loose. In the process of arousal, breathing and heart rate increase, temperature rises, and movements become more frequent. Shivering begins, generating still more heat. Within 15 minutes arousal is complete, and the animal is able to fly.

Food: Barbour and Davis (1969) stated that big brown bats emerge at dusk. Vaughan (1954) caught big brown bats at ponds from 10 minutes to 2% hours after sunset. According to Bailey (1936), big brown bats emerge to forage early in the twilight. Along the Oregon coast, they are the first bats to emerge, often before the swallows have stopped eating, 30 to 40 minutes before full darkness. Before hunting, they go to the nearest water and drink (Bailey 1936). These bats often feed over lighted streets and in city parks. Along the coast, they usually feed high over the forest; at times they appear to be over 46 meters above the ground. As dusk deepens, they sometimes descend to within 12 meters of the ground. When feeding along roads through the forest, on the other hand, they may be only 6 meters above the ground. Their flight is strong and steady. When hunting over

treetops, they often fly in great, sweeping circles; however, along roads they normally fly in a relatively straight course with frequent sallies after insects. They are relatively solitary while hunting and appear to have definitely established foraging territories in which they fly again and again.

About territories, Dalquest (1948, p. 167) observed: "When the bat approached the turning point of the seventh trip, a bat from the adjoining strip of road approached the area. The two animals fluttered about each other with shrill squeaks, audible 50 feet away. The fluttering and squeaking continued for nearly a minute, after which both bats resumed their hunting." They seem to ignore other species of bats hunting in their territories.

Big brown bats are efficient hunters, and adults can fill their stomachs in about 1 hour. Gould (1955) found that an adult bat can catch an average of 2.7 grams of food per hour, but the young of the year average only 1.2 grams per hour. Time and practice probably help young bats learn to hunt efficiently. After feeding, a bat flies to a night roost to rest. Hamilton (1933a) found that big brown bats in New York fed entirely on insects during the summer. He listed the various groups of prey in the percent of frequency that they occurred: beetles (Coleoptera), 36.1; bees, wasps, and ants (Hymenoptera), 26.3; flies (Diptera), 13.2; stone flies (Plecoptera), 6.5; mayflies (Ephemeroptera), 4.6; true bugs (Hemiptera), 3.4; caddis-flies (Trichoptera), 3.2; lace-wing flies (Neuroptera), 3.2; scorpion flies (Mecoptera), 2.7; and crickets, etc. (Orthoptera), 0.6. Bailey (1936) cited noctuid and geometrid moths as food of big brown bats. Whitaker (1972a) studied the food habits of 184 big brown bats in Indiana from April through October. He found that beetles accounted for 49.1 percent of the bats' diet; true bugs and ants were also important foods. He stated that 4.3 percent of the diet was composed of nonflying prey, such as crickets, which might have been picked off vegetation. This might account for the small amount of plant material in the bats' stomachs. He also examined numerous stomachs from bats taken in hibernation and observed that they probably stop feeding in late October and apparently do not feed during the winter. A total of 22 types of food were consumed in western Oregon. The four most important were: moths (Lepidoptera), scarab beetles (Coleoptera), termites (Isoptera), and unidentified beetles; collectively, they formed 63.3 percent (by volume) of the bats' diet (Whitaker et al. 1977).

Reproduction: The production of sperm occurs during the summer, a little earlier in adult big brown bats than in young of the year. By the middle of October sperm production ceases (Christian 1956). Breeding pairs have been observed from November through March (Mumford 1958). Ovulation takes place about the 1st week of April, and the eggs are fertilized by the sperm previously stored in the females' reproductive tracts. From the Atlantic coast to the east edge of the Rocky Mountains, each female produces two young per year; but from the eastern slope of the Rocky Mountains west to the Pacific coast, females nearly always produce only a single young per year. Maternity colonies, ranging from 20 to 300 individuals, are formed about the middle of May, 2 to 3 weeks before the young are born. As the time of birth approaches, the females become reluctant to fly and spend more time in the roost at night (Barbour and Davis 1969). No maternity colonies were found along the Oregon coast. In the southern part of the United States, young are born the last week in May and the 1st week in June; in the

northern portion of the United States, including western Oregon, pregnant females are found in late June, and the young are born near the end of June or the beginning of July. Lactating females have been found as late as August 9.

Newborn big brown bats are large, averaging 4 grams. They cling so tenaciously to the mother's teats that they are difficult to remove without injury. Even the tiniest baby is left in the roost when the females leave at night to forage. How a mother induces her young to release its grip is not known (Davis et al. 1968).

In Nevada, Hall (1946) shot 25 adult big brown bats from July 11 to 17 as they emerged from a small crevice near the summit of a large rock about 24 meters high. All 25 bats were females, and several had one young each clinging to them. Five of six females taken on July 20 also had one young each clinging to them. Davis et al. (1968) found that females in the Eastern United States only transported their young in flight when moving them from one day roost to another. They suggested that this behavioral difference may result from females in the Eastern United States producing two young annually, whereas females in the Western United States produce a single young.

Mothers with very young babies feed early in the evening, close to the maternity colony, and return within an hour to nurse their young. On returning, each mother crawls around among the young as though looking for its own. Conversely, each baby tries to grab any adult that comes within reach. Before a mother allows her baby to nurse, she licks it about the face and lips (Davis et al. 1968).

Baby bats occasionally fall to the floor of the roosting site. Although some die, others are retrieved by their mothers and live. When bats less than 2 weeks old fall from the roost or otherwise appear to be lost they squeak continually. Squeaking may have survival value in aiding the mother to locate and retrieve her offspring (Davis et al. 1968).

Young bats grow rapidly, gaining as much as half a gram per day. As the young mature, the mothers spend less time at the maternity colonies during the night and start using other night roosts. The young can fly when they are 3 weeks old and, shortly thereafter, begin joining the females at their outside, night roosts (Davis et al. 1968). Maternity colonies may either disband when the young are weaned or remain intact throughout the summer and break up when cold weather arrives (Barbour and Davis 1969).

Beer (1955) estimated the mortality rate of big brown bats at about 62 percent their 1st year, 33 percent the 2d year, and 23 percent per year after that. Based on banding records, Goehring (1972) reported that the oldest wild female was 17 years old and the oldest wild male 18 years old. Hitchcock (1965) had records of a female that lived 12 years and a male that lived 19. Beer (1955), on the other hand, found that the average age of banded bats was 2.6 years and the oldest, 9 years. Walker et al. (1968) reported a big brown bat that lived for 12% years in captivity.

Predation: Silver (1928) reported that the rat snake preyed on big brown bats roosting in the attic of a two-story frame farmhouse. He also found the shed skins of rat snakes in the attic and concluded that predation by these snakes might have accounted for a decline in the bat population. Barbour and Davis (1969) on two occasions watched sparrow hawks capture big brown bats after the bats were banded and released. Jackson (1961) wrote that great horned owls are known to prey on big brown bats. A long-tailed weasel was observed killing big brown bats in a maternity colony in the rafters of a barn. When the weasel could not be dissuaded from hunting the bats, it was shot (Mumford 1969).

Economic status: Big brown bats are particularly beneficial to the well-being of forests because they annually destroy vast numbers of injurious beetles, true bugs, moths, and other insects.

Disease: Big brown bats are carriers of rabies.

Selected references: Barbour and Davis (1969), Goehring (1972), Gould (1971), Long and Severson (1969).

Genus *Lasiurus*: Hairy-tailed bats

Derivation: The generic name *Lasiurus* is derived from the Greek words *lasios* (hairy) and *oura* (the tail); it refers to the characteristically hairy tail membrane of members of this genus of bats.

General description: Members of this genus are strong, fast fliers, usually feeding from 6 to 15 meters above the ground. These bats roost singly or in small groups among the foliage or on the trunks of trees and shrubs. Their coloration resembles the trunk of a tree or a dead leaf and, when disturbed while hanging, they often sway from side to side like a dead leaf. Constantine (1966, p. 37) studied the roosting behavior of five species of hairy-tailed bats in Iowa, Georgia, and California. He found that they

> ... almost invariably selected roosts in trees in "edge" areas, i.e., forest edge or wide fencerows, and with equal consistency these sites bordered dense, leafy crops, such as corn or beans. Roosts or shelters were of three general types. Each provided dense shade and cover above and at the sides with an open space below. Usually they could be viewed only from below. The first shelter type was an inverted bowl-shaped canopy made up of three branches infiltrated by grapevines, providing lush cover and structural rigidity, which resisted movement from wind. The second type was a dense leafy overhang of new, succulent growth, the leaves hanging downward limply; bats hid in the underside of the overhang. The third shelter type was a dense tuft of older, nonsucculent leaves.

Constantine (p. 40) found several similarities in the selection of sites for day roosts among the North American hairy-tailed bats that he studied. He enumerated the salient features:

> (1) permitting bats to be undetected except by inspection from below, (2) allowing bats to drop downward to initiate flight, (3) lacking lower perches

from which birds or other animals (Allan, 1947; Sperry, 1933) might detect the bats, (4) dark ground cover, providing a minimum of reflected sunlight, (5) having vegetation which interrupts wind currents, retards dust distribution and contributes to heat and humidity, and (6) occurring on the south side (Iowa, California) and southwest side (Georgia) of trees.

Females have four teats and have from two to four young, usually two or three. Lasiurus is the only genus of bats known to commonly have more than two young per litter. In northern latitudes, young are born from late May through early July. The mother leaves them in the roost when they become too heavy to carry; occasionally a mother carries two or three young whose combined weights exceed her own.

In Canada and the United States, red bats *(Lasiurus borealis)* and hoary bats are migratory, flying south in the fall and north in the spring.

World distribution: There are about 12 species within the genus *Lasiurus.* They normally occur from southern Canada south to Uruguay and Argentina and from the Hawaiian and Galapagos Islands east to the Greater Antilles, Cuba, and the Bahamas.

General references: Constantine (1966), Walker et al. (1968).

Species *Lasiurus cinereus:* Hoary bat

Derivation: The specific name *cinereus* is the Latin word for "ash-colored."

Specific description: Total length, 114 to 150 mm; tail, 42 to 65 mm; hind foot, 10 to 14 mm; ear-notch, 14 to 20 mm; ear-tragus, 5 to 12 mm; forearm, 46 to 58 mm; weight, 17.5 to 33 g.

The hoary bat is large; it is the most colorful and distinctive bat in Oregon. Its fur is long, thick, and very fine; the hairs are longer on the neck than they are on the back, forming a ruff. Most of the hairs on the back have four bands of color. The back is yellowish tan to light orangish brown, occasionally grayish, with many white-tipped hairs producing a heavily frosted appearance. The face and cheeks are more yellowish with little evidence of white-tipped hairs. The chin and forethroat are particularly yellowish and lack white-tipped hairs. The underside is paler, more yellowish than the back and only slightly frosted. The rounded, relatively short ears are partially covered with stiff, yellowish tan hairs, but the edges of the ears are naked and black. The tops of the wings have small clusters of stiff, light tan hairs on the elbows and wrists and soft, yellowish fur on the undersides, extending from the body to the wrists. The wing membranes are conspicuously bicolored, brown to slightly reddish brown along the forearm and part way down the fingers from the wrists; the rest of the wing membranes are dark brown. The tail membrane and the feet are completely covered with thick hair on the topside; they have a moderately frosted appearance. The underside of the tail has soft, yellowish belly fur extending about 10 to 15 millimeters onto the membrane. There are keels on the calcars.
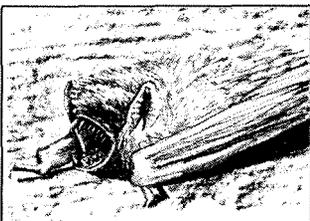
HOARY EAT

Distribution along the Oregon coast: Hoary bats occur along the entire coast. They also occur in appropriate habitats throughout the State.

Habitat: In general, hoary bats appear to be associated with forested areas, primarily coniferous or mixed coniferous-deciduous forests. They are not known to occur in the following habitats: beach, foredunes, deflation plain, and moving dunes.

Habits: The hoary bat is the most widely distributed bat in North America. It is rare throughout most of the Eastern United States but is more common in the prairie region. Records are scarce in the northern Rocky Mountains but more numerous in the Pacific Northwest. These beautiful bats are considered to be common only in California, Arizona, and New Mexico; however, their occurrence is seasonal (Barbour and Davis 1969).

Jones (1965) studied several species of bats in New Mexico in relation to basic habitat types. Of 191 hoary bats captured, 2.2 percent were taken in dry-shrub grassland; 41.3 percent in coniferous-deciduous woodland; and 56.5 percent in coniferous forest. Considered a highland species, they were secured below the 6 300-meter elevation in April, May, and June but were more abundant above 6 300 meters in July and August. Vaughan and Krutzsch (1954) found a similar distribution in California. The hoary bat has a correspondingly wide range of temperatures within which it is active, minus 2" to 22" C (Jones 1965).

Hoary bats spend summer days sleeping singly or in small family groups concealed in the foliage of trees. They are found occasionally in trees along busy city streets (Jewett 1930). Cowan and Guiguet (1965) reported that a hoary bat in British Columbia, Canada, had been found in an abandoned woodpecker nest-cavity in a tall, dead tree. Although hoary bats usually roost 3 to 5 meters above the ground, females with young as well as solitary young normally roost higher in the trees than do solitary adults.

> Selection of very high roosts by adult females with young would seem to favor survival by (1) providing greater concealment from terrestrial predators, (2) avoid disturbances from activity on the ground, which might result in dislodging young bats incapable of flight and (3) permitting young bats a greater opportunity to conduct successful initial flights, which might terminate otherwise by striking the ground before leveling off.
>
> (Constantine 1966, p. 40)

Barbour and Davis (1969, p. 145) stated that the hoary bat "is one of our most accomplished migrants." Findley and Jones (1964) indicated that data strongly suggest that hoary bats migrate in "waves" as do migratory birds. They found that pregnant females migrate north earlier than males. In April and May, pregnant females are more or less generally distributed throughout the Southern United States, but by June they are mostly concentrated in the North-Central and Northeastern United States where they give birth to their young. Males, on the other hand, concentrate in the Western United States. Migratory waves, sometimes segregated by sex, have been observed in spring and fall. Migration appears to begin in April in the Southern United States, and fall migration begins in August in

the northern regions of the United States and southern Canada. The Southern United States has frequently been considered an important wintering area, but, according to Findley and Jones (1964), evidence does not support this concept. They stated that the sudden appearance of large numbers of hoary bats throughout the Southwestern United States in April suggests that these bats migrate farther south for the winter.

Barbour and Davis (1969, p. 146) summarized the migration phenomenon in hoary bats: "Although strong circumstantial evidence for migration of this species is abundant, we as yet have no direct evidence of specific movements or migration paths or patterns. Few individuals have been banded and we know of no recoveries."

Findley and Jones (1964) showed that the earliest known arrival of hoary bats (all males) occurred in eastern Oregon in June. On April 19, 1972, I shot a male hoary bat while it was foraging 16 kilometers east of Brookings, Curry County. Findley and Jones (1964) indicated that only males had been taken within the western portion of the State in July, and a single female (near the coast) in August. I shot a male as it was feeding on August 12, 1971, near Otis Junction, Lincoln County. Findley and Jones (1964) listed three October records of hoary bats in northwestern Oregon, one female and two of unrecorded sex. Alex Walker collected a female hoary bat near Tillamook, Tillamook County, on October 9, 1924 (Bailey 1936); this is probably the same individual that was listed by Findley and Jones (1964). According to Findley and Jones (1964), all hoary bats had left Oregon by November. Whitaker (1967) summarized the data on hoary bats found in the United States between November and February; the westernmost record was of an individual discovered on January 31, 1967, in Terre Haute, Vigo County, Indiana. He cited two of these bats as having been discovered during unseasonably warm weather, suggesting the possibility of their occasionally hibernating in the Northern United States. On February 24, 1972, I found a female hoary bat 0.8 kilometer north of Gardiner, Douglas County, Oregon. The bat, dead no more than a week, was lying on the ground under the overhang of a roof and was completely wet. The weather had been cold and rainy for several days. The bat had neither fat reserve nor food in its stomach or intestine. The adverse weather was likely the cause of death.

It is difficult to determine the limits of the normal geographical distribution of hoary bats because of their extensive wanderings. Records of four hoary bats from the southwestern coast of Iceland in October and December and a single record from the Orkney Islands (off the north coast of Scotland) in September are surely of migrants that had gone astray, perhaps during storms. Although hoary bats may wander occasionally beyond the "normal" range of the species, they are probably more commonly blown off course during storms (Barbour and Davis 1969).

Food: Its large size and swift, rather straight flight pattern makes the hoary bat relatively easy to identify as it forages. Identification is further aided by the frequent audible vocalizations uttered during flight; however, vocalization is not constant.

In Oregon, hoary bats have been most often shot as they foraged 6 to 12 meters above roads through forested areas. Patrolling up and down forest roads appears to be a common practice. Jackson (1961, p. 100) wrote of the hoary bat in Wisconsin: "It is a strong and rapid flier, and frequently makes swift forays straightaway for a mile or more and then returns, and may maintain on these excursions a speed close to 60 miles an hour."

Hoary bats are usually considered late foragers, emerging after full darkness. Jones (1965) captured 154 hoary bats in New Mexico and found them active from about one-half hour after sunset until about 4 hours after sunset, but he noted most activity about 1 ½ to 1 ¾ hours after sunset. Kunz (1973) found that hoary bats in Iowa foraged 4 to 5 hours after sunset. The bat I shot on August 12, 1971, near Otis Junction, was secured at 9:15 p.m., when it was too dark to see. I located the bat by its audible chattering and shot it but did not see it until I found it dead with the aid of a flashlight. Bailey (1936, p. 385) wrote of several hoary bats in eastern Oregon that were observed (mid-August 1915) roosting during the day in large cottonwood trees, "They did not leave their leafy retreats, however, until so late in the evening that it was too dark for successful bat shooting. . . . " During migration, on the other hand, hoary bats apparently fly earlier than they do after their destinations have been reached (Dalquest 1943, Hall 1946). The bat I collected on April 19, 1972, 76 kilometers east of Brookings, is the earliest record for the species within the State; it was probably migrating north. I shot it at 7:05 p.m., 55 minutes before full darkness.

Whitaker (1972a) examined the stomach contents of three hoary bats. Two bats had 100 percent moths (Lepidoptera) in their stomachs, and the third had 65 percent moths, 25 percent leaf beetles (Chrysomelidae), and 10 percent muscoid flies (Diptera). Ross (1967 in Whitaker 1972a) examined stomach contents of 139 hoary bats. Of these, 136 contained moths representing three families: Phalaenidae (= Noctuidae), Geometridae, and Gelechiidae. Some bats had consumed as many as 25 moths. Other insects were found in fewer stomachs: ants (Formicidae), 78; grasshoppers (Acrididae), 1; termites (Isoptera), 7; common lacewings (Chrysopidae), 1; Scarab beetles (Scarabaeidae), 4; leaf beetles (Chrysomelidae), 2; round-headed wood-boring beetles (Cerambycidae), 1; and unidentified beetles (Coleoptera), 9. The stomach of one hoary bat shot in western Oregon contained 100 percent mosquitoes (Diptera) (Whitaker et al. 1977).

Bishop (1947, p. 293) wrote about a hoary bat in New York that preyed on a small bat (*Pipistrellus subflavus*).

> As we approached the spot, perhaps fifteen minutes later, I was also startled by a chattering noise and by something that seemed to bounce to a height of about 18 inches above the pavement. The beam of my flashlight revealed the "dark object" to be a hoary bat. . . which continued to bounce several times while exposed to the light, then settled down on the pave ment, and grasped in its jaws, the mutilated body of a small pipistrelle. . . .
>
> When picked up by the nape of its neck, the larger bat clung momentarily to the body of its smaller relative. Both specimens were taken and the pipistrelle was found to be bleeding from fresh wounds about the head and

shoulders. It was quite evident that the hoary bat resented the close ap-
proach of anything that interfered with its feeding for it twice demonstrated
its displeasure by voice and actions and refused to abandon its prey.

In addition, Orr (1950) reported a male hoary bat's pursuing a small bat "about the
size of a pipistrelle." How common it is for these large, swift bats to prey on other
species of bats is not known.

Reproduction: There is little information on the reproductive behavior of hoary
bats. Breeding probably takes place in the fall (Jackson 1961). Bogan (1972, p. 611)
observed pregnant female hoary bats in captivity. They ate prodigious amounts of
food before and shortly after giving birth, "often consuming an amount equal to 25
percent of their prefeeding body weight." One female ate 12 grams, 40 percent of
her body weight, after delivering her young. Thus, a rapid gain in weight before
and after parturition is not surprising. Six pregnant females captured on May 3
had an average weight of 24 grams; four caught on May 18 averaged 31 grams;
and six, just before delivery, averaged 36 grams.

Provost and Kirkpatrick (1952) and Bogan (1972) stated that the normal litter con-
sists of two young. Bogan (1972) cited what is probably the only known instance
of a female giving birth to a single young. As far as I know, there is no record of a
hoary bat having more than two young. The young are born in May and June and
possibly early July.

There are numerous instances cited in the literature of female hoary bats and their
young on the ground. The offspring, too heavy for the mothers to carry, cause
them to fall helplessly to the earth. Bogan (1972, p. 612), however, found that
"Females carried the young spontaneously in well-controlled flight within 24 hours
of birth, and continued to do so until the young were 6 to 7 days old." Thus when
youngsters are about a week old, they are usually left hanging in the roost while
the mothers forage. According to Barbour and Davis (1969), however, a mother
may move her babies to a new location if disturbance has been experienced at
the original site.

According to Bogan (1972, p. 613), "Hoary bats typically are intolerant to, and react
aggressively toward, handling. Initially, disturbance. . . elicited the typical threat
posture of hoary bats, characterized by wing-spreading, wide gaping of the mouth,
and a clicking-hissing vocalization." During late pregnancy, on the other hand,
there was a drastic decrease in aggressiveness. Instead of displaying the typical
threat posture, a female merely swung to and fro when disturbed; she would
become increasingly tractable and could be held without gloves when fed. Since
aggressive behavior resumed at the death of the young or the completion of wean-
ing, it is unlikely that the tractability of the captives was due to domestication.
Such transient phlegmatic behavior may have survival value for the females and
their offspring.

> First, such behavior might allow a normally solitary, tree-roosting bat to
> tolerate the excessive physical contact of its young. Secondly, the behavior
> suggests the bats may attempt to escape predation by remaining quietly
> hidden at a time when they are ill-equipped to threaten or flee from
> a predator.
>
> (Bogan 1972, p. 613)

Development of young hoary bats was observed by Bogan (1972). The newborns are covered with fine, silvery gray hair on the back of the head (including the margins of the ears), shoulders, tail membrane, and feet. They are naked otherwise. When they are 12 days old, their eyes open, and low frequency clicking is audible. Hair is present in the armpit. When they are 18 days old, the entire venter is well covered with hair. Patches of stiff, white hairs are present on the thumbs and elbows. At 27 days, the young bat spreads its wings when launched but does not flap them. Its landing is uncontrolled. By day 31, the wings are fluttered on launching, and landing consists of a gentle glide. Day flight is purposeful by day 33, and gently controlled turns are possible. When 34 days old, the young can sustain direct flight for 1 minute. Weaning is completed. A 44-day old youngster can launch itself and make deft, vertical swoops in flight. One bat, 45 days old, was 124 millimeters in total length.

Predation: No data were found about predation on hoary bats.

Economic status: As insectivorous forest-dwellers, hoary bats are beneficial.

Disease: Hoary bats are carriers of rabies.

Selected references: Barbour and Davis (1969), Constantine (1958, 1959, 1966), Findley and Jones (1964), Ross (1967).

Genus *Plecotus*: Long-eared bats

Derivation: The generic name *Plecotus* is derived from the Greek words *plekō* (twist) and *ōtos* (ear). At rest, these bats coil their large ears into a shape reminiscent of a ram's horn. (The old name for this genus was *Corynorhinus*.)

General description: Long-eared bats may be distinguished by their enormous ears, up to 40 millimeters in length, and by the glandular masses on their muzzles. In members of some species, the glandular masses rise above the noses as flap like lumps, and these bats are often called "lump-nosed bats."

All long-eared bats hibernate; none are known to make extensive migrations.

These bats forage well after dark. Their flight is slow, and they are able to hover at a point that interests them. They pick insects off foliage, as well as capture some in flight.

World distribution: Long-eared bats occur in Eurasia, northern Africa, and in North America, where they are generally distributed in the western half of the United States from southern British Columbia, Canada, to southern Mexico. They are also present in the Southeastern United States.

General reference: Walker et al. (1968).

Species *Plecotus townsendi:* Western long-eared bat

Derivation: The specific name *townsendi* is a proper name; this bat was named in honor of John K. Townsend who first recorded the species while at old Fort Vancouver, Washington, in 1835. John Kirk Townsend, primarily a naturalist, was in charge of the hospital at Fort Vancouver the winter of 183536 (Johnson 1943).

Specific description: Total length, 80 to 111 mm; tail, 32 to 55 mm; hind foot, 7 to 14 mm; ear-notch, 27 to 39 mm; ear-tragus, 10 to 19 mm; forearm, 39 to 48 mm; weight, 5 to 22 g.

Western long-eared bats are medium size. They have dull, rather long, soft hair. Their backs vary from brown, grayish brown, to black, with paler undersides. Their enormous ears are by far the largest ears of any bat along the Oregon coast. One or two fringes of short, stiff hairs extend two-thirds to three-fourths the length of the ears along the top edges. They have two prominent glandular lumps, one on each side of their noses. Their flight membranes are dark brown and very thin. There are no keels on the calcars.

Distribution along the Oregon coast: These bats occur along the entire coast. They also occur in appropriate habitats throughout the State.

Habitat: In western Oregon, I have found these bats most often in buildings; they also frequent caves when available. To date it is not possible to be more specific about their habitat preferences along the Oregon coast.

Habits: Western long-eared bats are seldom abundant but are widely distributed in North America, and they occupy a variety of habitats. These bats are most typically associated with the arid western juniper/piñon pine woodland and pine forests; they apparently do not occur in extreme desert. More than any other species of bat in the Western United States, western long-eared bats are characteristic dwellers of caves and abandoned mine tunnels. "It may be found in such retreats at any season and. . . is the only species that regularly can be found hibernating in fair numbers in western caves and mines" (Barbour and Davis 1969, p. 165). On the other hand, in the forested regions at higher elevations of the West and along the west coast, these bats regularly reside in buildings. They probably do not often use buildings as day roosts in the hot, dry regions of the Western United States because water loss during the day would be a serious problem (Barbour and Davis 1969).

Western long-eared bats seem to prefer dim light near the zone of total darkness in their retreats. They do not crawl into cracks or crevices but hang from the open ceiling. Furthermore, they apparently do not crawl away from the spot where they land, and clusters of suspended bats are therefore in areas easily reached by flight (Barbour and Davis 1969, Dalquest 1947b).

Dalquest (1947b, p. 24) examined many daytime retreats in California, and although he found no preference for temperature or humidity, he noted that "All retreats were places seldom disturbed by humans." Graham (1966) found that human disturbance caused the bats to permanently abandon caves; he stated that the growing popularity of cave exploration may cause the extinction of these bats

in natural caves. Pearson et al. (1952) found that even conservative scientific collecting among colonies of bats in caves caused serious decreases in the colonies. Removing individuals from a colony and banding these bats in their retreats caused more disturbance than they expected. They banded 75 young after the adults had left to forage; on returning, the adults picked up their young and moved to another roost 2.1 kilometers away (also see Bailey 1936, Dalquest 1948, Pearson et al. 1952, Scheffer 1930). Western long-eared bats living in occupied buildings sometimes become accustomed to the people and, so long as they are not unduly disturbed, do not seem to be bothered by their presence. Pearson et al. (1952) found a colony of about 60 females occupying an attic over the kitchen of a summer resort, despite the noise from the kitchen and dining hall. J. K. Townsend, after whom the species was named, first mentions the "great-eared bat" in 1835 while at Fort Vancouver, on the Columbia River opposite Portland (Townsend 1839 in Bailey 1936, Dalquest 1948). He said that they were relatively common in the Columbia River district. The bats inhabited the "storehouses attached to the forts" and seldom left them even at night. They were protected by the "gentlemen of the Hudson's Bay Company for their services in destroying the *dermestes* (a species of beetle whose larvae ruin furs by eating them) which abound in their fur establishments." More often, in western Oregon, a single bat uses a human abode at any one time. Since the bat may be observed fairly regularly for several years, more than one individual may be involved.
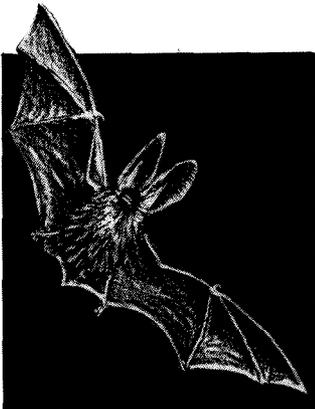
WESTERN LONG-EARED BAT

In flight, the western long-eared bat is one of the most versatile of the North American insectivorous bats. When released in a room, its movements vary from swift, easy flight with deep, smooth wingbeats to slow, deliberate flight, to hovering. Wingbeats are often alternated with "set wings" and short glides. During a glide they noticeably lose altitude which is smoothly recovered with the next series of wingbeats. Unlike most North American bats which merely circle *re*-peatedly around a room close to the ceiling, western long-eared bats inspect the room from ceiling to floor. The flight patterns of such inspection tours are usually narrow "figure 8's" varied occasionally with ovals and circles (Barbour and Davis 1969, Dalquest 1947b). Dalquest (1947b, p. 24) marveled over the flying abilities of the western long-eared bat. He stated that it "is a swift flier, an agile dodger, and possesses an excellent sense of danger." On one occasion, he and three other persons, armed with butterfly nets, spent several hours trying to catch these bats in flight in a building.

> A number of bats were touched on the wing but only one was caught in free flight. The nets were useful only to clap over bats that lit momentarily on the ceiling. Hundreds, if not thousands, of sweeps were made with the nets, only to have the target drift tantalizingly to one side.

On another occasion, Dalquest tried for nearly half an hour to catch one of these bats which was trapped in a low-ceiling room about 6 meters square. When placed on a flat surface, such as a floor, the bats stretch their wings, and with a single violent motion, are in flight; they neither walk nor scramble over the surface.

Dalquest (1947b, p. 25) thought that a western long-eared bat represented "grace and beauty" in action when alighting. A bat approaches a landing site from beneath, and, sweeping upward with set wings, it seems to "bob" in the air. Several things then happen almost simultaneously:

> The wings close and the body completely reverses itself in the air. Holding its vertical position in the air, the entire body pivots sideways with seeming slowness until the head is down. At that precise moment the feet touch the perch and the claws grasp tiny crevices. The action is soundless. The claws grip truly at the first attempt. Once the claws take hold, the wrists are brought in under the chin. The claws of the thumbs catch in crevices. The thumbs usually lie at a 45" angle upward and outward from the forearm. The wings are brought in close to the forearm, and the wing-tips are pulled in close to the flanks and lie against the side of the body, sticking up like tiny sails. The tail is relaxed and curves under and down, in a semi-circle. The head is drawn back and the neck bent outward. Some arching of the back occurs as the chest is pushed out from the wall and supported by the wrists. As the bat peers about, moving its head, the ears swing from side to side and from a horizontal to a vertical position. If undisturbed, the bat usually relaxes after a few mintues. The head is bent inward until the muzzle touches the chest and the long ears droop downward. The claws of the thumbs release their grip on the wall and the fore arms swing out parallel with the body.

Western long-eared bats readily move from one roost to another but probably do not undertake major migrations. Pearson et al. (1952) banded over 1,500 of these bats in California; the longest movement they found was the 32-kilometer journey of a young male. Barbour and Davis (1969) found movement of 64 kilometers.

Throughout most of their range, western long-eared bats hibernate in caves and mine tunnels, but where they hibernate in western Oregon is unknown.

Dalquest (1947b) and Pearson et al. (1952) stated that western long-eared bats hibernate "in a sense" or become dormant at any time of the year, and Dalquest asserted that although the cause of dormancy is not clear, it appears to be involuntary within certain temperature limits. Pearson et al., on the other hand, indicated that bats of either sex roosting in places warmer than 17" C are normally awake and those in places of lower temperatures, dormant. They stated, however, that dormancy is not involuntary, but that the bats seek different temperatures at different seasons. They also indicated that the tendency to hibernate in winter is stronger in females than in males, and in midwinter females are usually dormant both day and night. Males are less inclined to hibernate, and, choosing warmer places than females, may awaken at night and fly around even in hibernation caves in midwinter. Some males occasionally fly outside the caves and use night roosts in buildings; thus, a few males arrive at and depart from hibernation colonies throughout the winter.

Pearson et al. (1952) wrote that the bats started arriving at the hibernation caves in late October, but the winter colonies did not reach maximum size until January. The females arrived earlier and remained longer in the hibernation caves than did

the males. In western Oregon these bats remain active until the latter part of September, then disappear. Males, however, are found occasionally in buildings in midwinter.

When an individual is dormant, the enormous ears are coiled and held tightly against the neck. The long, thin tragus remains erect, and may be mistaken for an ear. The tail membrane is curved under and is brought forward against the ventral surface of the body. The wings, with fingers spread, are wrapped around the body, effectively covering the ventral surface; the body hairs are erect (Barbour and Davis 1969, Dalquest 1947b).

Juvenile western long-eared bats accumulate substantially greater stores of fat before hibernation than do the adults, whereas adults of other species of bats have greater accumulations of fat before hibernation (Pearson et al. 1952).

Hughes (1968) studied the body temperatures of 12 western long-eared bats in the wild during their arousal from dormancy in western Washington. The individual rate of arousal varied the first 8 minutes, but, depending on initial temperature, the rate was similar. A dormant bat with an initial temperature of about 14" C would require about 14 minutes to warm to 29" C, whereas a bat having an initial body temperature of about 5.7" C would need about 32 minutes to warm to 29" C. The rise in the bats' internal temperatures increased progressively more per minute as arousal continued, but after the internal temperature had reached about 30" C the rate of temperature increase declined rapidly. Barbour and Davis (1969) observed the arousal of a western long-eared bat that had been dormant in a refrigerator. The bat's body temperature rose steadily until it was above 20" C. When the bat was able to move, its temperature rose in jumps of several tenths of a degree. "These sudden rises in body temperature were always followed immediately by strenuous muscular effort, such as an attempt to fly." Hughes (1968) said that 11 of the 12 bats that he observed flew when their internal temperatures were between 28.6" C and 31° C. Furthermore, as their body temperatures neared the temperature at which they could fly, their ears uncurled and stood erect 10 to 15 seconds before actual flight. They raised their heads, made a small leap, and were in flight. He concluded that seasonal changes, as well as temperature changes, probably influence the depth of dormancy. Thus, the lowering of internal temperatures to about the ambient (external or surrounding) temperatures during late December or early January may distinguish bats in autumn dormancy from true hibernators.

Food: Western long-eared bats are late fliers and, with rare exception, emerge to forage only after full darkness. As with several other species of bats, western long-eared bats exhibit "light sampling behavior." As twilight deepens, individuals fly to the entrance of the roost, then return to its interior to rest a few moments before testing the light again (Handley 1959, Twente 1955). Bailey (1936) cited one of the few instances of these bats foraging before dark. He shot two of them as they circled during the evening along the edge of the forest near McKenzie Bridge, Lane County, Oregon.

In western Oregon, the stomachs of 16 western big-eared bats contained 99.7 percent moths (Lepidoptera) and 0.3 percent bugs (Hemiptera) by volume (Whitaker et al. 1977).

All the specimens that Hamilton (1943) examined in the Eastern United States had consumed only moths (Lepidoptera). Dalquest (1940a) found the wing scales of moths and the wings of small flies (Diptera) in the stomach of a male big-eared bat from Washington. He also noted that food was not so finely chewed as food found in other species. Dalquest (1947b) indicated that these efficient and rapid feeders retire to night roosts when their stomachs are full.

Reproduction: Females breed when they are 4 months old, but data suggest that males probably do not breed until their 2d year. Although some females have bred before they arrive at the winter roosts, most breeding occurs in the winter roosts the first 3 weeks of October. Repeated mating occurs, reaching a peak from November to February (Pearson et al. 1952).

Only one copulation was observed, but it took place so high on the ceiling of a cave that the details could not be seen. It was noted, however, that the female was dormant, suggesting that females are bred when they are unable to escape from the males. Furthermore, the passivity of the females would allow each to be mated many times during the course of the winter; data also suggest that males continue to mate with females that have already bred (Pearson et al. 1952).

The duration of pregnancy varies widely because of delayed fertilization. It ap pears to depend on the body temperature of the female and the length of dormancy as well as on the temperature in the roosting site and the general climatic conditions. After nursery colonies are formed in early summer, pregnancy proceeds at a more regular rate because higher metabolism is maintained, and therefore, higher body temperatures. Gestation periods varied from 56 to 100 days in different colonies in different years. The earliest birth date recorded was April 19 and the latest July 22. Birth dates probably extend over a long period in nursery colonies in which females roost in different places at different temperatures, but most young are born in late May and early June in California (Pearson et al. 1952). Scheffer (1930) found females in a cave in Washington nearly ready to give birth on July 12, and on his return a week later, many had delivered young. Dalquest (1948) found females in Washington that contained nearly full-term embryos on July 7. Information on birth dates for Oregon should be similar.

Female western long-eared bats produce a single young per year. Pearson et al. (1952) found the weights of 10 newborn of both sexes to range from 2.1 to 2.7 grams; the average was 2.4. The length of their forearms ranged from 16 to 18 millimeters; the average was little more than 16.6. Two young that died within 30 hours of birth were 34 and 35 millimeters in length. There was no significant difference in size of males and females at birth. Pearson et al. described the newborn as a "grotesque creature." The pink, naked baby has large ears that flop over unopened eyes, and the disproportionately large hind feet and thumbs give it a spiderlike appearance. Within a few hours of birth, the youngster can utter a characteristic sharp, metallic chirp. The dried umbilical cord may remain attached for a day or two. Within the first 4 days the baby becomes covered with short, gray hair. At about 7 days, the ears become erect and the youngster can make the squawking noise of a disturbed adult. During the first 2 weeks, the forearm lengthens 1.2 millimeters per day. (The length of the forearm is a reliable indicator of age for the first 3 weeks, but by the 4th week, the forearm is so close to the length of an adult's that it is no longer reliable.) The eyes open at about 9 days.

The young do not fly until they are about 3 weeks old. They are left hanging in the roost during the nightly foraging flights of the adults. Nursery colonies range from 1,000 long-eared bats in the Eastern United States to 200 in the Western United States, and the young cluster together when left by their mothers, yet each mother finds her own offspring when she returns to the roost. Pearson et al. (1952) observed females selecting their young from clusters of other babies. Adult females were collected, banded, and released in the rear of the tunnel in which the nursery colony was located. The young, from 1 to 18 days old, were released on the floor of the tunnel about 3 meters from the entrance. All but one youngster immediately crawled to the sides of the tunnel and climbed 15 to 91 centimeters up the sides where they formed clusters. As a mother approached the clusters, the babies made audible squeaks that attracted her attention; babies that were not squeaking were ignored by the mother. The only females attracted by the squeaks were those not carrying young. At first a mother flew back and forth in front of the cluster; then she landed and crawled about on it as though searching for her own offspring. She would select a baby and cover it with her body and wings, seeming to encourage it to attach itself to her, before she flew off with it.

> Although the squeaking of the babies may be important in originally attracting the adult, some other sense, perhaps smell, is used in locating the particular baby she seeks, for in each of the six times that we watched a female come and extract her baby from the clusters of young bats, the female first rejected one or two other babies after a momentary contact with each of them. The adults and the babies had been banded on an earlier visit. . . , so we were able to certify, by catching an adult as she left a cluster of ten with a baby clinging to her, that she had picked up the one which she had previously been carrying.

(Pearson et al. 1952, p. 310)

The youngsters grow rapidly and are almost fully grown at 1 month. They can fly at about 3 weeks, and by 6 weeks some fly out of the roost at night as the adults do. They are not weaned, however, until they are about 2 months old. One banded 42-day-old bat, as large as its mother and a skillful flyer, had its stomach full of milk when it was examined, but no fragments of insects (Pearson et al. 1952).

The nursery colonies begin to disband in August, about the time weaning is completed. Adults that have lost their young leave the nursery colonies earlier than the lactating females. Young males depart before the young females (Pearson et al. 1952).

Predation: No information was found on predation of western long-eared bats.

Economic status: These bats destroy many insects annually and are considered beneficial.

Disease: Western long-eared bats are carriers of rabies.

Selected references: Barbour and Davis (1969), Dalquest (1947b), Pearson et al. (1952).

Order Lagomorpha: Hares, Rabbits, and Allies

Derivation: The ordinal name Lagomorpha is derived from the Greek words *lagos* (a hare) and *morphe* (form or shape). For many years, pikas (rock rabbits), rabbits, and hares were considered a suborder of Rodentia; however, several characteristics that differentiate them from rodents have been identified and they are now considered a distinct order. Three easily distinguishable differences are: (1) Lagomorphs have four upper incisors-two large teeth in front and two small peglike teeth, lacking cutting edges, directly behind them-whereas rodents have only two upper incisors. (2) The testes and scrota of lagomorphs are in front of the penis, whereas the testes and scrota of rodents are behind the penis. (3) Depending on species, lagomorphs have 26 to 28 teeth; rodents have 16 to 22 teeth.

General description: Lagomorphs usually have a thick, soft pelage, but some species exhibit a coarse pelage. They are all ground dwellers. A few are diurnal, but most are crepuscular and nocturnal. Although a few species are distinctly colonial, most are not. The species that are poor runners generally stay close to thickets, burrows, or rock crevices. Species that are good runners normally use a shallow nest or "form" situated under cover but on the surface of the ground. Forms are usually located in relatively open areas, and their inhabitants depend on speed for protection. One escape mechanism the white-sided jackrabbit (hare) uses is to shift its skin from side to side as it runs, thus revealing alternating flashes of white ventral and dark lateral pelage. Such maneuvering presumably confuses pursuers. Another escape maneuver is to "freeze" after making a short dash, thus seeming to disappear.

In addition to being able to deliver vicious, raking kicks with their powerful hind legs and sharp claws, rabbits and hares also produce a singularly loud, piercing distress cry or "scream" when captured. Except for pikas, which communicate vocally, lagomorphs are essentially nonvocal as adults.

Strictly vegetarians, lagomorphs normally eat grasses and other herbaceous plants. Some species also feed on the leaves and bark of trees. Lagomorphs have a remarkable method of obtaining maximum nutrition. They produce two types of fecal pellets: (1) Dry pellets that are expelled as waste material and (2) moist, cecal pellets which, after they have been expelled, are reingested almost without being chewed; hence, most of the food is passed through the digestive tract twice.

Lagomorphs do not hibernate. Some forms are noted for changing color from brown during summer to white during winter. In addition, rabbits and hares are noted for periodic fluctuations in population. These are particularly well marked in northern latitudes, where peak populations tend to occur at IO-year intervals.

World distribution: Lagomorphs occupy a wide variety of habitats on most continents and many large islands, except Antarctica, Madagascar, and most islands of southeast Asia. They have been introduced into Australia and New Zealand, and other islands.

Fossil record: The oldest fossils showing lagomorphlike characteristics are from the late Paleocene in Asia. Fossils of true lagomorphs appeared during the later Eocene in North America.

Number of species along the Oregon coast: Two.

General references: Anderson and Jones (1967), Walker et al. (1968).

Key:

la Ears with blackish tips on backs and usually with distinctive white margins; chin, belly, and insides of legs white; tops of feet may have considerable amounts of white hair; nape of neck without patch of bright reddish brown hair-LEPUS *AMERICANUS* (snowshoe hare), page 124

lb Ears lacking blackish tips on backs and without distinctive white margins; few if any white hairs in pelage; nape of neck with patch of bright reddish brown hair—*SYLVILAGUS BACHMANI* (brush rabbit), page 128

Family Leporidae: Hares and Rabbits

Derivation: The familial name Leporidae is derived from the Latin word *leporis* (a hare) and the Latin suffix *idae* (family).

General description: The vernacular names "rabbit" and "hare" are used as though they are synonyms, and they are often applied to the wrong group. The names "jack rabbit" and "snowshoe rabbit" are applied to hares, and the name "Belgian hare" is applied to a rabbit. Externally, the differences between hares and rabbits are not well defined; the major differences are in the structures of the skulls. Young hares are born under cover, but not in a specially constructed nest. They are fully haired at birth, their eyes are open, and they are capable of running around a few minutes after delivery. Rabbits, on the other hand, are born naked and blind in a nest especially constructed by the females.

Unlike most mammals, female leporids are usually larger than the males. Members of this family range in total length from about 25 to 76 centimeters. Hares, being larger than rabbits, may weigh as much as 7 kilograms. The pelage is usually thick and soft, and if small patches of hair are torn out, they are quickly replaced with new hair.

A sensory pad, normally hidden by hairy folds of skin, is located at the entrance of each nostril, and a naked, Y-shaped groove extends from the upper lip to and around the nose. The term "hare-lip," an unusual condition in humans, is named after this groove.

Leporids have from three to five pairs of teats and produce from two to eight young, often more. The maximum number of young per litter is 15. Gestation periods range from 28 to 47 days; hares have longer gestation periods than do rabbits. Most species produce several litters per year.

World distribution: Leporids inhabit most of the major land masses and some islands. Their natural distribution does not include the antarctic region, Madagascar, parts of the Middle East, southern South America, Australia, or most oceanic islands. Among the most widely introduced groups of mammals, leporids have been introduced into Australia, New Zealand, and other islands.
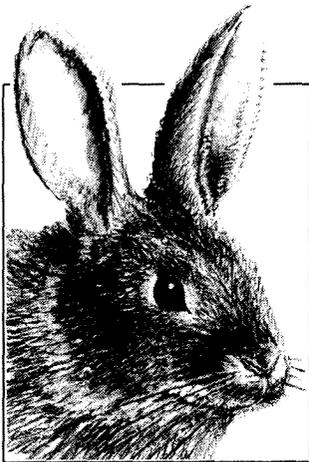
RABBIT

Fossil record: In North America the fossil record of leporids dates to the late Eocene.

Number of species along the Oregon coast: Two.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus Lepus: Hares

Derivation: The generic name Lepus is the Latin word for "hare."

General description: The genus *Lepus* contains the largest of the lagomorphs. They range in head and body length from 40 to 70 centimeters and weigh 1.4 to 7 kilograms. All members of this genus have long ears and large hind feet; the latter are well haired regardless of the climate in which they live. Most species-such as the big, long-eared, slender-bodied jack rabbits-prefer open, grassy areas. A few, however, are associated with forested areas.

Hares do not dig burrows but spend their inactive periods hidden among vegetation in shallow depressions called "forms."

Northern species of hares exhibit drastic fluctuations in numbers that appear to be in cycles of 9 to 10 years. They increase to great abundance, then suddenly decline. Although the reasons for the fluctuations are not definitely known, various diseases, as well as disruption of the endocrine gland system, may be responsible. (Endocrine glands, such as the thyroid and the pituitary, secrete internally and produce hormones.) The most regular fluctuations in populations of hares occur in the northern half of North America. When hares are abundant, the populations of foxes, lynxes, weasels, mink, and other predators increase because of the abundant supply of food; when the populations of hares decrease, however, so do the populations of predators that depend on them as food.

Various species of hares are used as food by people. Although their pelts are neither durable nor valuable, they have been used extensively in the manufacture of felt; they are also used as trimming and lining for garments and gloves.

World distribution: The combined, original distribution of the approximately 26 species of hares included most of Eurasia, as far south as Sumatra, Java, Formosa, and Japan; most of Africa, except the rain forest of the Congo and the region along the Gulf of Guinea on the Atlantic coast; and most of North America south to the end of the Mexican plateau. In the eastern half of the United States, however, their distribution is limited. After their introduction, they became common in some parts of South America, Australia, New Zealand, islands off the northwest coast of Africa, and in some portions of the Northeastern United States.

General reference: Walker et al. (1968).

SNOWSHOE HARE

Species *Lepus americanus:* Snowshoe hare

Derivation: The specific name *americanus* is a proper name.

Specific description: Total length, 382 to 430 mm; tail, 35 to 56 mm; hind foot, 100 to 131 mm; ear, 66 to 79 mm; weight, 950 to 1 416 g.

Because snowshoe hares are brown in summer and white in winter over most of their geographical distribution, they are often called "varying hares." The subspecies *washingtoni,* however, found in western Oregon and western Washington, remains brown throughout the year.

Snowshoe hares have moderately large ears, long hind legs, and large hind feet. They have long, thick, soft pelages. Dorsally, summer pelages are relatively light reddish brown with few black-tipped hairs. Winter pelages, on the other hand, have many more black-tipped hairs, creating a dark brown appearance that is less reddish. The throats of snowshoe hares are also reddish brown. Chins, bellies, and the insides of their legs are white. The tops of the feet may also have considerable amounts of white hair. The inconspicuous tails are blackish on top and light gray to whitish underneath. The ears are relatively light reddish brown with blackish tips on the backs and usually with distinct white margins.

Distribution along the Oregon coast: Snowshoe hares occur along the immediate coast from the Columbia River, Clatsop County, south to Gardiner, Douglas County, and possibly to Coos Bay, Coos County. South of Coos Bay, no evidence of snowshoe hares was found along the coast, but they do occur farther inland in the Coast Ranges and extend at least as far south as Bear Camp Lookout on the Curry-Josephine County line, elevation 1 491 meters (Sherrell 1970). Isolated pockets of suitable habitat along the southern portion of the coast may harbor showshoe hares.

Habitat: Snowshoe hares occupy the mature conifer (Douglas-fir variant), immature conifer, alder/salmonberry, riparian alder, Sitka spruce/salal, and cedar swamp habitats.

Habits: Snowshoe hares were abundant along the northern portion of the Oregon coast in 1970, 1971, and 1972 but were seldom seen elsewhere. They are normally shy and secretive, seldom venturing far from protective cover; their dark, rich color blends into the deep, shadowy forests and dark fern undergrowth. Often, the only evidence of the hares' presence is their trails and droppings or "pellets." In western Oregon, and particularly in the dense forests and vegetation of the coast, their trails and pellets are inconspicuous. Although these hares may have lived close to humans for years, many local residents are unaware of their presence.

Snowshoe hares are primarily active during the evening and throughout the night into the early morning. On foggy or rainy days, however, it is not unusual to see a hare feeding or just sitting along the edge of a road in the forest. During the day, snowshoe hares normally retire to their forms that are located among clumps of swordfern, in thickets of salal or other suitable vegetation, or under jumbled piles of windthrown timber. I have even trapped hares that were using the large burrows of mountain beaver as daytime retreats.
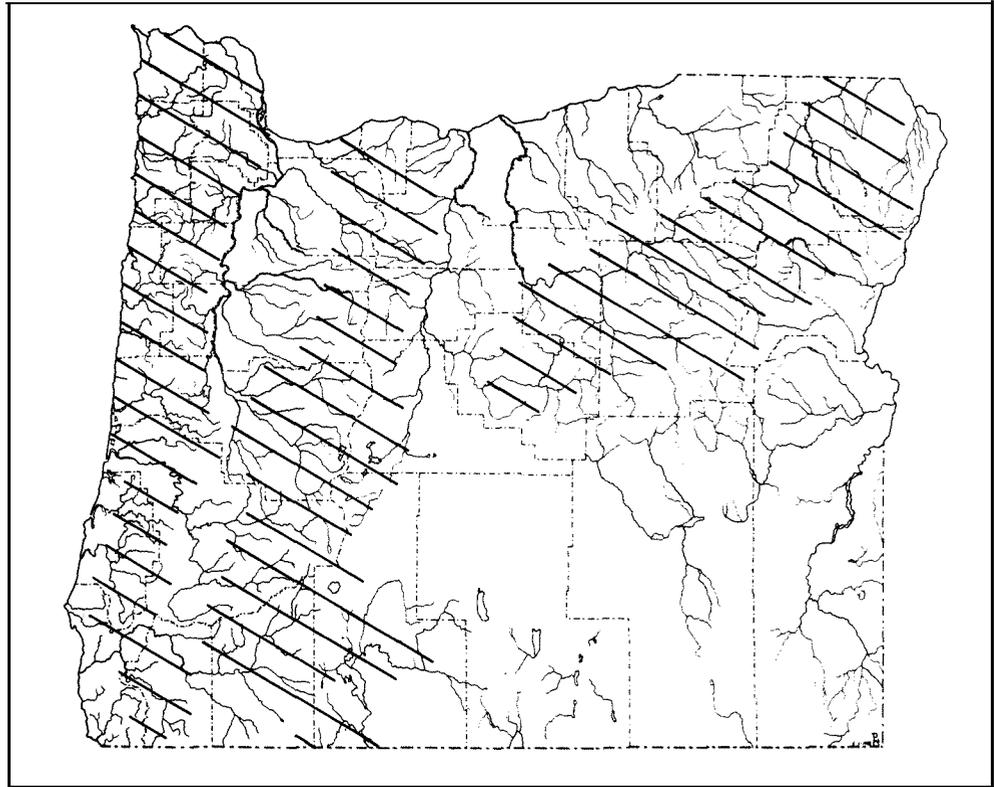
KNOWN DISTRIBUTION OF SNOWSHOE HARE

When disturbed, adult hares usually make a few short hops, "freeze" (remain motionless) for a few seconds, hop a few more feet, then freeze again; in this way, a hare may slip quietly away without attracting attention. Juveniles, on the other hand, freeze immediately. The hares, particularly juveniles, depend on freezing so "intently" to escape detection that, by walking slowly and quietly, I have occasionally been able to get close enough to a youngster to catch it by hand.

During the breeding season, snowshoe hares seem to be moving most of the time, making them more conspicuous than at any other time of year. Furthermore, along the northern Oregon coast, the juveniles appear more active and less cautious than the adults.

Although snowshoe hares are not gregarious, they often play, but only during the breeding season do males and females seem to tolerate one another. Males are generally intolerant of each other, particularly during the breeding season, and fights are frequent (Jackson 1961).

Adult showshoe hares do not usually move great distances and may remain in a small area for a long time. The average size of a hare's home range was 5.9 hectares (O'Farrell 1965).

In addition to the characteristic distress cry, showshoe hares make other vocalizations: a grunt (Grange 1932a, Severaid, 1942); a chirp or click "resembling a human sound sometimes written 'tch'" (Trapp and Trapp 1965); and a "birdlike warble that is difficult to describe" (Forcum 1966).

Both sexes frequently thump their hind feet on the ground. The thumping is surprisingly loud and can be heard for some distance. It probably denotes an intercommunication or warning signal (Jackson 1961, Seton 1928).

The drastic fluctuations in population for which the snowshoe hare is famous are neither readily apparent nor, to my knowledge, have they been studied in the Pacific Northwest. References on population fluctuations of snowshoe hares are: Green and Evans (1940a, 1940b, 1940c), Green and Larson (1938), Green et al. (1938, 1939), Keith (1963), MacLulich (1937), Seton (1928).

Food: In western Oregon during the spring, summer, and fall, snowshoe hares feed on a wide variety of herbaceous plants (such as grasses, clover, false dandelion, woolly everlasting) and some woody plants (such as young sprigs of Sitka spruce and Douglas-fir, and young leaves and twigs of salal). During the winter their diet consists mainly of needles and tender bark of such conifers as Sitka spruce, Douglas-fir, and western hemlock. They also eat the leaves and green twigs of salal; twigs, buds, and bark of willow; and some herbaceous vegetation that remains green. See Hansen and Flinders (1969) and Radwan and Campbell (1967).

Reproduction: The testes of male snowshoe hares begin to enlarge in December and reach maximum size in May. In June, they start to shrink and reach minimum size in November. Sperm was found in about 30 percent of the males in February, about 70 percent in March, 100 percent from April through July, and 50 percent in August (Bookhout 1965).

Showshoe hares are normally not reproductively active until their second summer. Their gestation period is 35 to 37 days (Bookhout 1964, Severaid 1942). They have two litters per year-occasionally three. The hares commonly urinate on each other during their premating activities. A hare of either sex runs beneath its partner who jumps and, in midair, ejects urine. Such behavior may indicate the onset of the breeding season (Bookhout 1965) that begins in early to mid-February along the Oregon coast and lasts at least to the end of June or the beginning of July. Litters range from one to seven; the young are commonly called leverets. Scheffer (1933) found that five young constituted the usual litter in western Washington. The little data I was able to gather on the Oregon coast, however, indicate that the usual litter may be three young. Young are born from about the middle of April through the middle of August. Since showshoe hares are not fully grown until they are about 5 months old (Grange 1932a), young born in August would be only 4 months old in December, during some of the worst winter weather. Young born in the summer may have a better chance of survival in winter.

Litter size apparently depends on latitude; hares are smaller in the southern end of their range (Rowan and Keith 1956). In mountainous areas at the southern end of the hares' range, size of the litter may also depend on elevation.

Predation: Along the Oregon coast, bobcats are the main predators of snowshoe hares, but mink, long-tailed weasels, foxes, coyotes, domestic dogs, domestic cats, great horned owls, and, according to Forsman (1976), northern spotted owls also prey on them.

Economic status: Over much of their geographical distribution, snowshoe hares are important game animals, and they are excellent food. In western Oregon, they are of primary importance in the diets of some fur-bearing mammals. When abundant, they can do considerable damage to seedling coniferous trees and are considered detrimental by timber companies.

Diseases: West of the Cascade Range, snowshoe hares do not carry diseases communicable to humans. Although they are not the main source of tularemia ("rabbit fever"), snowshoe hares and the ticks that parasitize them are **a** source of tularemia. Therefore, as a precaution, hares found dead in the wild or that are obviously sick should not be touched. See Jellison (1970), Kistner and Bone (1973).

Selected references: Dalquest (1942), Grange (1932a, 1932b, 1953), Keith and Surrendi (1971), Meslow and Keith (1968), Rongstad and Tester (1971).

Genus *Sylvilagus*: Cottontail rabbits

Derivation: The generic name *Sylvilagus* is derived from the Latin word *silva* (wood, as in woods or forest) and the Greek word *lagos* (hare).

General description: The head and body of cottontail rabbits range in length from about 25 to 45 centimeters. They weigh from about 0.4 kilogram to 2.3 kilograms. Their pelages usually vary from grayish brown to reddish brown above and are normally whitish, tannish, or grayish underneath. There usually is a patch of bright reddish brown hair on the nape of the necks. Cottontail rabbits do not turn white in winter.
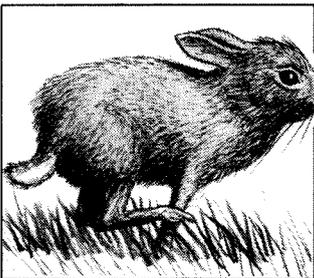
COTTONTAIL RABBIT

These rabbits are active in the evening, throughout the night, and into the early morning. Although most species live in burrows, only one is known to dig its own. A few do not inhabit burrows. The rabbits have relatively small home ranges and tend to maintain definite trails within them.

Herbaceous vegetation is the major food, but during the winter twigs and bark of woody plants are also eaten.

Gestation periods range from 26 to 30 days, and litters vary from two to seven young. Young are born in nests constructed in shallow depressions by the mother. Such nests are occasionally placed under protective structures made by humans. They are generally composed of soft plant fibers and lined with fur from the mother's underside.

These rabbits occupy a variety of habitats; although most species seem to prefer open or brushy clearings in forested areas, a few inhabit forests, swamps, marshes, sandy beaches, or deserts. Their ability to survive in areas of dense human population makes some species popular as game animals.

World distribution: Rabbits of the genus *Sylvilagus* are restricted to the Western Hemisphere. They occur from southern Canada through most of the United States, south to Argentina and Paraguay in South America.

General reference: Walker et al. (1968).

Species *Sylvilagus bachmani:* Brush rabbit

Derivation: The specific name bachmani is a proper name; this species was named in honor of Dr. John Bachman. The subspecies *ubericolor,* the only subspecies along the Oregon coast, was first captured at Beaverton, Washington County, Oregon, on February 25, 1890.

Specific description: Total length, 280 to 363 mm; tail, 25 to 43 mm; hind foot, 67 to 85 mm; ear, 52 to 62 mm; weight, 450 to 965 g.

Brush rabbits are small and compact. They have short ears and legs and small tails. Their pelages are fine and soft with few white hairs. Summer pelages are lighter than those of winter. Dorsally, summer pelages are reddish brown and heavily mottled because of numerous black-tipped hairs. Winter pelages are also heavily mottled but are brown dorsally. The napes of brush rabbits' necks have a patch of bright reddish brown hair. The sides vary from slightly more grayish brown to slightly more yellowish brown than the back. The undersides are gray in winter and light gray washed with light tan, or tan, in summer. The tops of the feet are grayish to almost tan in some individuals. The undersides of the small, inconspicuous tails are usually gray but may be almost white. Brush rabbits' short, dark ears have neither a distinctive black tip nor a distinctive white margin.

Distribution along the Oregon coast: Brush rabbits occur along the entire coast.

Habitat: The brush rabbit is well named since it inhabits the thick, brushy edges of various habitats along the coast. The only time it penetrates particular habitats is when roads or unusually wide trails are in such habitats. The edges of such roads and trails rapidly become bordered with dense thickets of almost impenetrable brush-perfect for these rabbits.

Along the coast, humans have had a profound effect on the distribution of these rabbits. Alteration of timberland by development, construction of roadways, and severe grazing by livestock have opened unsuitable land and created inhabitable, brushy areas. Further, the stabilization of the moving sand dunes through the planting of Scotch broom, lodgepole pine, and European beachgrass has extended the habitat of brush rabbits onto the sand dunes. In some cases these rabbits have followed favorable habitats across a mile or more of sand to the edge of the foredunes, almost to the open beach.

Brush rabbits are most abundant from Coos Bay, Coos County, south into California; this is partly due to the lower elevation and relatively more gentle terrain, as well as the continuously brushy areas of the southern Oregon coast. The brushier
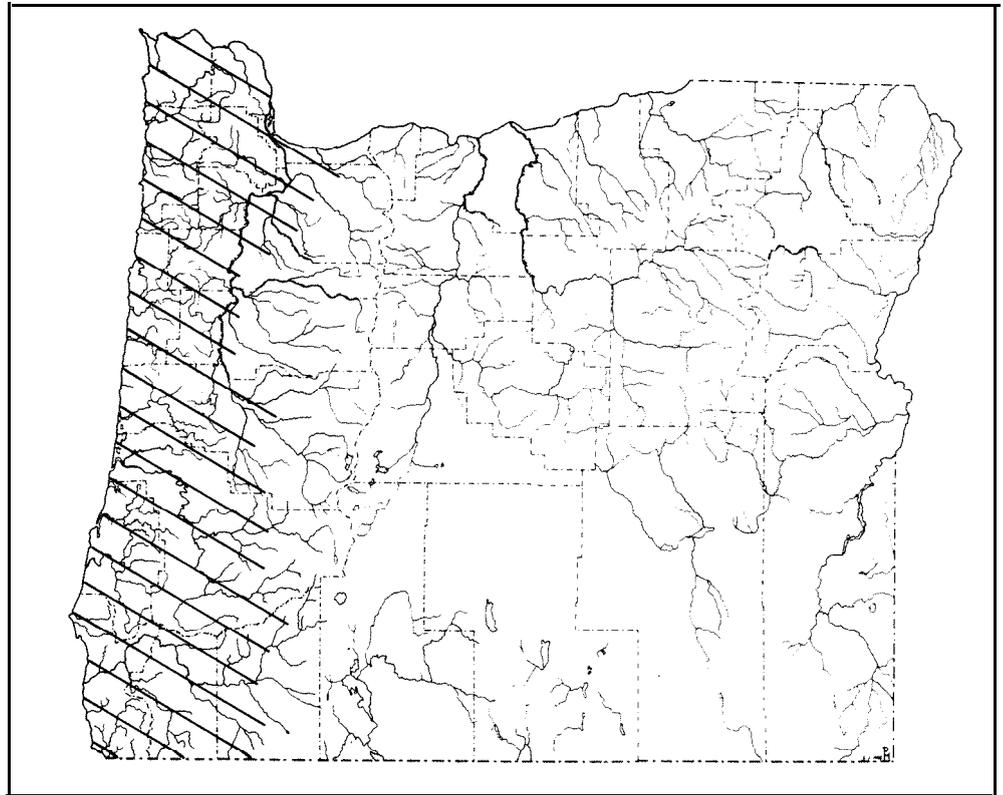
KNOWN DISTRIBUTION OF BRUSH RABBIT

habitat results from the southern vegetation types, such as shrubs, as well as past extensive logging and past and present severe overgrazing. North from Coos Bay, the topography is intermittently much more rugged, and the forest extends to the edges of the rocky coastal headlands, which are usually higher in elevation. Therefore, these rabbits are confined mainly to the brushy valleys of lower elevation. Along the edges of forested areas, brush rabbits are forced to compete with snowshoe hares for living space as well as for food.

Brush rabbits occupy the thickly vegetated edges of all habitat types except the beach, moving dunes, and tideland river. Although not abundant they are occasionally found along the edges of foredunes, deflation plain, skunkcabbage marsh, willow/sedge marsh, and cedar swamp habitats. They are one of the two mammals living along the edge of extensive gorse thickets along the southern Oregon coast. Rabbits use the thickets for cover but do not venture deeply into them, probably because of the extremely sharp, penetrating leaves of the gorse and because nothing is under the canopy of the thickets but dead gorse leaves.

Habits: Brush rabbits along the Oregon coast were seldom seen more than 3 feet from brushy retreats. Adult rabbits were most active in the evening, throughout the night, and into the early hours of the morning. On foggy days or days of constant, drizzling rain, some activity was seen throughout the daylight hours. During the summer and early fall, young rabbits were often active during the day-even clear, sunny days. Adults, on the other hand, usually retired to some secluded retreat.

Brush rabbits did not dig burrows and seldom used those available. When a rabbit did use a burrow as a retreat, it always used the large burrow of a mountain beaver. Use of burrows by brush rabbits occurred, so far as I could determine, only during the hottest summer days and the coldest and stormiest winter days. The rabbits normally had several secluded refuges within their salal, salmonberry, or blackberry thickets. Because these thickets were almost impenetrable to animals larger than the rabbits, a rabbit could usually zip along its runways to safety. Although adults would watch the approach of an animal for a second or two, their move into cover was immediate when danger seemed imminent. Young, on the other hand, frequently would "freeze." By a slow and quiet approach, I captured several by hand.

Connell (1954) found that the home ranges of brush rabbits were small. Home ranges of females had an average radius of 21 meters and those of males 35. Males moved around more freely than females and had overlapping home ranges, whereas home ranges of females seemed to be discrete. Connell did, however, find some emigration out of one area and immigration into another area. Home ranges largely conformed to the size and shape of the brushy cover (Chapman 1971a, Connell 1954). When a rabbit was living within a brier patch, its home range may have been as long as it was wide; but along the coast most home ranges appeared to be long and narrow because much of the suitable habitat occurred along the edges of roads, trails, and clearings which abutted dense forest with scant underbrush. There were regular trails that the rabbits used to get from one area to another. The trails normally went through or paralleled the edges of the brushy thickets, but sometimes they cut through small fringes of timber, provided there was sufficient brush for concealment. Although these trails were used to get from one place to another, they were probably not made by the rabbits.

Chapman (1971a) caught brush rabbits near Corvallis, Oregon, and removed them from their home ranges before releasing them. He found that they could not find their way home when they had been displaced more than 164 meters. He also discovered that they could find their way home only on clear nights. If they were released on a cloudy night, they would usually wait for a clear night to start home. On release, a rabbit sought the nearest cover and kept within available cover on its way home. There was no relationship between homing ability and the individual's sex or age, season, compass direction, or the time it had been held in captivity (up to 13 days) before being released.

After a rabbit was released and had found its way home the first time, the reestablished home range was smaller than it had been before displacement. When captured, displaced, and released a second time, however, the reestablished home range more closely approximated the size of the home range before the first displacement.

Food: Brush rabbits eat a variety of vegetation. During the spring, summer, and fall, they feed primarily on herbaceous vegetation, such as false dandelion, plantain, woolly everlasting, grasses, clover, and the fruits of blackberries and salmonberries. During the winter, they consume whatever green herbaceous vegetation is available (i.e., Douglas iris, plantains, and some grasses), but woody plants form

the bulk of the diet, primarily the leaves and green twigs of salal and, to some extent, the needles and small twigs of Douglas-fir. The Douglas-fir was found not to have been cut from trees, but rather to have been gleaned from boughs that had been broken off by winds and blown down to within the rabbits' reach. Along the coast, the rabbits' feeding sites, paralleling the brush line, were restricted to 3 feet from the edge of their thickets and were constantly cropped to within an inch or two of the ground. After some practice, these feeding sites could be easily located.

Along the coast, the maximum reingestion of cecal pellets by brush rabbits appeared to take place in the winter when most rabbits had as much as a fourth to a third of their stomachs filled with these pellets. In the summer many rabbits did not have cecal pellets in their stomachs, but one lactating female, captured in mid-July, had her stomach filled with them.

Reproduction: The breeding season of brush rabbits in Oregon begins by mid-February and lasts through mid-August. In male brush rabbits the testes begin to enlarge in December, and by January they contain mature sperm. Development of the testes culminates in March, then gradually declines until September or October, when they reach minimum size. By July there is so little sperm remaining within the shrinking testes that males are effectively sterile. Male brush rabbits do not appear to breed until the year after their birth (Chapman and Harman 1972).

In the Willamette Valley, Oregon, 13 percent of the adult female brush rabbits examined were reproductively active in February, 70 percent in March, 100 percent from April through July, 50 percent in August, but none thereafter (Chapman and Harman 1972). No pregnant females were encountered along the Oregon coast before March, but during the beginning of March females exhibited the onset of reproductive activity, which seemed to terminate no later than mid-August.

Although the reported range in size of litters is from 1 to 6 young (Chapman and Harman 1972, Mossman 1955, Orr 1940), along the Oregon coast 3 females each gave birth to 7 young, and 1 female had 10 fresh placental scars. The usual number of offspring appears to be three. Brush rabbits have a potentially higher reproductive rate than is realized because as many as 15½ percent of the embryos may fail to survive and are resorbed. Nevertheless, considering that the gestation period is about 27 days and that females average about five litters per year, a female still produces about 15 offspring in a single breeding season. Females do not usually breed until the year after birth (Chapman and Harman 1972).

Young are born in a specially constructed nest hidden by the mother. One such nest, found in a cranberry bog on July 27, 1970, was composed of an outer layer of dried grasses and an inner layer of fur that the female had plucked from her underside. The fur was thick enough to form a roof over the four youngsters. The nest was 15 centimeters in diameter and 10 deep.

Predation: The bobcat is the major predator of brush rabbits along the Oregon coast (Nussbaum and Maser 1975). Mink and long-tailed weasels are also important predators of these rabbits. In fact, a mink or a long-tailed weasel in pursuit of a brush rabbit in daylight hours is so intent on catching the rabbit that it may almost run into a person observing the chase. When pursued by a mink or a weasel, a rabbit will often break cover in apparent panic and run down the middle of a forest road where it is soon overtaken and swiftly dispatched by a deft bite through the back of the skull. Spotted skunks also are adept predators of brush rabbits. Minks, weasels, and spotted skunks probably kill more nestling brush rabbits than does any other predator. Striped skunks occasionally kill nesting rabbits. Foxes and coyotes, as well as domestic dogs and cats, kill a considerable number of brush rabbits each year, especially juveniles. Great horned owls and Cooper hawks prey on a few of these rabbits along the coast. Red-tailed hawks undoubtedly also capture some.

Economic status: Brush rabbits are important as food for a number of fur-bearing mammals. Timber interests consider brush rabbits detrimental to Douglas-fir seedlings, but the damage they cause does not appear severe and seedling recovery seems good (Hooven 1966). Where they are abundant along the coast, these rabbits may extensively damage home gardens.

Diseases: Although brush rabbits along the Oregon coast are not known to carry diseases that are communicable to humans, they are heavily parasitized by ticks and fleas that readily transfer to a person handling a rabbit.

Selected references: Chapman (1971a, 1971b, 1974), Chapman and Verts (1969), Davis (1936), Orr (1942), Regnery and Miller (1972), Seton (1928), Shields (1960), Verts (1967a).

Order Rodentia: Rodents

Derivation: The ordinal name Rodentia is derived from the Latin word *rodentis* (gnawing) and refers to the gnawing habits of this group. Rodents are unique among the mammals of North America in that they have four incisors, two above and two below. They lack canine teeth.

General description: The incisors of rodents grow throughout an animal's life. Growth is from the base, the only portion that contains nerves, and replaces the portion worn away by chewing hard materials. The outer surface (enamel) is harder than the inner surface (dentine) and is somewhat self sharpening because the dentine wears down faster than the enamel. Because of the structure and shape of these teeth, as well as their self-sharpening characteristic, these rodents are often referred to as "chisel teeth."

Rodents often grind their front teeth together when they are irritated and also at other times; this may help to keep the teeth in proper condition. If the tips are not constantly worn down, malocclusion occurs, and the teeth grow past one another in spiraling form. The result may be upper incisors that curl around into the mouth, grow upward, and possibly pierce the roof of the mouth. Sometimes, however, they grow upward and outward, forming a spiral on each side of the mouth. The lower incisors may grow upward in front of the nose or face. Such abnormal growth of incisors may cause death by starvation.

Rodents walk on the entire surfaces of their feet. The hind feet have from three to five toes; the front feet have five toes, although the "thumb" may be small or absent. Rodents, as an order, have evolved considerable ability to manipulate objects with their front feet.

Some members of this group possess either internal or external cheek pouches that open near the angle of the mouth. External cheek pouches are lined with hair and can be everted from cleaning. Internal cheek pouches lack hair and are attached firmly to the cheek, preventing inverting of their position. Cheek pouches serve as storage areas during food gathering.

The tails of some rodents are adapted for swimming, some for gliding, and a few for the storage of excess fat. Most are important in the maintenance of balance. The tails of spiny mice, *Acomys,* break off readily when they are grabbed, enabling the animals to escape. Other rodents have skin on their tails that breaks and tears readily and slips off, leaving flesh and bone exposed. If such a rodent loses the skin from its tail, the exposed flesh and bone dry and fall off. The tail then heals but does not regrow.

Generally speaking, the testes of male rodents remain small and are retained within the body cavity except during the breeding season. With the advent of the breeding season, the testes enlarge and descend into the scrotum, that is located behind the penis. As the breeding season wanes, the testes shrink and ascend into the body cavity, becoming reproductively nonfunctional.

Rodents comprise over one-third of the known species of mammals. In many areas of the world they are the most abundant animals, in species as well as in numbers. Members of this group usually have high birth rates.

Rodents are extrememly diverse in form and highly adaptable. They have a wide geographical distribution and are usually abundant in most land areas. Some rodents are specialized for digging or burrowing; some are primarily arboreal; some are primarily aquatic; most are terrestrial. Of the latter, some are adapted to arctic regions, whereas others are adapted to desert regions. Members of this group are adapted for digging, running, leaping, climbing, gliding, or swimming. Many species use a combination of locomotion methods.

Rodents are extremely important to humans. Some species destroy insects and weeds; others, such as beaver, muskrat, nutria, and chinchilla, are valuable for their fur. Members of this group are used extensively as laboratory research animals. Some are considered pests because of the extensive damage they cause to agricultural crops or because they carry parasites that transmit diseases to which humans are susceptible. Some rodents transmit diseases directly to people.

World distribution: Rodents are cosmopolitan. They are native to most land areas except some arctic and oceanic islands, such as New Zealand and Antarctica. Almost everywhere people have traveled, they have introduced rodents.

Fossil record: Rodents date to the late Paleocene. Although they exceed all other groups in variety and actual numbers, the fossil record of their distribution is comparatively poor; this has caused problems in classification of the higher taxonomic groups. Fossil remains of rodents may be more common than is supposed; they may be just difficult to locate because of their small size.

Number of species along the Oregon coast: 25-4 introduced.

General references: Anderson and Jones (1967), Walker et al. (1968).

Key:

la Body covered with heavy, sharp, naked quills on back, sides, and tail—
ERE THIZON DORSATUM (North American porcupine), page 238

lb Body without quills of any type..   2

    2a Tail large and wide, horizontally flat, paddlelike, scaly, with almost no hair
        except at extreme base-CASTOR CANADENSIS (North American
        beaver), page 176

    2b Tail not large and wide, not horizontally flat, not paddlelike.   3

        3a Tail small, apparently absent, whiskers appear disproportionately
           long and very stiff; small patch of whitish hair at base of each ear—
        APLODONTIA RUFA (mountain beaver), page 140

        3b Tail readily visible (even if short); whiskers of moderate, proportional
           length; without patch of whitish hair at base of each ear.   4

           4a Face with two deep, external, fur-lined cheek pouches, one on
             each side of lower jaw; external ears very small, appearing naked,
             with small patches of blackish hairs behind each ear; tail naked
             but not visibly scaly-GEOMYIDAE (pocket gophers). 10

           4b Face without external cheek pouches of any kind; external ears
             moderately large even if concealed by hair; without a patch of
             blackish hair behind each ear..   5

              5a Tail long, slender, and tapering to a fine point, about 1½ times
                longer than the head and body, naked, scaly; hind feet excep-
                tionally long and narrow with long, slender toes; upper front
                teeth rich orange, each tooth with a deep longitudinal groove
                running its entire length—ZAPUS TRINOTATUS (Pacific jump-
                ing mouse), page 231

              5b Tail hairy, if naked then less than 1% times as long as the
                head and body; hind feet and toes not exceptionally long and
                narrow; upper front teeth without grooves.   6

6a Hind feet large, 100 mm or more in length and webbed be-tween the toes; tail heavy, rounded, tapering, and scaly-MYOCASTOR *COYPUS* (coypu or nutria), page 241

6b Hind feet, 90 mm or less in length, not webbed between toes, or, if webbed, then with tail vertically flattened and scaly.. 7

7a Ears readily visible, naked or nearly so; tail round, tapering, nearly naked of hair, conspicuously encircled with rows of scales-MURIDAE (Old World rats and mice)................................. 11

7b Ears and tail well haired, or if ears appear to be naked then tail is well haired, or if tail appears to be naked then ears are well haired and/or partially concealed in the pelage................................. 8

8a Ears well haired and relatively small; tail well covered with long hairs but without woolly under-fur, tail bushy or horizontally flat-SCIURIDAE (chipmunks and squirrels). 13

8b Ears scantily haired and relatively large, or scantily haired and relatively small, partially concealed in the pelage; tail not bushy, or if bushy then with long guard hairs and woolly underfur. 9

9a Eyes large; ears large and readily visible, not in any way concealed by the pelage-CRICETIDAE (New World rats and mice). . . 17

9b Eyes small; ears small and partially or almost completely concealed in the pelage because of long hairs on the nose side of the ears that tend to cover them-MICROTIDAE (voles = meadow mice and muskrats). 19

10a Northern two-thirds of Oregon coast (in suitable habitat), from the vicinity of Seaside, Clatsop County, south to the vicinity of Florence, Lane County; there is also an isolated population at the mouth of the Rogue River, Curry County-TtlOMOMYS *MAZAMA* (Mazama pocket gopher), page 171

10b Southern Oregon coast, from the mouth of the Pistol River, Curry County, south into California-THOMOMYS *BOTTAE* (Botta pocket gopher), page?70

11a Total length, less than 210 mm; length of tail, less than 110 mm-MUS *MUSCULUS* (house mouse), page 226

11b Total length, more than 210 mm; length of tail, more than 110 mm. 12

12a Tail longer than the length of the head and body-RATTUS *RATTUS* (black rat), page 220

12b Tail shorter than the length of the head and *body-RATTUS NORVEGICUS* (Norway rat), page 222

13a Nocturnal; pelage extremely fine and soft; a fold of loose skin present along side of body attached to wrists and ankles; outside of each wrist with a cartilaginous projection; tail relatively wide and extremely flat horizontally-GLAUCOMAS *SABRINUS* (northern flying squirrel), page 164

13b Diurnal; pelage coarse and rather stiff; without fold of loose skin along sides of body; wrists without cartilaginous projections; tail narrow to wide, not extremely flat horizontally. . . . . , ... 14

14a Longitudinal dark and light stripes present on sides of head and back; ears with prominent patches of white hair on backs-EUTAMIAS *TOWNSEND/* (Townsend chipmunk), page 146

14b Longitudinal dark and light stripes absent from body, or if dark longitudinal stripe on side, then none on head and back; ears without patches of white hair on backs.. 15

15a Ground-dwelling; upper parts dark brownish gray, mottled and scalloped with small, whitish spots and wavy, black crosslines; back with dark brown or blackish V-shaped area beginning (narrowest) at level of ears, widening, and terminating at middle of back—*SPERMOPHILUS BEECHEYI* (Beechey ground squirrel), page 152

15b Tree-dwelling; upper parts reddish brown to slightly grayish brown *or* clear, bright gray, without mottling, scallops, or wavy, black crosslines; back without dark brown or blackish V-shaped area. . . . . , ... 16

16a Back reddish brown or slightly grayish brown; sides with short, black stripe from forelegs to hips; underside light to dark orange in summer, orange obscured by dark-tipped hairs in winter; tail moderately bushy; ears with short tufts of hair on tips; eyes ringed with short, orange hairs-TAMIASCIURUS *DOUGLAS/* (chickaree), page 159

16b Back clear, bright gray; sides without stripes; underside clear white; tail extremely bushy; ears without tufts; eyes without rings of orange hair (occurring from the California border north to the vicinity of Bandon, Coos County)—*SCIURUS GRISEUS* (western gray squirrel), page 156

17a Mouse-sized; total length less than 230 mm; length of tail less than 133 mm; length of hind foot less than 30 mm; length of ear less than 25 mm; weight less than 36 g-*PEROMYSCUS MANICULATUS* (deer mouse), page 182

17b Rat-sized; total length more than 230 mm; length of tail more than 140 mm; length of hind foot more than 32 mm; length of ear more than 25 mm; weight more than 56 g. 18

18a Tail bushy with long guard hairs and woolly underfur-NEOTOMA *CINEREA* (bushy-tailed woodrat), page 190

18b Tail not bushy, covered thinly with short, stiff hairs, without woolly underfur-NEOTOMA *FUSCIPES* (dusky-footed woodrat), page 185

19a Total length, 305 mm or more; tail, 180 mm or more in length, compressed laterally with a distinct dorsal and ventral keel, covered with small scales, scantily haired; hind feet much larger than front feet; hind feet partly webbed between toes; feet with a fringe of short, stiff hairs on free margins, including toes and webs between toes-*ONDATRA ZIBETHICUS* (muskrat), page 216

19b Total length, less than 305 mm; tail, 102 mm or less in length, round, not compressed laterally, without keels, moderately well haired; hind feet moderately larger than front feet; hind feet not webbed between toes; feet without a fringe of short, stiff hairs on free margins.. 20

20a Tree-dwelling, rarely descends to ground; dorsum varies from brownish red to bright brownish red to orangish red; venter is light gray to light gray washed with reddish orange (juveniles are duller with less red and more brown); tail is well haired, varying from rich medium brown to black (essentially bicolored)—*ARBORIMUS LONGICAUDUS* (red tree vole), page 201

20b Ground-dwelling, rarely ascends trees; dorsum variable, some shade of gray or brown-not red; venter variable, some shade of gray or brown-not reddish orange. . . . . . . ,. 21

21a Front teeth weak and light, varying from light yellowish to whitish; back with a median stripe (sometimes indistinct) varying from light yellowish brown to deep reddish brown to bright reddish brown, with intermixed black hairs (juveniles may be almost black)—*CLETHRI-ONOMYS CALIFORNICUS* (California red-backed vole), page 195

21b Front teeth strong and heavy, varying from yellow to orange; back without a median stripe. 22

22a Rare; ears pale, almost naked of hair; tops of feet are white; tail is 56 to 71 mm in length and is distinctly bicolored, blackish above and white below—*ARBORIMUS ALBIPES* (white-footed vole), page 199

22b Common; ears dark, moderately haired; tops of feet brownish *or* grayish (if whitish then tail less than 53 mm); tail indistinctly to distinctly bicolored, brownish to blackish above and blackish, grayish, or whitish below-M/CROWS (small-eared voles)[5] 23

24a Total length, 156 mm or less; length of hind foot usually less than 20 mm; weight, 31 g or less-M/CROWS OREGON/ (Oregon or creeping vole), page 212

24b Total length, 160 mm or more; length of hind foot, usually more than 20 mm; weight, 36 g or more 25

25a Length of tail, usually more than 75 mm; length of hind foot, usually 26 mm or more-M/CROWS *LONGICAUDUS* (long-tailed vole), page 210

25b Length of tail, usually less than 75 mm; length of hind foot, usually less than 26 mm--M/CROWS TOWNSEND/ (Townsend vole), page 207

26a Total length, usually less than 156 mm; length of hind foot, usually less than 20 mm-M/CROWS *OREGONI* (Oregon or creeping vole), page 212

26b Total length, usually more than 156 mm; length of hind foot, usually more than 20 mm. 27

27a Tail distinctly bicolored, brownish to blackish above, whitish to grayish below—*MICROTUS LONGICAUDUS* (long-tailed vole), page 210

27b Tail indistinctly bicolored, blackish to black above, slightly lighter below-M/CROWS TOWNSEND/ (Townsend vole), page 207

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[5] Unless one is familiar with voles of the genus *Microtus* in western Oregon, species are often difficult to determine without examining their cleaned skulls. They may be identified by using a key to their skulls (see Maser and Storm 1970) or by comparing them with properly identified specimens in a good museum of natural history. Because of the variation, as well as the overlap, in the size and descriptive characters of these voles, the following part of this key must be presented in two parts: (1) the northern three-fourths of the Oregon coast (north of Bandon) and (2) the southern one-fourth (south of Bandon).

Family Aplodontidae: Mountain Beaver

Derivation: The familial name Aplodontidae is derived from the Greek words *haploos* (single or simple) and *odontos* (tooth) combined with the Latin suffix *idae* (family).

General description: The Sierra Nevada miners of California named this unique rodent "mountain beaver" because it occasionally gnaws bark and cuts off limbs in a manner similar to the true "stream" beaver, Castor (Price 1894). The name "mountain beaver" is a misnomer because the rodent is more closely related to the squirrels than it is to the true beaver.

Since there is only one living genus within the family Aplodontidae, refer to the genus for the general description.

World distribution: Mountain beaver inhabit the humid regions of western North America from southern British Columbia, Canada, south to San Francisco Bay, California, and east to the Cascade Range and Sierra Nevada.

Fossil record: Mountain beaver are the oldest known group of living rodents in the world. In North America, their fossil record dates to the late Eocene.

Number of species along the Oregon coast: One.

General references: Anderson and Jones (1967), Shotwell (1958), Viret and Casoli (1962), Walker et al. (1968).

Genus *Apiodontia*: Mountain beaver

Derivation: The derivation of the generic name *Aplodontia* is the same as the familial name.

General description: Mountain beaver are chunky, short limbed, long whiskered, and cantankerous. They have five toes on all feet. The toes of the forefeet are fairly long and are used for digging and grasping. The pelage is composed of sparse guard hairs and thicker underfur. Size, shape, uniform coloration, and the apparent absence of a tail are characteristics that distinguish mountain beaver from all other mammals within their geographical distribution. They are active throughout the year.

World distribution: The geographical distribution of the genus is the same as that given for the family.

General reference: Walker et al. (1968).

Species *Aplodontia rufa*: Mountain beaver

Derivation: The specific name *rufa* is the Latin word for "reddish." The original description of the species was based on a description by Lewis and Clark, who, in 1806, had obtained skins from the Indians near the Columbia River, Oregon. The first specimen of the subspecies *pacifica,* the only subspecies along the Oregon coast, was captured at Newport, Lincoln County, Oregon, by B. J. Bretherton in 1896.

Specific description: Total length, 238 to 370 mm; tail, 19 to 55 mm; hind foot, 48 to 63 mm; ear, 21 to 30 mm; weight, 502 to 1 419 g.

Mountain beaver have chunky bodies and large, wide, flat heads with small eyes and ears. There is a little patch of whitish hair at the base of each ear on the sides of the head. They have long, stiff whiskers. Mountain beaver have small, inconspicuous tails and short, stout legs. The forefeet are relatively small; the first finger is thumblike and has a small, blunt nail. The other four fingers terminate in long, sharp, slightly curved claws adapted for digging. The hind feet are larger than the forefeet, and the toes are shorter with more sharply curved claws. The pelages are short and coarse with sparse, shiny guard hairs. Dorsally, pelages are dark reddish brown with numerous black-tipped hairs, but the number of black-tipped hairs varies greatly by individual. Ventrally, pelages vary from grayish brown, to tan, to light reddish brown in some parts of their range; the animals commonly have patches of white hair on the undersides. Mature females have dark brown to black hairs encircling each of six teats. The pelages of young animals are woolly and dark brown but lack the shiny guard hairs.

Photo courtesy Oregon Depart
ment of Fish and Wildlife.
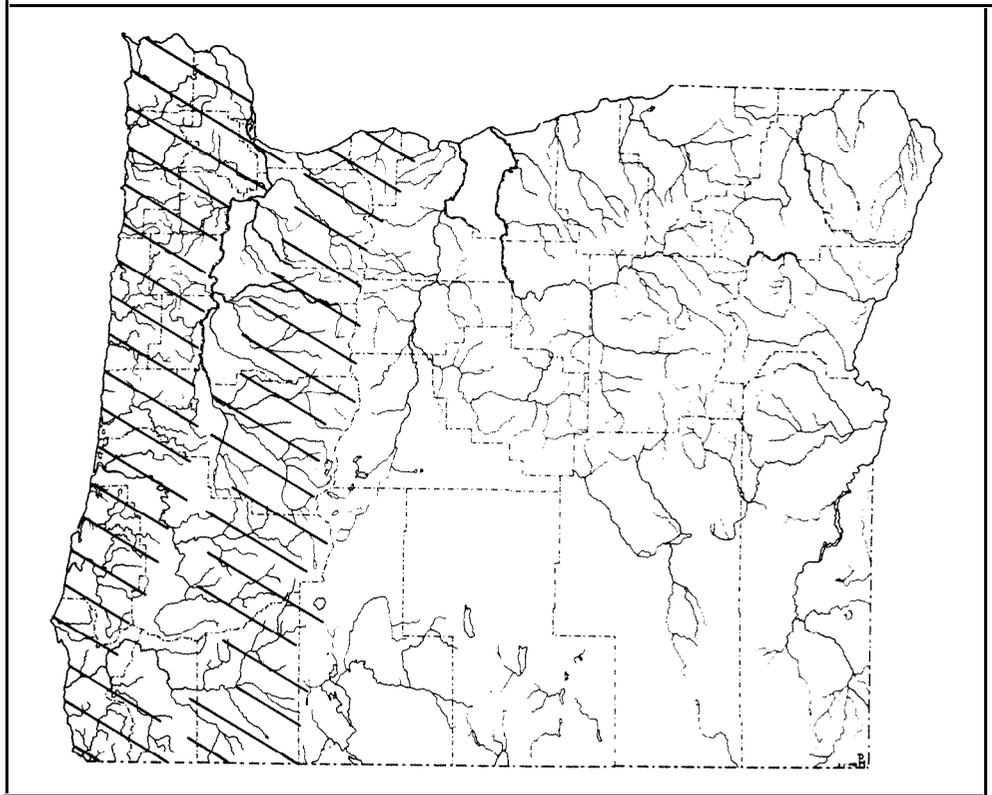
KNOWN DISTRIBUTION OF MOUNTAIN BEAVER

Distribution along the Oregon coast: Mountain beaver occur along the entire coast.

Habitat: Mountain beaver along the Oregon coast occupy the mature conifer, immature conifer, alder/salmonberry, riparian alder, riparian hardwood, Sitka spruce/salal, and skunkcabbage marsh habitats. They are found occasionally in the mountain river and along the edges of the coastal lake habitats.

Habits: Mountain beaver are burrowing rodents that are active primarily from the late evening, throughout the night, and into the early morning; but they may be active during all daylight hours.

They have well-developed senses of smell, touch, and apparently, taste (Kindschy and Larrison 1961, Voth 1968). Undoubtedly, their long, stiff whiskers are well adapted for detecting the sides of their extensive tunnels through which they usually make their way in total darkness. Their small eyes may not be very efficient, but they can detect light and movement. A thick, sticky, whitish substance is frequently seen in the eyes of trapped individuals. Based on numerous observations of mountain beaver, I think this substance probably aids the animal in keeping its eyes clean of the earth through which it burrows.

Although they are primarily active in and around their extensive burrow systems, along the Oregon coast mountain beaver do have definite trails on the surface of the ground. These trails are a result of continual use by the animals. Although no more than one mountain beaver was ever found in a particular burrow system, several individuals that had been using a particular surface trail were often trapped within a week. These trails did not have side branches, but they frequently extended under vast piles of brush that were too dense to allow thorough investigation. Furthermore, they were often long, going from one dense area of cover to another in a straight line without any evidence of a connection to nearby burrow systems. Where these trails originated and terminated is not known. I have seldom encountered such trails, probably because they were usually well concealed by rank vegetation. One trail, however, extended over 15 meters of completely open forest floor. Although it originated under a jumbled pile of small, windthrown timber, it gradually faded on the open forest floor, leaving no clue to its destination. To date, I do not know the exact purpose of surface trails. Only adult mountain beaver were trapped along these trails, and none were observed carrying either food or nest material.

In contrast to the well-concealed surface trails, the burrow systems of mountain beaver are often conspicuous. They are characterized by large holes ranging from about 15 to 20 centimeters in diameter and occasionally as much as 25 centimeters. The holes are surrounded by large piles of earth, rocks, and other debris. The burrows are frequently near the surface of the ground and are easily broken through. Caved-in burrow roofs are not repaired; the debris is merely removed from the tunnel, leaving an open trench. Burrow systems are normally located in or near cover. Most of the entrances and exits, as well as the short trails on the surface that connect entrances to burrows, are usually well hidden. Along the coast burrow systems of mountain beaver often follow the contours of open hillsides in areas that have been logged.

A variety of mammals use mountain beaver burrows: shrew-moles, coast moles, snowshoe hares, brush rabbits, deer mice, California red-backed voles, white-footed voles, long-tailed weasels, mink, and spotted skunks (Maser and Johnson 1967; also Maser, unpublished data on file at Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington).

Nest chambers, circular in form, are situated from 0.3 meter to 1.5 meters below the surface of the ground. Although the nest of an adult may contain a bushel of vegetation, the nest of a young animal is usually much smaller. Nests are composed of two layers-an outer layer constructed of coarse vegetation and an inner layer composed of soft, dry vegetation. Bracken fern and occasionally Douglas-fir and hemlock sprigs are used for the outer layer, but any readily available vegetation may be used. When available, the leaves of salal are used for the inner layer. Although nests may be moist on the outside, they are dry inside (Martin 1971).

Dead end tunnels, located near the nests, are used as fecal and food refuse chambers. Fecal pellets are deposited at the rear of the tunnel; when the tunnel is full, a new one is constructed. New nest sites, particularly those of young animals, have only one fecal chamber, but long-established nest sites have several

chambers that are completely filled with fecal pellets and other refuse. In addition to those "toilets," feeding and food storage chambers also are located near the nest (Martin 1971; Voth 1968).

Nests are often used for long periods. Sometimes they can be located by noting the amount of activity and discarded nest material and feeding debris around the burrows. The two longest periods during which animals (both males) consistently used specific nest sites were 31 and 44 months (Martin 1971).

Martin (1971) studied the home ranges of mountain beaver. He found that they had small, but often overlapping, home ranges varying from 0.03 to 0.20 hectare; the average was 0.12 hectare. The maximum distance the beaver moved from the nest was 43 meters. About 90 percent of the adults operated within 24 meters of their nests. Martin also found that the size and shape of a home range were influenced by the arrangement and quality of the habitat, as well as by the territorial behavior of an animal. Nest sites, defended against trespass by these generally solitary mammals, are located in such a way that advantage is taken of both good drainage and available cover. The burrows that radiate from the nest sites are also constructed to take advantage of available drainage and cover. On the other hand, I have found numerous, much-used tunnels (presumably away from nest sites) with permanently flowing rivulets coursing through them.

Mountain beaver have various vocalizations, ranging from "soft whining and sobbing" (Kindschy and Larrison 1961) to a "kind of booming noise" (Matteson 1877). The most frequent sound is a harsh chattering-grating sound produced when these rodents gnash the lower incisors across the tips of the upper incisors. Gnashing of teeth indicates irritation and had best be heeded because mountain beaver are normally cantankerous and are swift, vicious biters.

Food: Mountain beaver are strictly vegetarians. They consume a wide variety of plants, but ferns-primarily swordfern and bracken fern-are the most important foods on a yearly basis. Voth (1968) studied the food habits of these rodents in western Oregon. The following summarizes his findings (expressed in percent of diet): (1) The diet of adult males and nonpregnant females was: mosses, 1.0; ferns, 84.0; coniferous trees, 3.4; grasses, 2.5; hardwood or deciduous trees, 5.4; shrubs, 1.1; forbs (herbaceous plants other than grasses), 1.9. (2) The diet of lactating females from April through June was: mosses, 3.5; ferns, 37.7; coniferous trees, 33.9; grasses, 18.4; hardwood trees, 1.3; forbs, 4.8. (3) The diet of juvenile animals from June through September, the first 4 months after weaning, was: mosses, 0.9; ferns, 90.7; grasses, 4.6; hardwood trees, 1.3; forbs, 2.6. Voth discovered that changes in diet were related to the protein content of the food. Adult males, for example, had a diet composed principally of ferns, but they shifted to red alder (a deciduous or hardwood tree species) for a short period in the early fall when the leaves of the alders had amassed their greatest protein content of the year. Milk production in mammals depends on a high protein diet. Therefore, in spring the nursing females fed most heavily on the new growth of coniferous trees, which was high in protein. Later, when the protein content of grasses and forbs reached its peak, they showed a decided preference for these items. The diet of nursing females also appeared to have a higher moisture content that did that of males. The diet of newly weaned animals was similar to that of adult males, but the young consumed more grasses and, thus, additional protein. Along the Oregon

coast, mountain beaver rely heavily on the leaves of salal throughout the year. During the winter, they also eat Douglas iris and Douglas-fir. The latter, however, are primarily small branches and twigs broken from the tops of trees and blown to the ground during storms. In extreme southwestern Oregon, mountain beaver eat the needles and twigs of redwood trees. See Crouch (1968a), Voth (1968), and Voth and Black (1973).

Voth (1968, p. 184) found that there is a definite difference in the harvesting of food and the gathering of nest material. Nest material is always dry, whereas food plants are never allowed to dry out. For nest material, the animals "carry in plentiful already-dry vegetation from a previous year" that they gather on the ground after it has been thoroughly dehydrated. Food, on the other hand, is cut while it is fresh and piled next to a burrow, under a log, or on top of a log. There it is allowed to "permanently" wilt before the animal transports it by mouth into the feeding chamber. Since the relative humidity of the feeding chamber is 100 percent, the food does not dry out. Voth (p. 184) postulated, "By wilting some vegetation (which proceeds too slowly inside the feeding chamber) and then mixing it with fresh plants the animal achieves a desired ratio of intake volume of water content." Along the coast I have found numerous piles of wilting or nearly wilted skunk-cabbage at the entrances of mountain beaver burrows in late spring and early summer. Similarly, Oregon oxalis was found beside the burrows of young animals in August. Douglas iris, cut by mountain beaver along the southern coast during winter rainstorms, was also piled outside the burrows.
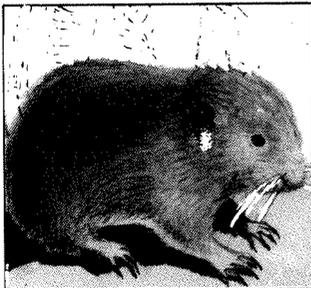
MOUNTAIN BEAVER

Mountain beaver climb hardwood trees, such as alder, to get the leaves. The knowledge that mountain beaver climb is not new (Ingles 1960, Scheffer 1929). Along the coast, mountain beaver climbed as high as 4.6 meters into alder trees and 1.5 to 1.8 meters into vine maples to lop off living limbs that were sometimes nearly 2 centimeters in diameter. The animals cut the limbs off as they climb but not flush with the trees; this leaves stubs for their descent.

Mountain beaver produce two kinds of fecal pellets-hard and soft. The hard pellets are waste material and discarded, whereas the soft pellets are produced in the cecum and reingested as soon as they are expelled. This secondary digestion allows maximum use of the nutriments and vitamins contained in the food (Ingles 1961 b).

Mountain beaver have "earth ball" chambers that provide for storage of "mountain beaver baseballs." These "baseballs" are earth or stones that the animals keep when they find them while excavating burrows. The baseballs, composed of heavy clay or friable rock, may be spherical or lopsided, about 80 millimeters in diameter and 200 grams in weight. The function of these balls seems twofold: (1) Because the animals' diets furnish little abrasive material, gnawing the balls keeps the animals' incisors in proper trim. (2) They are used as chocks to close the nest-feeding chamber complex during an animal's absence, preventing trespass (Camp 1918, Voth 1968).

Reproduction: Along the Oregon coast, testes of the male mountain beaver begin to enlarge in December and reach maximum size about mid-January. By April, they have decreased to their prebreeding size.

Scheffer (1929) stated that, in the Puget Sound region of Washington, sexually developed females were not found before late February and the first stages of pregnancy were not detected before March 20. Their gestation period was about 30 days. I found young already born along the coast by March 22; therefore, mating must have occurred in January and February. Moreover, the uteri and ovaries of the females showed signs of enlargement and of increased blood supplies to the ovaries during late December.

Scheffer (1929) cited litters ranging from two to three young. The litters I found ranged from three to five offspring, but four or five was the usual size. Scheffer (1929, p. 14) noted that mountain beaver are born naked and blind with disproportionately large heads: "The interesting adaptation of the front feet to serve as hands for grasping, noted in the adult, is even more pronounced in the young. On the heel of the palms are two elongated processes, which, with the thumb, oppose the four fingers and thus assist in grasping"; also see Cramblet and Ridenhour (1956). Voth (1966) captured young animals as early as June, but along the coast none were caught before July. Although some young animals become sexually mature the year after their birth, most do not mature until the 2d year (Scheffer 1929). One litter per year seems normal.

During dispersal, the young follow existing burrow systems, or they may travel along the surface of the ground. When dispersing through existing burrow systems, they may attempt to establish several nest sites before finding one that suits them. Nest sites are established either by enlarging or extending burrows or by occupying vacant, already established nest sites. After a nest site has been established, movements of the young are similar to those of the adults (Martin 1971).

Predation: Throughout western Oregon, the main predator of the mountain beaver is the bobcat (Nussbaum and Maser 1975). Mink and long-tailed weasels are also important predators of mountain beaver. Mink trapped in mountain beaver burrows are usually large males. In some areas fur trappers use the meat of mountain beaver as bait for mink. Large, male long-tailed weasels apparently hunt mountain beaver on a one-to-one basis, but the smaller females and young appear to hunt these aggressive rodents in family groups. Clarence Mullins has watched families of long-tailed weasels (including one family of nine) systematically hunting in mountain beaver burrow systems on an open hillside near Otis Junction, Lincoln County, Oregon.[6] Although he did not actually see the weasels kill the mountain beaver, Mullins indicated that when the weasels left, mountain beaver no longer occupied the burrow systems. The small short-tailed weasels are often caught in burrows of mountain beaver, but they could scarcely subdue one of these large rodents. Spotted skunks, which are much more weasellike in their habits than are striped skunks, are often caught in the burrows of mountain beaver. They undoubtedly could kill young animals. Wayne Hammer said that, where coyotes and mountain beaver exist together, coyotes frequently prey on the beaver.'

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[6] Clarence Mullins, U.S. Fish and Wildlife Service (retired), Otis, Oregon, personal communication, 1971.

[7] E. W. Hammer, U.S. Fish and Wildlife Service (retired), personal communication, 1972.

In view of the formidable front teeth of mountain beaver and the swiftness of their biting ability, Voth (1968) suggested that tunnels with blind ends, called "backup burrows," may be used as retreats in the event of attack. Backup burrows extend laterally and diagonally up from the walls of the nest-feeding chamber complex and apparently act not only as ventilation ducts but also as safety retreats. If a mountain beaver backed into such a burrow, a predator's sole avenue of attack would be directly into slashing teeth.

Economic status: There is no doubt that mountain beaver cause severe, local damage to plantations of coniferous tree seedlings, primarily Douglas-fir. Examples of several studies on the damage caused by these rodents are: King (1958), Lawrence et al. (1961), Scheffer (1929).

In years past, the Indians of the Northwest coast used the skins of mountain beaver to make blanketlike robes. The Indians also ate the meat of these rodents. Bailey (1936, p. 227) stated that "one cooked in the writer's camp was strong, tough, and dark colored. No one seemed to enjoy it, and even the dog would not eat the meat." I have eaten mountain beaver and think they have a pleasant flavor, provided the fatty scent glands are removed from the flanks of the carcasses before they are cooked.

Selected references: Anthony (1916), Dalquest and Scheffer (1945), Dicker and Eggleton (1964), Fisler (1965), Fry (1961), Guthrie (1969), Ingles (1959), Klingener (1970), Lawrence and Sherman (1963), Lewis (1949), Lum (1878), McGrew (1941), Pfeiffer (1953, 1958), Pfeiffer et al. (1960), Pilleri (1960), Seton (1928), Taylor (1918).

Family Sciuridae: Chipmunks and Squirrels

Derivation: The familial name Sciuridae is derived from the Greek words *skia* (shadow) and *oura* (tail) combined with the Latin suffix *idae* (family). The name alludes to the shadow or shade cast when a squirrel holds its bushy tail over its back-in other words, a shade-tail.

General description: The family Sciuridae includes chipmunks, tree squirrels, ground squirrels, flying squirrels, marmots, woodchucks, and prairie dogs. All members of this family are diurnal, except the flying squirrels which are nocturnal.

Tree squirrels and flying squirrels nest in trees. They live in hollow trees and limbs or in the cavities of woodpecker nests, but when these are not available they construct nests on limbs. Nests are made of twigs, shredded bark, leaves, or mosses. Tree squirrels make long leaps. When leaping, they extend their legs widely, broaden and flatten their bodies, and stiffen and slightly curve their tails. Such a position presents the broadest possible surface to the air, partially providing lift. Flying squirrels have furred membranes extending along the sides of the body from the forelimbs to the hind limbs. In members of some genera, the membrane extends to the neck and to the tail. At the outer edge of the wrist, the gliding membrane is extended by a cartilaginous projection that acts as a spreader. These squirrels are noted for their ability to glide.

Ground squirrels dwell in burrows. They normally come out of hibernation early in the year and feed on green plants in the spring and early summer. Many species retire to their burrows during the hottest part of the summer and become dormant until early the next spring.

Squirrels occupy a wide variety of habitats, ranging from the Arctic to the Tropics and from the coasts to the mountains to the deserts. Accordingly, some squirrels are active throughout the year; some are dormant during the hottest part of the year (estivate); some hibernate during the coldest part of the year. They have a correspondingly varied diet that includes such items as seeds, nuts, green vegatation, insects, meat, birds' eggs, and fungi.

World distribution: Squirrels are cosmopolitan, except for the Australian region, Madagascar, southern South America (Patagonia, Chile, most of Argentina), the polar regions, certain desert regions (such as Arabia in Egypt), and many oceanic islands.

Fossil record: The fossil record of squirrels in North America dates to the Oligocene.

Number of species along the Oregon coast: Five.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus Eutamias: Western chipmunks

Derivation: The generic name *Eutamias* is derived from the Greek prefix *eu* (good or true) and the Greek word *tamias* (storer, distributor).

General description: The length of the head and body of western chipmunks ranges from 8 to 16 centimeters and their weight from 25 to 125 grams. These chipmunks characteristically have nine longitudinal stripes on their backs, four dark and five light. The stripes originate on the head in the region of the nose and eyes and continue along the back to the region of the tail. Chipmunks have internal cheek pouches in which they carry food.

CHIPMUNK

Chipmunks live primarily on the ground but are good climbers and spend some time in shrubs and trees. They seek refuge in their burrows, in hollow logs and rock crevices, and occasionally in bushes and trees. Food is stored primarily in their underground burrows. They retire into their burrows during the winter and become torpid, but from time to time they arouse to feed on their caches of stored food. They are unlike ground squirrels in this respect. Ground squirrels hibernate, surviving off their accumulated stores of body fat.

Chipmunks occupy diverse habitats, ranging from northern spruce to fir, redwood, and pine forests, and from humid coastal forests to brush-covered mountains and sagebrush plains. They eat a wide variety of foods, including seeds, fruits, bulbs, fungi, insects, and some bird eggs.

Each pregnant chipmunk produces a single litter annually of four to eight young.

World distribution: Of the 17 chipmunks of the genus *Eutamias,* 16 inhabit North America from the central Yukon and southern Mackenzie drainage basins of Canada south to the Baja Peninsula and the Mexican states of Durango and Sonora.[8] The Asiatic chipmunk, *Eutamias sibiricus,* occurs from northern Russia east through Siberia to the Far East, Manchuria, Mongolia, northern China, and northern Japan.

General reference: Walker et al. (1968).

Species *Eutamias townsendi:* Townsend chipmunk
(see footnote 8)

Derivation: The specific name *townsendi* is a proper name. The species was named in honor of J. K. Townsend, who collected the first specimen near the lower mouth of the Willamette River, Multnomah County, Oregon, in 1834. John Kirk Townsend, primarily a naturalist, was in charge of the hospital at Fort Vancouver the winter of 183536 (Johnson 1943).

Specific description: Total length, 221 to 275 mm; tail, 91 to 131 mm; hind foot, 32 to 40 mm; ear, 18 to 27 mm; weight, 51 to 109 g.

The Townsend chipmunk can be distinguished from the other four species of squirrels along the Oregon coast by the wide, longitudinal, dark and light stripes on the sides of the head continuing down the back. Additionally, there is a prominent patch of white hair on the back of each ear.

Although the Townsend chipmunk is large for a chipmunk, it is the smallest squirrel along the Oregon coast. It has a moderately long, lax pelage and rather diffuse coloration. Summer pelage is lighter, brighter, and more contrasting than is the winter pelage. There are three black stripes on the back. The middle one extends from between the ears almost to the base of the tail; the outer two extend from about the shoulders to the rump. There is an additional, short, dark brown stripe along each side of the back, extending from behind the shoulders almost to the rump. Between the dark stripes are four lighter stripes varying from light brown, to yellowish brown, to whitish. The stripes on the sides of the head are lighter than those on the back. The sides, below the short, brown stripes, vary from brown to slightly yellowish brown. The long, rather bushy tail is blackish above, with many white-tipped hairs; the underside is bright reddish brown with a black margin and a "frosted" edge of white-tipped hairs.

There are two subspecies of Townsend chipmunks along the Oregon coast. The subspecies townsendi occurs from the Columbia River, Clatsop County, south to Bandon, Coos County; it has a whitish underside. The subspecies *ochrogenys* occurs from Port Orford, Curry County, south into California; the underside of this subspecies varied from yellowish tan to reddish tan. The two subspecies intergrade between Bandon and Port Orford.

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[8] There is some evidence that the chipmunk species *Townsendi* is, in fact, a complex of four species (Sutton and Nadler 1974). If this is the case, the chipmunk along the southwestern Oregon coast would become *Eutamias siskiyou.* More research is needed, however, before these relationships are clarified.
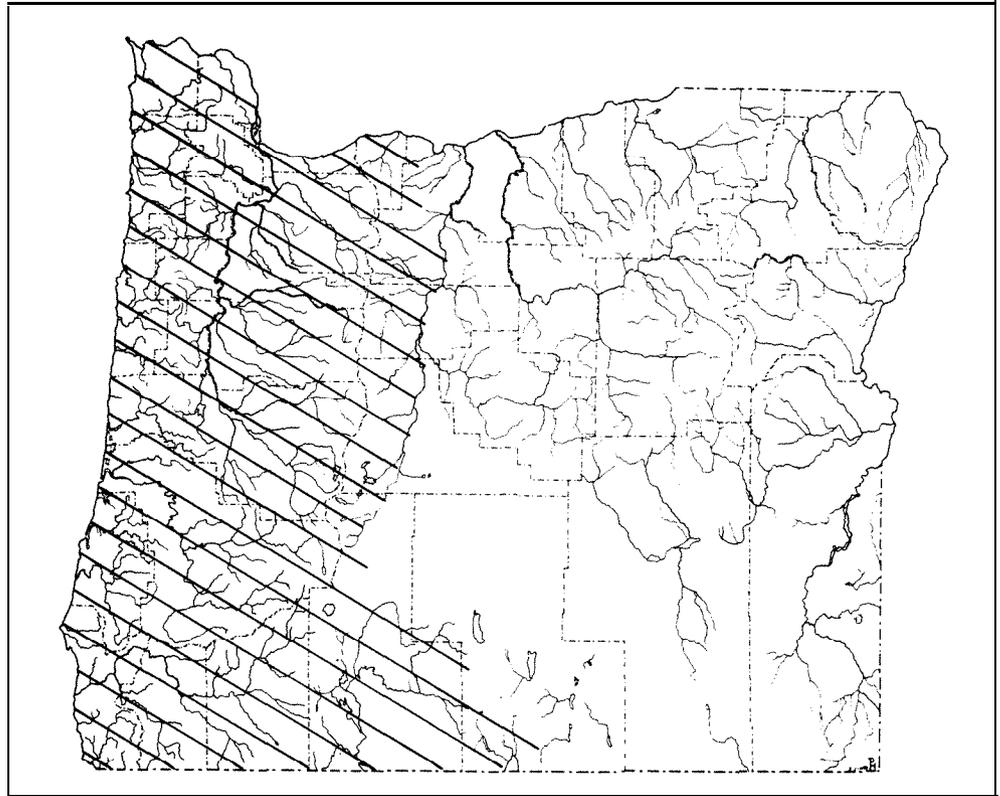
KNOWN DISTRIBUTION OF TOWNSEND CHIPMUNK

<u>Distribution along the Oregon coast:</u> Townsend chipmunks occur along the entire coast.

<u>Habitat:</u> These chipmunks occupy the mature conifer, immature conifer, alder/ salmonberry, riparian alder, riparian hardwood, lodgepole pine/rhododendron, lodgepole pine/salal, Sitka spruce/salal, coastal lake (edge only), and tanoak habitats; but they are most commonly seen in the riparian hardwood, lodgepole pine/rhododendron, lodgepole pinelsalal, and tanoak habitats.

Habits: Townsend chipmunks are active from dawn until dusk. Unlike their smaller chipmunk cousins, they are shy, wary little squirrels that normally are heard rather than seen. Their calls are quiet, birdlike, and often muted by the rank vegetation in which they live. Most people do not even realize that it is a mammal to which their ears are attuned. The calls usually emanate from shadowy undergrowth in which the diffuse coloration of the squirrels blends with the varying light of the surroundings. Townsend chipmunks tend to "freeze" or to crouch when they hear a sound or movement. They have a unique, but quiet, alarm call, that can be simulated by forming a rigid "O-shape" with the lips, and then, placing the little finger inside the mouth so that the back of the hand is toward the face, sliding the finger out of the mouth, all the while pressing firmly against the cheek. The sound produced is high and crisp and may be written "po, po, po," with the sharpest accent on the beginning of the sound.

Although they live primarily in burrows, Townsend chipmunks are expert climbers. They often forage, hide, or sun themselves in bushes and trees. When startled or chased, they usually dash quietly for cover, but they are just as apt to scurry up a tree where they are difficult to locate. These silent, graceful, soft colored denizens of the humid coast are generally not seen.

In areas blanketed with deep snow, these squirrels normally accumulate body fat and remain in their winter burrows until released by the spring sun. Coastal Oregon, however, seldom has much snow. Townsend chipmunks are active above ground throughout much of the winter, remaining in their warm nests only during the worst winter storms. They do not, as far as I could determine, accumulate body fat.

Food: In the summer and fall, Townsend chipmunks eat a variety of fruits, such as evergreen huckleberries, red huckleberries, salal berries, salmonberries, blackberries, blackcaps (also called wild raspberries), and thimbleberries. In late autumn they eat mainly acorns of tanoak, seeds of bigleaf maple, California laurel, thistles, grasses, Douglas-fir, hemlock, spruce, and occasionally cedar. Their diet during the fall, winter, and spring is augmented with subterranean fungi which they dig out of the soils and with the semidried, evergreen huckleberries that remain attached to the bushes throughout most of the winter despite frequent and heavy rains. In addition to vegetable foods, the chipmunks consume insects, primarily beetles.

Reproduction: The testes of Townsend chipmunks begin to enlarge toward the end of January. By March, nearly all males are in breeding condition; by July, their testes have decreased in size and appear sexually inactive.

Each pregnant Townsend chipmunk produces a single litter per year. Families may include from two to six young but usually consist of four to six offspring. Breeding begins in March and apparently lasts into May. Young are born in May and June but are not seen out of their nests until July. Even then, they are nursed until mid- or late-July.

The newborn are naked, blind, and toothless; they range from 3.2 to 3.9 grams in weight and from 55 to 60 millimeters in total length. Their loose skin is so translucent that milk can be seen in the stomachs of recently fed babies. When the young are 20 to 22 days old, the lower incisors erupt; the upper incisors do not erupt for 28 or 29 days. The canal leading to the inner ear opens on the 24th or 25th day, and the eyes normally open between the 27th and the 29th day. The pelage is bright and fuzzy with markings more distinct than those of the adults. They can eat solid food at about 39 days (Forbes and Turner 1972) but apparently do not mature sexually until their second summer. One wild Townsend chipmunk lived 7 years. During that time his home range was about 0.6 hectare (Gashwiler 1965a).

Predation: The main predators of Townsend chipmunks along the coast are long-tailed weasels and mink; however, spotted skunks probably also eat these chipmunks. Bobcats catch a surprising number of these small squirrels (Nussbaum

and Maser 1975), and domestic cats take a considerable toll. Townsend chipmunks are occasionally captured by owls that hunt during the late afternoon and early evening, such as the great horned owl (Maser and Brodie 1966).

Economic status: Since Townsend chipmunks consume the seeds of coniferous trees, such as Douglas-fir, they are considered detrimental by timber interests and have been poisoned. Along the southern coast, they raid cranberry bogs, but it is doubtful that they do much damage.

Selected references: Adams and Sutton (1968), Bailey (1936), Meredith (1972), Shaw (1944), Sutton and Nadler (1969), Tevis (1952), Walker (1923), White (1953a, 1953b).

Genus *Spermophilus*: Ground squirrels

Derivation: The generic name *Spermophilus* is derived from the Greek words *sperma* (seed) and *phileō* (to love).

General description: Ground squirrels vary from small (about 85 g) to large (about 1 kg). They have four basic markings. The most common is yellowish gray to gray that is darker above, with a few to many spots. The second is similar to the first, but the spots are faint or absent. The third marking is two dark, longitudinal lines separated by a light stripe along each side of the back. The stripes extend from the shoulders to the hips. The fourth marking consists of light, longitudinal stripes beginning at or on the head and extending to the base of the tail; these light stripes are separated by longitudinal rows of spots. Pelages of ground squirrels vary from coarse and thin to fine, soft, and thick.

Ground squirrels are well adapted to digging and primarily live in underground burrows. Their burrows may be located in meadows and prairies; around logs, stumps, or trees; or among rock piles, rock outcroppings, or cliffs. They eat a wide variety of foods, such as seeds, nuts, fruits, roots, bulbs, stems and leaves of herbaceous plants, small mammals, carrion, birds, and birds' eggs. Some foods are transported in cheek pouches located inside each cheek.

GROUND   SQUIRREL

Ground squirrels feed throughout the spring and into the summer, accumulating great stores of body fat. In late summer, squirrels in the northern area retire to their burrows and do not re-emerge until the next spring. Ground squirrels in southern regions are more or less active throughout the year, but they remain in their burrows during inclement weather or when the supply of green food disappears.

Each pregnant ground squirrel has a single litter per year. Gestation periods range from 23 to 30 days, and litters tend to be large-2 to 15 young. Babies are born naked, blind, and toothless. Although not strictly gregarious, ground squirrels tend to live in loose colonies.

World distribution: Ground squirrels occupy North America from Ohio to the Pacific Ocean and from northern Alaska and Canada to west-central Mexico. They also inhabit eastern Europe and Asia south to Turkestan and western Mongolia.

General reference: Walker et al. (1968).

Species *Spermophilus* beecheyi: Beechey ground squirrel

Derivation: The specific name beecheyi is a proper name. The species was named in honor of Captain Fredrick W. Beechey, who sailed the British naval ship "Blossom" along the west coast of Mexico and California in 1828. The subspecies *"douglasi,"* the only subspecies along the Oregon coast, is named in honor of David Douglas, the Scottish botanist who collected the first specimen along the Columbia River in 1825.

Specific description: Total length, 370 to 500 mm; tail, 145 to 227 mm; hind foot, 49 to 64 mm; ear, 20 to 34 mm; weight, 280 to 738 g.

The Beechey ground squirrel is the only ground squirrel along the Oregon coast. It is relatively large and has a heavy body with a coarse, short pelage. In summer the upper parts are dark brownish gray, mottled and scalloped with small whitish spots and wavy, black crosslines. There is a dark brown or black V-shaped area on the back; the V starts at the level of the ears and becomes broader until it ends at the middle of the back. The sides of the back bordering the V are light gray. The venter is tan. The dark gray tail is moderately bushy and has three concealed black and gray or black and tan bands along each side and around the tip. During the summer a squirrel's markings may be inconspicuous when it lives in a dusty habitat. The winter pelage is grayer than the summer pelage, and the markings are less conspicuous. The claws are dark gray, long, slightly curved, and well adapted for digging.

Distribution along the Oregon coast: Beechey ground squirrels occur along the entire coast.

Habitat: Beechey ground squirrels (also called "gray diggers") live primarily in open areas; therefore, they are only abundant in some areas along the coast. They are found in riparian hardwood, beach, foredune, headland shrub, wet pastureland, and tanoak (most common) habitats.

Habits: Beechey ground squirrels are most often seen sitting in the sun on an elevated lookout. Their daily activities begin at dawn, and it is not unusual for them to climb trees to find a warm spot-a sun-bathed limb. They normally retire to their burrows at sunset.

Although they are good climbers, these large, husky squirrels are ground dwellers. They usually seek their burrows when danger threatens, even though they may have to leave the safety of a tree at the time. Their burrows are usually deep, and when possible, are constructed under logs, trees, rocks, buildings, or other objects. A lack of protective objects, however, does not deter them from digging burrows in open hillsides, fields, or pastures. Each burrow normally has a mound of earth at its entrance and from one to several trails radiating from its mouth. Such trails may lead to another burrow or to a favorite feeding site or lookout. Although squirrels may travel relatively long distances from their dwellings, most of their activity seems to be in the vicinity of the burrows.

Beechey ground squirrels may live singly or in groups of two's and three's (particularly in the marginal habitat along the coast), but they usually live in loosely organized colonies. The squirrels in these colonies are always vigilant. They communicate with each other vocally, and their warning calls are often heard before a squirrel is seen.

The squirrels begin to accumulate body fat as summer changes to autumn, and by the end of September they have large quantities. They usually retire to winter quarters toward the beginning of November and do not reappear until sometime in mid-February. Occasionally, however, an individual will suddenly appear during a warm period in midwinter, only to vanish again in adverse weather. According to Edge (1931), females are the first to appear outside their winter burrows and to assume normal, aboveground activities; they are also the first to seek winter quarters.

Food: Beechey ground squirrels eat a variety of foods. After emerging from their winter quarters, they feed largely on fresh, green vegetation. During the spring and summer they gorge themselves on leaves, flowers, bulbs, roots, and green seeds. In late summer and early fall they shift from green vegetation to berries, ripe seeds, grains, and nuts. In the tanoak habitat, the ground squirrels feed almost exclusively on the acorns of tanoak trees and on the large seeds of California laurel. In late fall they occasionally climb small coniferous trees and eat the bark. Insects, and even meat, are included in the squirrels' diet. Occasionally, a Beechey ground squirrel may be seen eating the flesh of another Beechey ground squirrel that had been killed by an automobile.
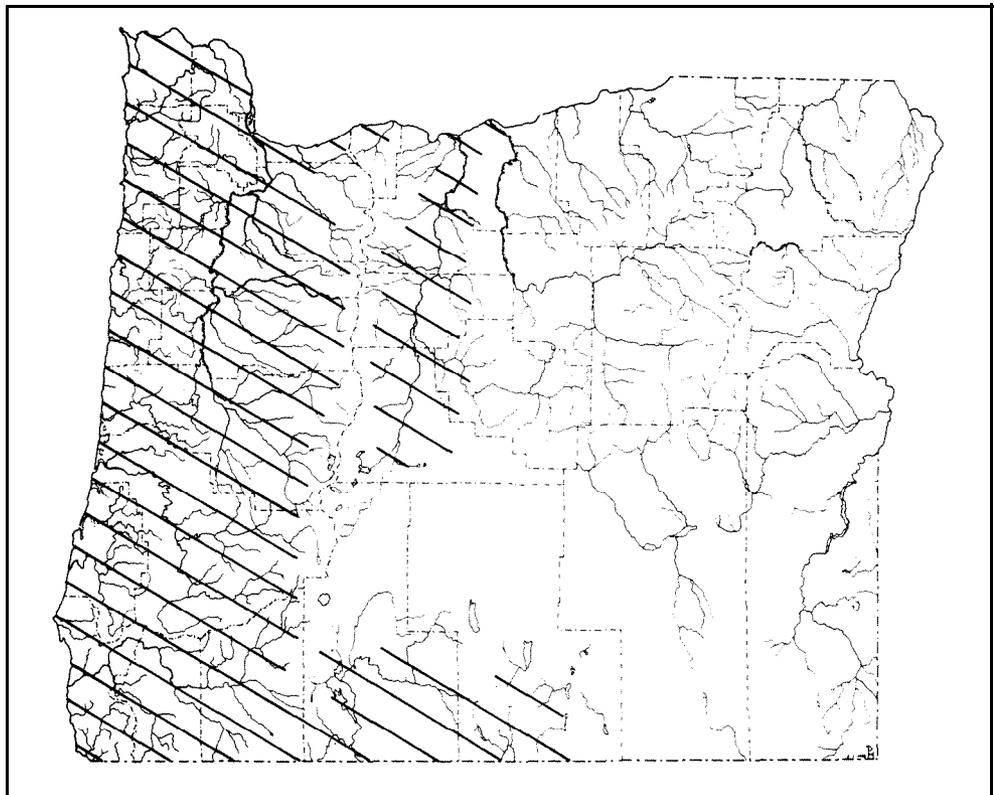
KNOWN DISTRIBUTION OF BEECHEY GROUNDSQUIRREL

Reproduction: Enlargement of testes in Beechey ground squirrels begins in February; in March, males are in breeding condition. According to Edge (1931), breeding did not appear to begin before late March and attained a peak of activity about April 1. Whether more than one litter for each pregnant squirrel is produced in a single year is doubtful.

Chapman and Lind (1973) documented a correlation between latitude and the average size of litters produced by Beechey ground squirrels. The average litter in the northern portion of western Oregon is five offspring. In the southern portion of western Oregon the average litter is six; an average of eight young per litter occurs in southern California. Chapman and Lind postulated that the warmer temperatures and more freeze-free days in southern portions of their range allow the ground squirrels to spend more of the year outside their burrows, thereby increasing predation. Larger average size of litters in southern localities may be a response to greater predation pressure caused by longer aboveground activity periods.

After a gestation period of 25 to 30 days, the young are born hairless, wrinkled, and red. Their eyes are closed and their coordination is poor. At birth they weigh about 12 grams. At 2 weeks they are covered with fuzz, their whiskers are beginning to appear, and they weigh 24 grams. Their eyes are not quite open at 4 weeks; they can raise their heads off the ground but not their bodies. They weigh about 35 grams and can shuffle around. At the end of 5 weeks, some babies have their eyes open and weigh 47 grams. By the end of 6 weeks, the young squirrels weigh 53 grams, are quite active, and can support themselves on their feet and legs in an upright position. At 8 weeks, they weigh 64 grams and are active, leaving the nest frequently. At the end of 8 weeks, young ground squirrels weigh 73 grams and are active throughout much of the day. They begin to leave their burrows in early June (when about 8 weeks old) but undoubtedly nurse for a time while becoming adjusted to solid food. At this age the young squirrels are about 210 millimeters in total length. During their first 8 weeks of life, they gain from 8 to 10 grams per week (Edge 1931).

Predation: Bobcats prey on Beechey ground squirrels, particularly along the southern Oregon coast; but they do not capture many (Nussbaum and Maser 1975). Coyotes prey on these ground squirrels, and domestic dogs kill them. Red-tailed hawks hunt the squirrels by day; large owls, such as the great horned owl, which hunt during the late afternoon, occasionally capture a squirrel (Maser et al. 1970). The greatest toll, however, is taken by humans with traps, poisons, and guns.

Economic status: Locally, Beechey ground squirrels are very destructive to crops grown in open valleys-the squirrels' optimum habitat. They are especially detrimental to cereal crops, on which they feed from the first appearance of a plant above the ground to the removal of crops from the fields. Ground squirrels may often be seen sitting on their haunches along the edges of cereal fields, systematically bending down the stalks of ripening grain with their forefeet, stripping the seeds off the heads, and then, with their cheek pouches full, running to their burrows. The procedure is repeated again and again. These squirrels also raid fruit and nut crops. Furthermore, when squirrels are abundant, their burrowing activities and trails cause considerable damage to meadows and pastures.

These ground squirrels are excellent food. They have a pleasant flavor, comparable to that of the larger tree squirrels that are hunted as game animals.

Diseases: Beechey ground squirrels are carriers of sylvatic plague (Olsen 1970). Since fleas that parasitize ground squirrels are the actual transmitters of plague, one should not touch, molest, or otherwise come in contact with an obviously sick or dead ground squirrel. In addition to being a potential health hazard, these squirrels are normally vicious and should not be kept as pets.

Selected references: Adams and Davis (1967), Fitch (1948), Jacobsen (1923), Linsdale (1946), Marsh and Howard (1968, 1971), Marsh et al. (1969), Storer (1930), Tomich (1962).

Genus Sciurus: Tree squirrels

Derivation: The generic name *Sciurus* has the same derivation as the familial name.

General description: Tree squirrels are fairly large, ranging in head and body length from 20 to 32 centimeters, with tails from 20 to 31 centimeters in length. In weight, they range from 200 to 900 grams but may weigh as much as 1 kilogram. Colors of the various species differ greatly. The backs and sides are usually gray, grayish brown, blackish brown, or various shades of red; the undersides range from white, through tan and yellow, to orange. Individuals or whole populations, however, may be much darker, even black.

Tree squirrels inhabit deciduous, coniferous, and tropical forests (both humid and arid). Their periods of greatest activity are early morning and late afternoon when they often descend to the ground and forage for food. Their food consists of nuts, seeds, fruits, buds, shoots of young trees, mushrooms, insects, birds' eggs, and occasionally young birds. Some nuts are buried, not eaten; thus, the squirrels often plant nut-bearing trees.

Nests are constructed with twigs, leaves, or mosses on limbs or in forks of branches. Hollows in trees are used as nests when available. Although individual squirrels have favorite nest-trees, they also maintain several other nests to escape from enemies. Tree squirrels can be noisy, especially during territorial disputes.

Some species have two litters per pregnant squirrel per year. After a gestation period of 38 to 44 days, a litter of from 1 to 10 young is born. Females usually do not breed until their second summer.

World distribution: Tree squirrels occur in most of Europe and Asia, south of the northern limits of tree growth; Japan; and the New World, from southern Canada south, through the United States, Mexico, and Central America, into South America as far as northern Argentina.

General reference: Walker et al. (1968).

TREE SQUIRREL

Species *Sciurus griseus:* Western gray squirrel

Derivation: The specific name *griseus* is from the Middle Latin word *griseus,* "gray." The species is based on the description of a squirrel seen by Lewis and Clark at The Dalles, Wasco County, Oregon.

Specific description: Total length, 445 to 593 mm; tail, 240 to 310 mm; hind foot, 75 to 86 mm; ear, 35 to 42 mm; weight, 315 to 965 g.

The western gray squirrel (also called "silver-gray") is the largest squirrel along the Oregon coast; it also has the longest and the bushiest tail. The back is clear, bright gray that appears frosted because of many white-tipped hairs. The backs of the ears are a light reddish brown. The tail hairs are long and have five bands of color on each hair, including those on the tip. The top of the tail appears black with white frosting; however, the bands are usually clear on the underside. The underside, except for the tail, is clear white.

Distribution along the Oregon coast: Western gray squirrels have been found from the California border north only as far as Bandon, Coos County.
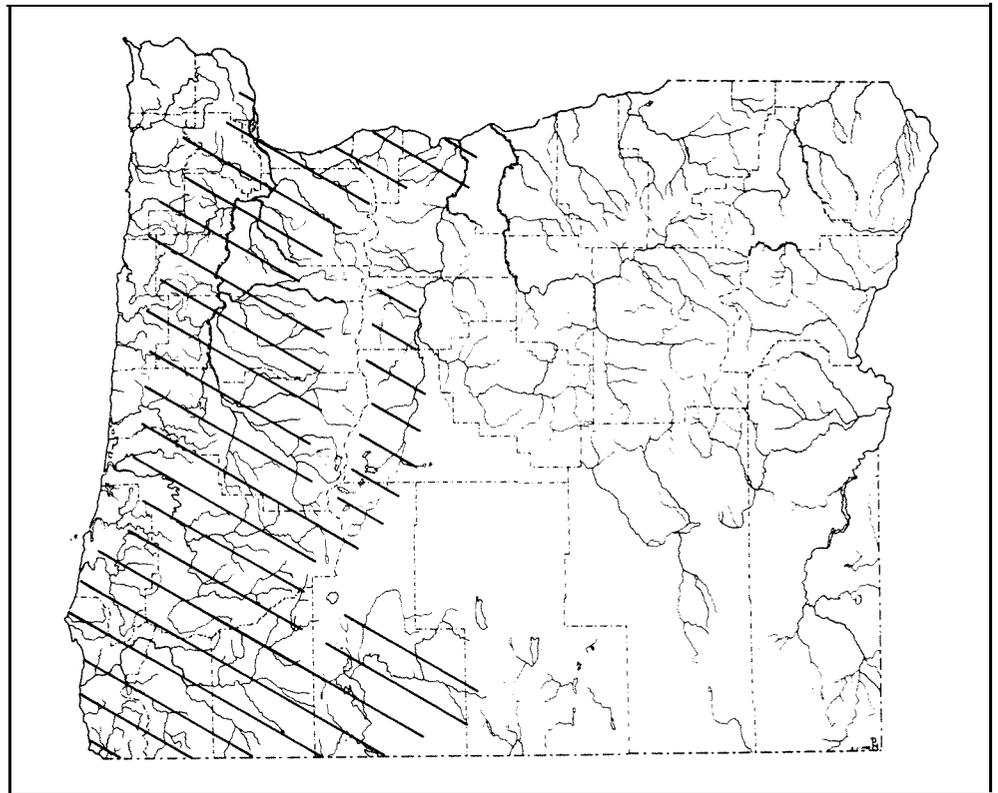
KNOWN DISTRIBUTION OF WESTERN GRAY SQUIRREL

Habitat: These squirrels occupy the tanoak and riparian hardwood habitats. From Port Orford north, their main distribution is several miles inland, corresponding to the tanoak and riparian hardwood habitats. They only occasionally are found in the more humid lodgepole pine/salal habitat type in the vicinity of Bandon.

Habits: Western gray squirrels are most active in early morning and again in late afternoon. These beautiful squirrels are amazingly stealthy in their movements and very clever at vanishing when pursued. Once in a tree, they stretch out on a limb with their plumy tails over their backs and are motionless. Except for an occasional, hoarse bark-"chuff, chuff, chuff"-they are silent. Their warning "bark" is heard most often in August, September, and October.

Western gray squirrels build large nests on the limbs of oak, fir, or pine trees. East of Brookings, Curry County, their nests were found up 15 meters and higher in the trees. The outer portions of the nests are composed of sticks and twigs with leaves attached, or occasionally mosses and lichens. The sleeping quarters are lined with fine lichens, mosses, or the shredded bark of dead maple, California laurel, or other broad-leaved trees. During the wet coastal winters, however, these squirrels probably use available hollows in trees rather than outside nests. Although active throughout the year, they retire to their warm nests during the worst winter storms.

Western gray squirrels are adroit climbers, often leaping from one treetop to another with amazing swiftness and dexterity. Dalquest (1948, p. 285) wrote of one of these squirrels leaping out of the top of a tall fir tree:

> . . . the squirrel leaped far out into the air. Its legs were stretched out stiffly, the tail was extended and the body slightly arched. It struck the ground with an audible thud and bounced fully 18 inches. At the height of its bounce, the squirrel's legs began moving rapidly, and it struck the ground the second time at a full run.

When bounding over the ground, these squirrels are grace and flowing beauty in motion. Their long, plumy tails seem to float out behind them as they cover the ground in long, flowing, undulating bounds. People stop to admire them (see Seton 1928).

Food: In Oregon western gray squirrels eat the seeds of sugar pine, ponderosa pine, Jeffrey pine, and lodgepole pine. They also eat the acorns of Oregon white oak, tanoak, Sadler oak, canyon live oak, and California black oak, as well as hazel nuts and the large nuts of California laurel and golden chinkapin. Fungi, green vegetation (such as false dandelions and the tender shoots of coniferous trees), berries, and insects are also included in their diets.

Reproduction: The testes of western gray squirrels begin to enlarge in December and are fully enlarged by mid-January. Each pregnant female gives birth to one litter per year. Litters, consisting of from two to five young, are born from March into June. Babies are born naked and blind in nests as high as 18 meters above the ground. June was the earliest that the young squirrels were seen out on their own along the coast. Adults are silent and unobtrusive while the young are being raised.

Predation: The bobcat is the only predator in Oregon that I have found to capture western gray squirrels; there are undoubtedly others. People probably take the greatest toll through hunting and control measures. Some squirrels are killed by automobiles.

Economic status: Western gray squirrels are favored game animals over much of their geographical distribution; as such, they are protected and managed through hunting regulations. Their meat is excellent. In areas where nuts, such as walnuts and filberts, are grown as crops, however, these squirrels do a considerable amount of damage by stripping the nuts from the trees before they are ripe enough to harvest. If an orchard is small, the squirrels can pack away an entire crop. Under these circumstances, the squirrels may be shot, trapped, or controlled by other means, and protection under the status of game animal may be with-drawn Western gray squirrels become very tame when not molested and add much enjoyment to city, county, and State parks.

Genus *Tamiasciurus*: Red squirrels and chickarees

Derivation: The generic name *Tamiasciurus* is derived from the Greek words *tamias* (storer, distributor) combined with *skia* (shadow) and *oura* (tail). The name alludes to the shade cast when a squirrel holds it bushy tail over its back and to the fact that this genus is noted for its storage of excessive quantities of winter food.
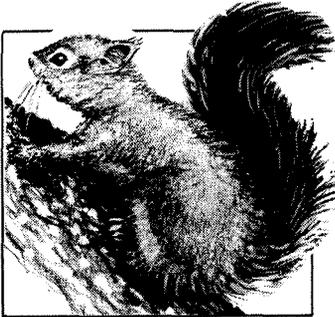
RED SQUIRREL

General description: Red squirrels and chickarees, often called "pine" or "timber" squirrels, are relatively small for North American tree-dwelling squirrels. In length of head and body, they range from 16.5 to 23 centimeters, and their tails are from 9 to 16 centimeters long. Their weight ranges from 141 to 312 grams. Dorsally they vary from slightly yellowish brown or orangish brown, to rich brown, to reddish brown, to an almost reddish green-brown. Ventrally they are white, through yellowish, or orange, with a blackish, longitudinal line on each side separating the dorsal and ventral coloration.

These attractive, little squirrels are noisy, alert, and active. Chickarees are less vociferous than are red squirrels and, therefore, are frequently overlooked. Each in-dividual maintains several nests that are of four basic types: (1) a loosely con-structed nest in a tree for use during the summer; (2) a hollow in a tree used during the winter; (3) a weather-tight nest in the densest foliage of a tree-an alternate winter nest; and (4) an underground nest, usually in the main midden pile and used during severe winter storms or prolonged periods of exceedingly cold weather.

Red squirrels and chickarees eat a variety of foods, such as seeds from the cones of coniferous trees, nuts, fruits, and berries; the young and tender shoots of con-iferous trees; and occasionally, birds' eggs and young birds. These squirrels are notorious cone-cutters. The cones, cut while still green, are stored for winter food-a necessity, since the squirrels are active throughout the year.

Except for mating, these squirrels are solitary in their habits. There may be two litters per pregnant squirrel each year, consisting of from one to eight young per litter, but usually from four to six. Gestation periods vary from 36 to 40 days. These squirrels are fairly long lived; one lived 9 years in captivity.

There is a popular misconception in Pennsylvania-namely, that red squirrels and eastern gray squirrels are enemies and that when they fight, the red squirrels castrate the gray squirrels and prevent their reproduction. Since eastern gray squirrels are a favorite game animal, the red squirrels are ruthlessly hunted and killed.

World distribution: Members of this genus occur from Alaska and Quebec, Canada, south in the Cascade Range into California, south in the Rocky Mountains to New Mexico, and south in the Appalachian region to South Carolina (see Smith 1970).

General reference: Walker et al. (1968).

Species *Tamiasciurus douglasi*: Chickaree

Derivation: The specific name *douglasi* is a proper name; this species was named in honor of the Scottish botanist, David Douglas, who collected the first specimen near the mouth of the Columbia River in the early 1800's.

Specific description: Total length, 273 to 355 mm; tail, 100 to 150 mm; hind foot, 44 to 57 mm; ear, 19 to 31 mm; weight, 150 to 300 g.

The chickaree, also called Douglas squirrel or spruce squirrel, is relatively small. The eyes are encircled with short, orange hairs, and the small ears have short tufts of blackish hair at the tips. In summer, the dorsum varies from slightly reddish brown to slightly grayish brown with many orange- and black-tipped hairs. There is a short, blackish stripe on each side, extending from the forelegs to the hips. The venter and the tops of the feet are light to dark orange; however, occasionally there are white patches on the throat, chest, and near the forelegs. The bushy tail is wide and somewhat flat. The middle of the tail is reddish brown. Outward from the middle, the reddish brown of the hairs grades into black, then into white, yellowish, or light or dark orange at the tips of the hairs. The hairs at the end of the tail are black with orange tips; hence, the tail appears to have a predominantly black tip. In winter, the pelage is slightly grayer than in summer, and the black stripes on the sides are less apparent. The orange of the underside is obscured by many gray-, brown-, or black-tipped hairs. The tops of the feet are dark gray. The short, sharply curved claws vary from brown to dark gray.

Distribution along the Oregon coast: Chickarees occur along the entire coast.

Habitat: Chickarees are denizens primarily of the mature conifer, immature conifer, lodgepole pine/rhododendron, lodgepole pine/salal, and Sitka spruce/salal habitat; but they occasionally occur in the alder/salmonberry, riparian hardwood, tanoak, and coastal lake (along the edge) habitats, provided some Douglas-fir, Sitka spruce, or lodgepole pine are present.
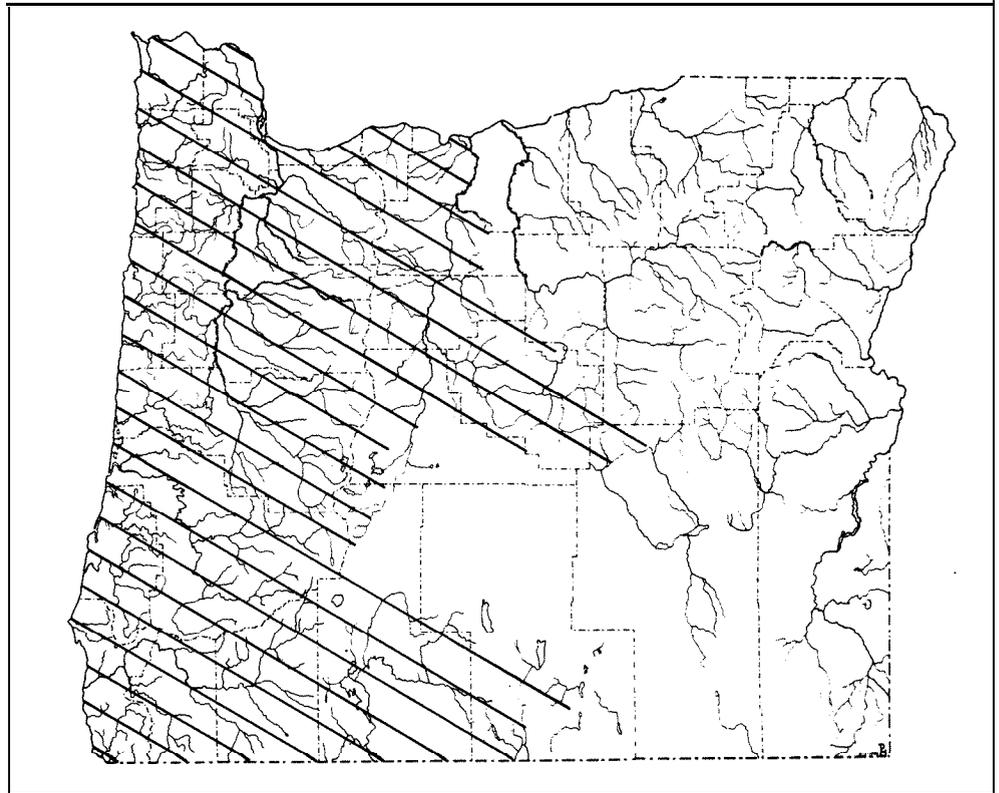
KNOWN DISTRIBUTION OF CHICKAREE

Habits: Chickarees arise at dawn to begin their daily activities and usually retire when the sun sets. They are sentinels in the forests of the Pacific Northwest; little escapes these alert, active squirrels. Throughout much of the year, their commentaries call attention to such things as an owl's trying to sleep, a sleeping raccoon exposed to view in a tree, or a weasel abroad during the day.

Chickarees spend much time climbing up and down trees, searching the ground for food, minding the affairs of others, or sitting hunched up quietly on a limb next to the trunk of a tree with their tails over their backs.

They build their nests of twigs, mosses, lichens, and the shredded inner bark of maples, alders, and cedars. They occasionally include such items as string, shoelaces, old socks, paper, or whatever is available. When building a summer nest of twigs, a squirrel cuts many living twigs (primarily Douglas-fir) up to 6 milli-meters in diameter, carries the twigs to the selected site, and in a short time con-structs a loose nest. In the nest, the squirrel uses soft, dry mosses, lichens, or shredded inner bark for its sleeping quarters. Summer nests may be merely large balls of mosses, lichens, or shredded bark into which the squirrel burrows a hole and sleeping quarters. Chickarees often take over and remodel an abandoned nest, such as that of a bird, woodrat, western gray squirrel, flying squirrel, or red tree vole. Winter nests are often located in hollows in trees, frequently abandoned woodpecker nest-cavities. When nests are constructed on limbs, however, they are

well within the crown of the tree and are bulkier and much thicker than summer nests. Although the nests appear to be weather-tight, examination of nests in the spring has revealed several dead chickarees; the nests were soaked all the way through.

Chickarees have several calls, ranging from a low "chirrr" or "burrr" to an explosive "bauf, bauf, bauf." Except during the spring and summer when the young are being reared, the squirrels are relatively vociferous; noisy territorial disputes and, occasionally "temper tantrums," are not infrequent, especially in the fall. One chickaree, after winning a territorial dispute, was so "irritated" by the trespass that it bounced up and down on top of its abode with such vigor that the whole nest was knocked out of the tree. After a "cooling off period," the chickaree retrieved its nest, to the last shoelace, and packed it all back to the original site and rebuilt it.

Chickarees are active throughout the year but usually remain in their nests during the worst of the winter storms and during periods of extremely cold weather.

Food: Chickarees eat a variety of foods. During the early spring they frequently cut the newly active terminal shoots of coniferous trees, such as Douglas-fir, ponderosa pine, and lodgepole pine. They eat the developing inner bark and needles but discard the old, mature needles. Some squirrels also eat the mature pollen cones of Douglas-fir in great quantities, turning their feces yellow because of the high pollen content. During the summer, they eat some green vegetation and various ripening fruits and berries. They may also eat sap that oozes from the holes made by sapsuckers (a bird in the woodpecker family). When the seed-bearing cones of the conifers near maturity in early fall, the squirrels cut them off the limbs, extract the ripening seeds, and eat them. A cone is held with the forefeet, and individual scales are cut off the central core (called the "rachis") of the cone. Good seeds are eaten and defective ones discarded. A squirrel normally eats in one or two selected places near its nest or food storage area. The discarded scales of the cones accumulate on the ground under a low limb, on a stump, log, or other elevated feeding perch. Squirrels do not normally eat cones on the ground where they cannot see what is happening around them. As the majority of the cones ripen, the squirrels ascend to the tops of the trees in the early morning, cut the cones off, and let them fall to the ground. (Experience proves that it is unwise to take a nap under a tree in which a squirrel is cutting cones, especially a ponderosa pine.) The cones are then collected one at a time and carried to a storage area, such as an underground burrow or a hollow log. Cones are

Photo courtesy Oregon Department of Fish and Wildlife.

also deposited in small streams or springs. Cones are normally cached in a moist area which prevents them from drying out and shedding the seeds. Cones stored under water remain fresh for a year or more. Those stored on land, however, become moldy and spoil much faster. An examination of a squirrel's kitchen middens in the winter will usually show whether the cones have been stored under water. Cones stored under water often have the scales pulled off, whereas those stored on land are hard and the scales have been chewed off. An individual usually stores more food than it consumes during a winter. There is, however, survival value in this excessive harvesting of cones; should there be a failure in the next year's crop, the squirrel can rummage through its unused stores of cones and often find enough good ones to augment an inadequate harvest. In areas where the main source of food is the seeds of coniferous trees, the upward and downward trends of the squirrel populations are correlated with the relative success or failure of the cone crops.

Where available, acorns, hazel nuts, and the seeds of bigleaf maple are eaten. Chickarees have an uncanny ability to distinguish good nuts or acorns from bad ones.

Along the Oregon coast, evergreen huckleberries are eaten throughout the fall. In addition, underground fungi are dug out by the squirrels and are an important part of their diet. They also eat mushrooms that grow above the ground. Mushrooms are often cut off at their bases in the fall-particularly in dry, cold areas-and stuck in the forks of small limbs. They are thus available for food during the winter. A word of caution-there is an old, untrue belief that any mushroom a squirrel can eat is safe for human consumption. Squirrels eat mushrooms that are poisonous to people-so beware!

Reproduction: The testes of some male chickarees begin to enlarge as early as the beginning of December; most, however, start to enlarge in January, February, and March. The majority of the males are reproductively active from March through May; a few have mature testes as late as mid-August.

A pregnant female has from two to eight youngsters per litter, usually four to six. The earliest pregnancy was found on January 1, but young are usually born from May through June. Occasionally a litter is delivered in early July or later. In western Oregon, chickarees appear to have only one litter per year, but Dalquest (1946) cited a nursing female's having been captured as late as October 10. It may be that some females have two litters per year, or a female born early enough in the year may occasionally breed during her first summer.

Chickarees are born naked and blind in nests as high as 6 meters or more in trees. They stay in their nursery nests until they are about one-half or two-thirds the size of their mothers. Along the coast, most young first appeared out of their nests in mid-July to late July and early August. When first out of their nests, siblings stay close together and are tended by their mother. By the end of August, families are still together, although they are more independent of the mother and sibling associations are less evident. Families tend to remain relatively close together through December. The offspring probably mature and breed during their second summer, but along the coast, some nonreproductively active yearlings were found throughout the breeding season. Some individuals may not reach maturity until their third summer-perhaps those born late in the year of birth.

Predation: The main predators of chickarees along the Oregon coast are bobcats and, in some places, martens. Domestic cats take a considerable toll on the young. Coyotes and the larger owls also catch a few. Long-tailed weasels, which are excellent climbers, undoubtedly catch an occasional youngster in autumn and early winter. Even though chickarees are now protected by law, many fatalities must be attributed to "varmint hunters" who use them as targets.

Economic status: Chickarees occasionally cause damage to filbert orchards by harvesting the nuts prematurely. They may cause considerable damage to summer cottages by gnawing on them. Because they consume the seeds of coniferous trees, they often unwillingly harvest the seed-laden cones for humans. Each year in western Oregon, many people collect and sell the cones of coniferous tree species, and whenever possible, they rob the chickarees of their winter supplies of cones. These green cones are graded for quality and used as a source of seed-iings at tree nurseries. Baiiey (1936, p. 121) best captured the spirit of these squirrels when he wrote: "Their greatest value. . . is. . . their cheery note and. . . bright interesting ways as they scamper and sing in the forest. Without them the forest would lose one of its greatest charms."

Selected references: Seton (1928), Smith (1988, 1970).

Genus *Glaucomys*: North American flying squirrels

Derivation: The generic name *Glaucomys* is derived from the Greek words *glaukos* (silvery, gray) and *mys* (a mouse).

General description: North American flying squirrels have fine, soft, thick pelages that are gray with varying amounts of tannish or brownish wash. Being strictly nocturnal, they have large eyes that are sensitive to light.

FLYING SQUIRREL

Flying squirrels cannot fly; they can only glide downward. They climb to an elevated point and launch themselves with impetus. As they leap into space, they extend their legs outward from the body. Such action erects the cartilaginous projections on the outside of each wrist. These projections spread the large, loose folds of skin along the sides of the body so that a monoplane is formed, allowing the squirrel to glide gently and quietly with good control. Steering is accomplished by raising and lowering the forelegs. The tail, flattened horizontally, is used as a stabilizer to keep them on course.

Before a squirrel starts its glide, it carefully examines the chosen landing site by leaning to one side and then to the other; this possibly acts as a method of triangulation in measuring the distance. As a squirrel reaches a landing point, normally the trunk of a tree, it changes course to an upward direction by raising the tail. At the same time, the forelegs and hind legs are extended forward, allowing the gliding membrane to act as a parachute to slow the glide. The arms and legs are extended forward to absorb the shock of landing. The instant the squirrel lands, it races around the trunk of the tree, thereby eluding any predator, such as an owl, that may be following it. To make another glide, it dashes to a higher position with incredible swiftness and agility and again launches itself into space. From a height of 18 meters, a squirrel can glide about 50 meters at a rate of 1.8 meters per second.

Flying squirrels inhabit hollows in trees and abandoned woodpecker nest-cavities. They also establish residence in buildings and artificial birdhouses. Nests, constructed on the limbs of trees, are composed of shredded bark, mosses, dry leaves, and other soft materials.

These squirrels have a varied diet that includes nuts, seeds, acorns, lichens, fungi, fruits, insects, and occasionally meat.

There may be one to two litters per pregnant squirrel per year, depending on the species. The gestation period is about 40 days, and litters range from one to six young. Offspring, usually born in April or May, are naked, pink, and blind at birth. Their eyes do not open until they are about 25 days old. They nurse for 60 to 70 days and are neither vigorous nor confident in their actions before that. Flying squirrels must be well developed before they can successfully cope with the hazards of an arboreal and gliding life style. Their development is slow compared with many ground-dwelling mammals of similar size.

World distribution: The two species of North American flying squirrels are primarily confined to the forested and wooded areas of North America from central Alaska and northern Canada south throughout the Eastern United States; south in the Rocky Mountains through much of Idaho and Wyoming into Utah; and south through most of Washington and Oregon into southern California. They also occur in small, isolated areas in Mexico and Guatemala.

General reference: Walker et al. (1968).

Species *Glaucomys sabrinus:* Northern flying squirrel

Derivation: The specific name *sabrinus* is a Latin word meaning "a river nymph." The name probably alludes to the fact that these squirrels are often abundant along the edges of forest streams and rivers.

Specific description: Total length, 226 to 430 mm; tail, 105 to 180 mm; hind foot, 33 to 45 mm; ear, 20 to 31 mm; weight, 47 to 186 g.

The northern flying squirrel has long, very fine, soft hairs. Because all the hairs are about the same length, the pelage is not separated into guard hairs and underfur; hence, the pelage appears sleek. One of the most distinctive features of the northern flying squirrel is the loose fold of skin that stretches from the wrist of the foreleg to the ankle of the hind leg.

The hairs of the back are bicolored, the shafts are dark gray, and the tips are dark reddish brown, giving the back a predominantly dark reddish brown appearance. The cheeks are light grayish brown, and dark gray hairs encircle the large eyes. The top edge of the gliding membrance is dark gray, and the hairs along the margin of the membrane are tipped with light tan, giving the appearance of an almost whitish stripe. The underside is tannish. The tail is relatively wide and horizontally flat; the hair of the tail is dense and of the same texture as that of the body. The top of the tail is dull; it is brownish gray along the basal one-third,

becoming dark gray toward the tip. The hairs on the underside are gray, tipped with light to dark tan, and give a tan appearance. The underside of the tail is dark tan with a dark gray margin.

Distribution along the Oregon coast: Northern flying squirrels occur along the entire coast. - - -
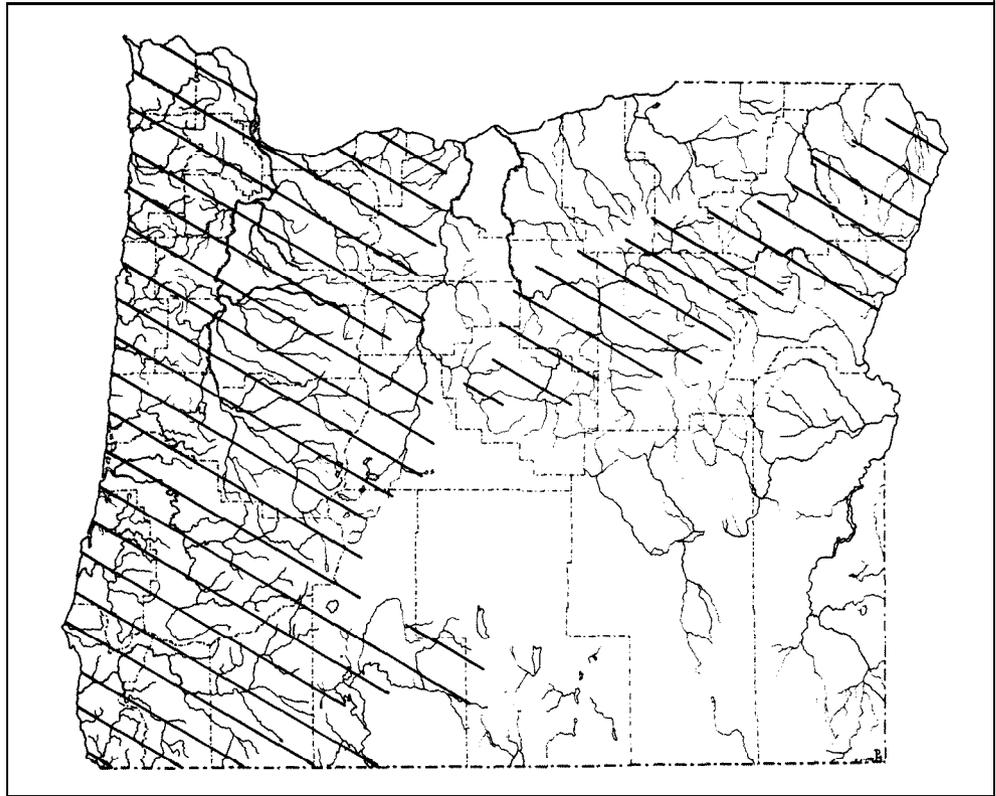
KNOWN DISTRIBUTION OF NORTHERN FLYING SQUIRREL

Habitat: These squirrels occupy the mature conifer, immature conifer, Sitka spruce/salal, cedar swamp, and tanoak habitats; they occasionally may be found in the lodgepole pine/rhododendron, lodgepole pine/salal, and riparian hardwood habitats.

Habits: Because the squirrels are strictly nocturnal and seldom seen, few long-time residents of the Oregon coast suspect their existence.

Seton (1928, p. 888) stated that "this bright-eyed child of the night is both sociable and gregarious." Jackson (1981, p. 182) stated that they are "somewhat gregarious, particularly in winter when as many as eight to a dozen have been found together in a tree cavity." In regions characterized by cold winters, this "gathering of the clan" would be a valuable way of conserving body heat, but along the mild west coast there is no evidence of this type of gregarious behavior.

From the literature may be gained the general impression that over most of their geographical distribution northern flying squirrels use hollows in trees as nesting sites when at all possible. Although this may be the case, many outside nests have been found on limbs of trees in western Oregon. In part, this may be due to the extensive logging to which western Oregon has been subjected since the mid-1800's. In many areas, heavy logging has reduced the number of trees that are old enough to provide suitable hollow spaces for nesting, and the scarcity of hollows in young, second-growth timber forces the squirrels to construct their abodes on exposed limbs. These outside nests are normally composed of mosses, lichens, or the shredded inner bark of cedars or bigleaf maple. A combination of materials, including twigs, is occasionally used. For the most part, nests of flying squirrels are round balls of material situated in a fork of the trunk of a tree or on a whorl of limbs against the trunk. The squirrels also take over and remodel the nests of chickarees, western gray squirrels, red tree voles, and various birds. Bailey (1936, p. 164) gave an account of flying squirrels' nests at McKenzie Bridge, Lane County, Oregon:

> , , ,a few specimens were taken in the heavy forest of conifers, alders, ash, and maples. The trunks and branches of maple and ash trees were heavily laden with tree mosses, great cushions, sheets, and streamers of deep soft old fleeces in which the flying squirrels had their nests and under which they had well-worn trails up the trunks and along the larger branches.

Northern flying squirrels are not vociferous animals, at least in western Oregon, but a person with good hearing in the forest at night can hear the little sound of their claws as they land on, and scramble up, the trunks of the trees. Few realize how abundant these beautiful night-gliders really are. Fur trappers, particularly those who trap marten, probably best realize how common flying squirrels are; they catch hundreds of them each winter in traps.

In many areas of their distribution, flying squirrels apparently often share human abodes. In Oregon they do not seem to be thus socially inclined and seldom take up "squatter's rights." Bailey (1936, p. 166) related a story about a squirrel that invaded a cabin near Wallowa Lake, Wallowa County, in northeastern Oregon:

> In a log cabin back in the mountains where some old settlers resided, an old-fashioned spinning wheel was long stored in the attic. This wheel was sometimes heard revolving at night when no one was near it and was often found still in motion when examined. The house finally acquired the reputation of being haunted until one brave member of the family stole silently up to the dark room when the whirring of the wheel was heard and with a flashlight saw one of these flying squirrels running on top of the wheel as it spun beneath the animal's skillful tread.

Food: Northern flying squirrels appear to be omnivorous, although little is known about their diet in Oregon. The little data available show that underground (hypogeous) fungi may form almost 100 percent of their diet during the summer

and autumn. More than 10 species of underground fungi have been identified from the stomach contents of these squirrels in western Oregon. The squirrels also eat green vegetation and insects[9] (Maser et al. 1978), as well as nuts, seeds, fruits, and meat (Bailey 1936, Jackson 1961). Jackson (7961, p. 183) stated: "It has an avid taste for raw meat, fresh, dried, or putrid. Its attempt to eat meat bait at traps set for carnivorous animals frequently causes it to be trapped, usually to the disgust of the trapper."

Reproduction: Enlargement of the testes of male northern flying squirrels begins in February; breeding starts in March. Although most breeding occurs from March through May, some takes place in early July.

So far as is known, each pregnant female produces a single litter per year. The gestation period is about 37 days (Muul 1969). Most litters are born in May and June, but in western Oregon a litter occasionally may be delivered the end of July or the beginning of August. One nestling about 1 month old was found near Otis Junction, Lincoln County, on August 27, 1971, and several lactating females have been captured in late August and early September. Litters range from one to six young, but three to five is more common. Babies weigh about 5.8 grams at birth. Their eyes open when they are about 32 days old. By this time they are fully furred, and their locomotion and coordination are well developed. They begin leaving the nest for short periods at about 40 days (Muul 1969). That their eyes open so late (when their coordination is already well developed) undoubtedly has significant survival value for young born and raised high in trees. It is doubtful that they breed before their second summer.

Predation: Northern spotted owls are the main predators of flying squirrels in Oregon. Jackson (1961) stated that domestic cats are one of their main enemies. Bobcats and marten prey on flying squirrels when they descend to the floor of the forest to dig out subterranean fungi.[10] Long-tailed weasels probably capture a few on the ground. Some are caught by great horned owls (Jackson 1961, Maser and Brodie 1966).

Economic status: Flying squirrels are beneficial because they disperse spores of fungi important to coniferous forests (Maser et al. 1978).

Selected references: Cowan (1936), Howell (1918), McKeever (1960).

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[9] J. M. Trappe and C. Maser. Unpublished data on file at Forestry Sciences Laboratory, Corvallis, Oregon.

[10] C. Maser. Unpublished data on file at Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington.

Family Geomyidae: Pocket Gophers

Derivation: The familial name Geomyidae is derived from the Greek words geios (of the earth) and mys (mouse) combined with the Latin suffix *idae* (family).

General description: Pocket gophers are stout-bodied rodents with almost no externally visible neck. They have small eyes and ears, short legs, and two external, fur-lined "cheek pouches." The cheek pouches extend from the lower portion of the face back to the shoulders. They can be turned inside out to be cleaned and are pulled back into place by a special muscle. They apparently are used only for transporting food. Pocket gophers have strong forelimbs; their forefeet have five toes, each terminating in a powerful claw adapted for digging. Their naked or sparsely haired tails are generally short and sensitive to touch. Gophers have very loose, flexible skin that is thickest in the region of the head and throat; this may be an advantage when they fight since pocket gophers are normally pugnacious.

These rodents are adapted to burrowing. Their small eyes are cleansed by a thick fluid from the teat glands, and their lips can be closed behind the protruding, curved incisors, allowing the animals to gnaw their way through the earth without any of it getting into their throats. The softness and laxness of their pelage allow them to move backward in their tunnels. They can run backward almost as fast as they can run forward.

Pocket gophers exhibit significant differences in size both between and within species. The variations are influenced, at least to some extent, by sex (males are usually larger than females) and by the type of soil they frequent. The length of head and body ranges from 9 to 30 centimeters. Their pelage, which lacks underfur, varies from black to almost white.

Pocket gophers dig two types of tunnels: shallow tunnels for gathering food, such as roots and tubers, and deep tunnels for shelter. The deep tunnels include chambers for nesting, food storage, and deposition of fecal pellets. The burrow systems are usually marked by a series of earth mounds on the surface of the ground. Unlike moles, which expel excess earth through vertical shafts into conical or volcano-shaped mounds, gophers expel excess earth through inclined lateral shafts, making fan-shaped mounds. Digging is accomplished primarily with the strong foreclaws, but the large front teeth are used to loosen soil and rocks, as well as to cut roots. Loose earth is held between the chest and forelegs and pushed to the surface.

Pocket gophers do not hibernate, but in the colder parts of their range they may become less active during winter. Although gophers occasionally travel through unlined tunnels in the snow, they normally push earth into these tunnels. When the snow melts, these ropelike strands of earth ("gopher cores") settle to the ground, and the different directions and relative levels of the gophers' winter burrows can be seen.

Pocket gophers lead solitary lives except during the breeding period. Each pregnant female annually has one to several litters, consisting of 2 to 11 young.

World distribution: Pocket gophers occur only in North America from about 54" North latitude in western Canada south to Panama in areas where the habitat is suitable.

Fossil record: The fossil record of pocket gophers dates to the Miocene in North America.

Number of species along the Oregon coast: Two.

General references: Anderson and Jones (1967), Walker et al. (1968).
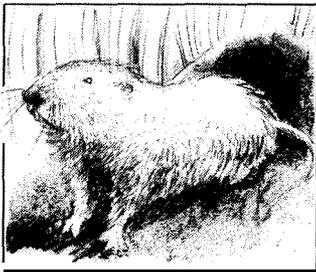
Genus Thomomys: Western pocket gophers

Derivation: The generic name *Thomomys* is derived from the Greek words *Thbmos* (a heap) and *mys* (mouse); the name alludes to the mounds of earth deposited as refuse around the openings of the gophers' burrows.

WESTERN POCKET GOPHER

General description: In length of head and body western pocket gophers range from 16.5 to 30.5 centimeters; their tails range from 4.4 to 9.5 centimeters in length; and they weigh from 65 to 545 grams. Males are considerably larger than females. These pocket gophers have robust bodies, small eyes and ears, short legs, and long front claws. The slightly tapered tail is highly vascular and well supplied with nerves, making it sensitive to touch. Unlike most members of other genera within this family, the incisors of the genus Thomomys lack the longitudinal grooves on their outer surfaces. The pelage is short, soft, and smooth; it varies from black through gray and brown to almost white. The venter is only slightly lighter than the dorsum.

Western pocket gophers spend most of their lives underground. These burrowing mammals inhabit many types of soil in deserts, prairies, open forests, grasslands, and mountain meadows. The length and design of a burrow system do not seem to follow a particular pattern. The earth thrown out of a burrow forms a fan-shaped mound. The burrow entrance may be carefully plugged from within. The gophers do not hibernate, even in the coldest areas, and evidence of their winter activities-gopher cores-appears as the snow melts. Their burrows have separate chambers for nests, food storage, and elimination of waste products.

As far as is known, western pocket gophers are strictly vegetarians. Their diets consist of roots, bulbs, and tubers, as well as the aboveground portions of plants. The gophers forage above ground from early evening to dawn of the next morning. They occasionally may be seen foraging abroad on overcast days; more often than not, they bite off the roots of a plant and pull the plant down into the burrow with them. The plants may be consumed immediately, or they may be cut into convenient lengths and pushed with the forefeet into the fur-lined cheek pouches to be transported in large quantities to a storage or eating area. Because these gophers apparently obtain sufficient moisture from their food, they need not drink.

Although little is known about the breeding habits of this genus, northern species seem to have a more limited breeding season than do southern species. Litters, ranging from 3 to 10 young, are born and raised in underground nests. At birth they are blind, almost naked, and helpless, and weigh from 2 to 6 grams. After they are weaned, they commence their solitary lives.

World distribution: Western pocket gophers inhabit most of the western half of North America from southwestern Canada, through the Western United States, into the Baja Peninsula and the mainland of Mexico.

General reference: Walker et al. (1968).

Species *Thomomys bottae*: Botta pocket gopher

Derivation: The specific name *bottae* is a proper name; this species was named for Paolo E. Botta, one of the first naturalists in California-from 1827 to 1828.

Specific description: Total length, 190 to 273 mm; tail, 55 to 97 mm; hind foot, 26 to 34 mm; ear, 5 to 8 mm; weight, 71 to 250 g.
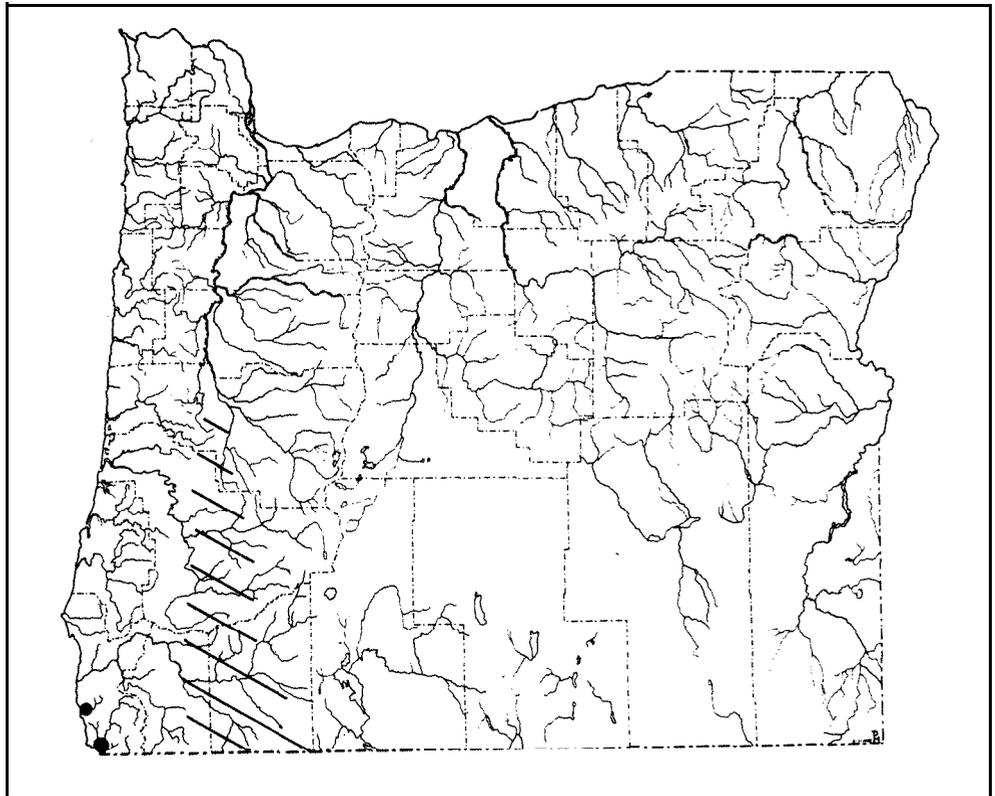
KNOWN DISTRIBUTION OF BOTTA POCKET GOPHER

The back is dark brown with relatively few black-tipped hairs. There are small patches of dark gray to black hairs around and behind the tiny ears. The underside is a mixture of light brown, light gray, and tan hairs, with irregular patches of white hair. The tail is light gray to tan.

Distribution along the Oregon coast: Botta pocket gophers occur from the mouth of the Pistol River, Curry County, south into California.

Habitat: These gophers occupy the headland prairie and headland shrub and, to some extent, the stabilized dunes and wet pastureland habitats.

Habits: Little is known about the Botta pocket gophers along the Oregon coast except that they seem to be confined to sandy soil. The species needs to be studied within the State.

Food: Pocket gophers eat a great variety of plants, both the underground and the aboveground portions; however, the specific food habits of the Botta pocket gophers in Oregon are not known.

Reproduction: The usual number of young per litter seems to be from four to eight; additional data on reproduction of Botta pocket gophers in Oregon are lacking.

Predation: Other than humans, probably the gophers' major enemies are owls, domestic dogs, and domestic cats.

Economic status: Although the Botta pocket gopher occurs in the extreme southwestern part of the Oregon coast, only the subspecies *detumidus,* along the Pistol River, damages pastures and various crops. Because detumidus is an isolated subspecies, it should be recognized as a unique component of our coastal fauna.

Species *Thomomys* mazama: Mazama pocket gopher

Derivation: The specific name *mazama* is a proper name; this species was named after Mount Mazama, which erupted and formed Crater Lake in Klamath County, Oregon. The first specimen of this species was secured near Crater Lake on September 3, 1896.

Specific description: Total length, 183 to 239 mm; tail, 55 to 81 mm; hind foot, 26 to 35 mm; ear, 6 to 8 mm; weight, 52 to 96 g.

There are three subspecies of Mazama pocket gophers along the Oregon coast. Because they are so different, I will describe them separately.

Thomomys mazama hesperus was first collected at Tillamook, Tillamook County, Oregon, on November 9, 1894. This subspecies occurs along the coast from Tillamook south to the Yaquina River, Newport, Lincoln County. The dorsum varies from reddish brown to dark reddish brown, to brown, to black. The reddish brown and brown individuals have large patches of black hair around and behind their small ears. The venter varies from light grayish brown to tan, to reddish brown, to

brown, to black. The cheek pouches and the tops of the feet are whitish. The tail varies from dark gray to brown at the base, becoming white at the tip. According to Bailey (1936), about 10 percent of the population is either partially or wholly black.

Thomomys mazama niger was first collected at Seaton (now known as Mapleton) at the head of tidewater on the Siuslaw River, Lane County, Oregon, on October 6, 1894. It occurs along the coast from the vicinity of Florence, Lane County, south to the mouth of the Umpqua River, Douglas County. The back is a uniform, glossy black with purple and green iridescence. The underside is duller and more gray, with irregular white spots. The feet and the tip of the tail are white.

Thomomys mazama helleri was first collected at Gold Beach at the mouth of the Rogue River, Curry County, Oregon, in 1901. It is known to occur only at the mouth of the Rogue River. The dorsum is a dark, rich reddish brown; the sides and venter are tannish. There are patches of black hair surrounding the ears. The nose and face are blackish. Rarely is there a trace of white on the lips, but the tip of the tail is usually white.

Distribution along the Oregon coast: Generally speaking, the Mazama pocket gopher occurs from Tillamook, Tillamook County, south to the mouth of the Rogue River, Curry County. Refer to the descriptions of the subspecies for more detailed distribution.
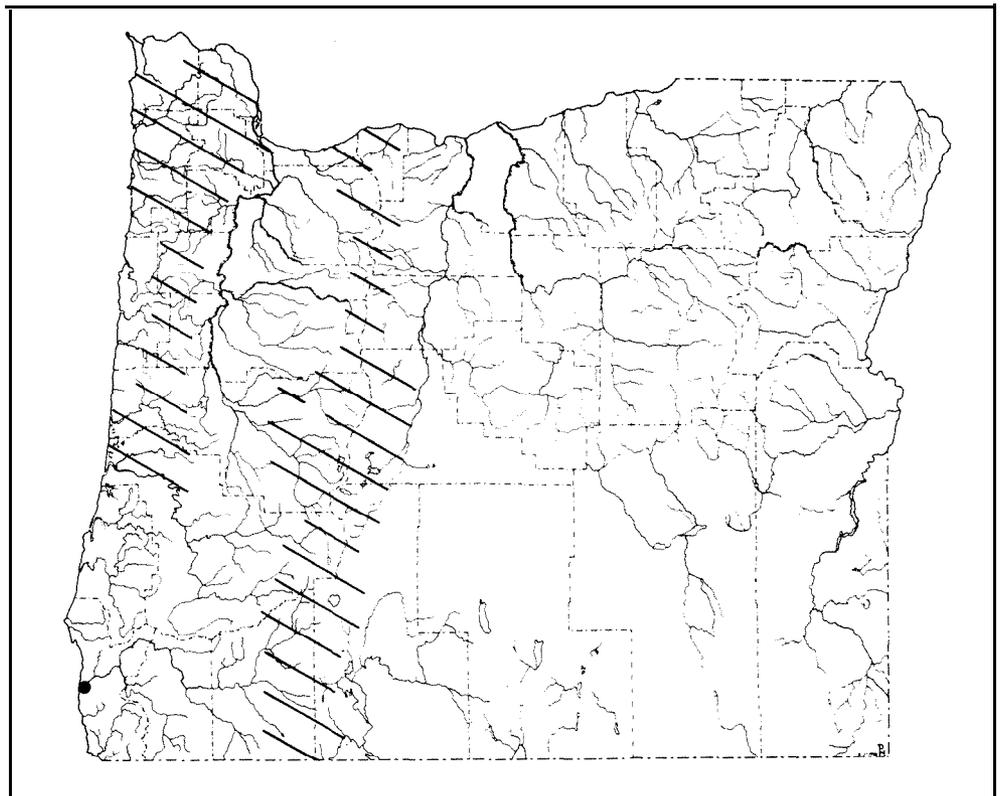
KNOWN DISTRIBUTION OF MAZAMA POCKET GOPHER

Habitat: Mazama pocket gophers along the Oregon coast occupy the headland prairie, headland shrub, and wet pastureland habitats. They are essentially inhabitants of open, grassy areas and usually do not penetrate forests.

Yabits: These gophers are active on the ground primarily from the evening, throughout the night, into the early morning; but they may be active at any time on warm, overcast days. Underground activity seems to be almost continuous. If a gopher's burrow has been opened, the gopher seldom procrastinates in closing it, but a delay may occur if the gopher is working in another part of its burrow system. By this means it can usually be determined whether or not a particular burrow system is in use.

The earth plugs or "buttons" used by the Mazama pocket gopher to close the entrance to its burrow are usually loose and only a few inches in length; however, a plug may be as long as 30 centimeters and may be solidly compacted. A burrow occasionally may appear to be open. It may be, but excavation of the burrow often will reveal an earth plug some distance underground. Although these small gophers do not create large mounds, their burrow systems may be rather extensive and usually are readily apparent.

Food: Mazama pocket gophers eat a wide variety of plants, both the above-ground and the belowground portions. They appear to be particularly fond of bulbs, and during the spring they frequently eat wild onion and wild garlic. They also eat such plants as clover, lupine, false dandelions, and grasses; in some areas, they even feed on the bark of trees. Bailey (1936, p. 257) wrote of one of these gophers:

> . . . one came up in the middle of the tent where. . . [I]. . . was at work, quietly preparing specimens. There was a muffled gnawing or scratching, then an aster stem began to move, and soon the tip of a little brown nose showed in the middle of a tuft of short grass, and the hole was quickly enlarged to allow the pocket gopher's head to protrude. The aster stem was cut off and drawn down into the burrow. . . . Within a minute a good meal was. . . gathered and the hole securely plugged. . . . The pocket gopher safely enjoyed its morning meal below,
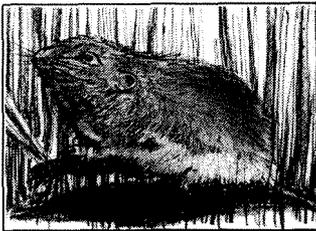
MAZAMA POCKET GOPHER

I have observed these gophers as they forage on the ground during the evening. While foraging, they normally are alert and stay close to their burrows. Gophers quickly cut off vegetation, cram as much as possible into their cheek pouches, and disappear underground. They frequently reappear in a short time to continue gathering food. The food that is carried into a burrow is undoubtedly deposited in a storage chamber. During late summer these gophers sometimes remain outside for longer periods; they sit on their haunches and, with their forefeet, deftly and systematically bend down one grass stalk after another. The soft, green heads are cut off, stuffed into the cheek pouches, and transported below. I have not seen one of these gophers take time to eat while it was exposed on the ground.

Reproduction: Scheffer (1938a) found the gestation period of 312 females to be about 28 days and the average litter to consist of five young; however, litters range from four to six young. Each pregnant female produces a single litter per year, sometime between March and June. By July the young are active and are readily trapped.

Predation: Owls, particularly the larger owls-great horned, barn, and short-eared owls-prey on pocket gophers. Forsman (1976) stated that the northern spotted owl also preys on the Mazama pocket gopher, and I have found the coyote and the bobcat to be predators of this gopher. Scheffer (1932) cited a number of long-tailed weasels, as well as gopher snakes (also called "bull snakes") as having been seen or trapped in gopher burrows. He wrote (p. 54) that on one occasion "two weasels. . . were observed in a field of clover. . . . One of these was taken in a double setting of the Maccabee trap, the other came out of a burrow carrying a limp, warm gopher in its mouth." About gopher snakes, he wrote (p. 54): "In the one case. . .the snake had ingested the gopher as far as the trap but had released it after stripping off a part of the skin. The other snake had also swallowed its prey as far as the trap and had then managed to get caught in the second trap of the setting." Domestic dogs and cats also take a toll on these gophers, particularly in northwestern Oregon; the greatest toll, however, is taken by humans with traps and poisons.

Economic status: Pocket gophers are usually mentioned in connection with the damage they cause to crops and young trees. (Along the Oregon coast, moles are often called gophers, even where gophers do not occur.) Bailey (1936, p. 256) wrote about the Mazama pocket gopher in Tillamook County:

> The county clerk at Tillamook said that $4,000 had been paid. . . in bounties on moles and pocket gophers during 1914, and over half of it on gophers, at 25 cents each. One man. . . had made. . . $100 a month catching them, and one little girl had earned $80 in a month. Then the boys all got busy, and the bounty fund was soon exhausted, while the pocket gophers remained numerous.

Dalquest (1948, p. 396) discussed pocket gophers and alfalfa:

> In fields of young alfalfa they are apt to crop back the plant more rapidly than it can grow. Once the alfalfa plant is well established, however, the cultivation resulting from activities of gophers, some persons believe, stimulates the plant to such an extent that it grows larger and healthier in spite of the gopher's feeding on it. . . . The most luxuriant growth was invariably in fields where gophers were common. In these fields, the largest plants were those in the immediate vicinity of gopher activity. The commensal relation between the gopher and alfalfa was understood by many farmers, who forbade us to take gophers for specimens from their fields. Several told us that they always trapped the gophers from the field of young alfalfa and from hay meadows but encouraged their presence in fields of older alfalfa.

Barnes (1973), Crouch (1971), and Hooven (1971a) discussed the damage to pine trees (trees important to the timber industry) by pocket gophers.

Pocket gophers are ecologically beneficial. Bailey (1936, p. 257) wrote the following in defense of the Mazama pocket gopher:

> These mountain pocket gophers are often so numerous in the mellow-soil parks that their mounds cover from 5 to 10 percent of the surface, and the burrows-6 inches to a foot below the surface-are so numerous that one's feet keep breaking into them, while cattle, sheep, and deer tracks often make so many openings that the gophers are kept busy closing them. The mounds are usually small, a few quarts to a half bushel of earth in a place at intervals of 3 feet to 1 rod apart along the line of each tunnel. The tunnels are constantly extended and gradually fill up as they are abandoned and the old nests, food refuse, and excrement are buried well below the surface, while the mounds are constantly burying the surface vegetation deeper and deeper underground. The soil is kept mellow and porous, and a great part of the rainfall is held in the ground instead of running quickly from the surface in destructive floods. The meadows are enriched, the forests are benefited, and soil erosion, the menace of the mountain ranges, is largely checked. To be sure, many plants are eaten that would make forage for sheep, but every bit of vegetation taken is eventually returned to the soil in such a manner that fire cannot reach it and some of the disastrous effects of overburning and overgrazing of the mountain parks is thus prevented.

Few people would be inclined to eat pocket gohper. I have, however, enjoyed eating them for many years. Bailey (1936, p. 258), who was more adventuresome than most, thought gophers tasted "somewhat like squirrel, but more tender and rather better flavored. Broiled on the coals they are especially good, and they provide an always available source of meat supply in the mountains when game is out of season."

Selected references: Gabrielson (1923), Johnson and Benson (1960), Scheffer (1938a), Walker (1949, 1955).

Family Castoridae: True Beavers

Derivation: The familial name Castoridae is derived from the Greek word *kastōr* (the beaver) combined with the Latin suffix *idae* (family).

General description: Since there is only one living genus within the family Castoridae, refer to the genus for the general description.

World distribution: New World beaver occupy most of North America, except parts of northern Alaska and northern Canada, central Nevada, parts of California, western Utah, Florida, and most of Mexico. Old World beaver inhabit Norway, Germany, and France, east through much of northern Asia to the Lena River in Siberia.

Fossil record: The fossil record of beaver in North America dates to the early Oligocene. Giant beaver inhabited both the New and the Old Worlds during the Pleistocene (Martin 1969, Shotwell 1955). The giant beaver from North America were almost as large as modern black bear.

Number of species along the Oregon coast: One.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus Castor: True beaver

Derivation: The generic name Castor has the same derivation as the familial name.

General description: Beaver are among the largest rodents in the world; they are the largest, living rodent in North America. Beaver are compact, thick-set animals with small eyes and ears. They have short legs and a large, broad, scaly, paddle-like tail. The length of their heads and bodies ranges from 73.5 to 130 centimeters; their tails are 21.5 to 46 centimeters long and 10.2 to 12.7 centimeters wide. Adult beavers often weigh more than 27.2 kilograms.

Beaver are well adapted to aquatic life. They are excellent swimmers and divers. They use oxygen economically and can remain submerged more than 15 minutes. Their small eyes are protected by nictitating membranes. (The word "nictitate" means "to wink.") A beaver's nostrils and ears are valvular and can be closed under water. They have large hind feet that are webbed between the toes. The claws of the second and third toes are split, presumably as an aid to grooming (Bailey 1923).

Beaver have unusually dense pelages consisting of fine underfur overlaid with coarse guard hairs. The soft, short underfur is gray, whereas the coarse, shiny guard hairs vary from rich glossy brown, to yellowish brown, to reddish brown. The guard hairs on the underside are not as long or as close together as they are on the top. The underparts, therefore, are lighter in color. The feet and the tail are black.

Beaver are usually thought of as the engineers of the animal world because of their ability to cut down large trees and because of the complex dams and abodes that they construct in streams and lakes. These large rodents do not hibernate but store food under the water for use during the winter.

World distribution: The geographical distribution of the genus is the same as that given for the family.

General reference: Walker et al (1968).

Species Castor canadensis: North American beaver

Derivation: The specific name canadensis is a proper name; the North American beaver was named after Canada, combined with the Latin suffix *ensis* (belonging to).

Specific description: Total length, 950 to 1150 mm; tail, 340 to 460 mm; hind foot, 170 to 173 mm; ear, 35 to 40 mm; weight frequently exceeds 27.2 kg.

Beaver are heavy-bodied, compact animals with large, flat, broad, naked, scaly tails. The eyes and ears are small, and the large incisors are deep orange and extremely sharp. The large hind feet are fully webbed between the toes, and each hind foot has two specialized, split "combing" claws. Winter pelages vary from dark reddish brown to brown on the back and are somewhat lighter on the underside. Spring and summer pelages are lighter and more reddish or occasionally yellowish.

Distribution along the Oregon coast: The North American beaver occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Along the Oregon coast beaver occupy the riparian alder/small stream, riparian alder/large stream, willow/sedge marsh, coastal lake, tideland river, and mountain river habitats. They may be found in any habitable water along the coast.

Habits: When living in remote, undisturbed areas, beaver may be active at any time of the day or night, but they normally begin their activities in the early evening. When living in populated areas, they normally become nocturnal and are seldom seen by people.

Perhaps more people are familiar with the dams that beaver build than with any other aspect of the animal or its habits. Although beaver dams may be large, over 2 meters high and occasionally more than 549 meters long, the dams along the Oregon coast are usually small and inconspicuous. Beaver dams impound water that may form ponds covering many hectares. In mountainous regions, these ponds gradually fill in with sediment and vegetation and ultimately form meadows.

The dams are inspected closely by the beaver (Hodgdon and Larson 1973) and are often maintained for years. Along the Oregon coast such dams are built with sticks (normally after the animal has eaten the bark off) shoved into the soft bottoms of the streams or into a "foundation" of mud carried to the damsite by the beaver. To the foundation of sticks (butt ends facing upstream), the beaver add mud, vegetation, brush, and more sticks. As the dam grows, the sticks become crisscrossed and the dam becomes securely anchored; such a dam is often extremely difficult to remove by hand. Along the coast, the frequently severe winter floods sometimes wash out the dams and, occasionally, the beaver with them. On December 1, 1970, one such beaver was washed almost to the jetty at the mouth of the Coquille River at Bandon, Coos County.
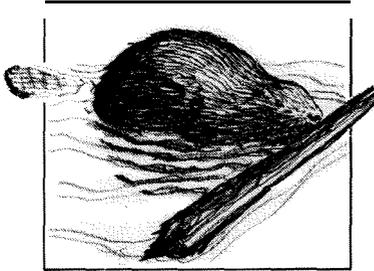
Beaver construct three types of abodes: a standing lodge in open water away from the bank, a bank-lodge built against the bank with a burrow extending into the bank, a simple burrow dug into the bank without a lodge of any type. Except in times of low water, such as outgoing tides or drying ponds, the entrance of a beaver's dwelling is under the surface of the water. Along the Oregon coast, particularly in the rivers, the burrow seems to be the most common type of dwelling. In the coastal lake habitat, the bank-lodge is most frequently used with occasional lodges in open water. One of the latter was found in the south end of Elbow Lake, Lane County, Oregon (Bailey 1926, Hodgdon and Larson 1973, Stephenson 1969).

Beaver have paired anal scent glands known as "castors" or "beaver pods." They occur in both sexes but are slightly larger in the male. The content of the castors is called "castoreum" and is used in marking territorial limits. The castoreum, a musk with a pleasant, rather sweet, odor is deposited on "scent-mounds" also called "beaver mud pies" or simply "beaver pies." These scent-mounds are made with piles of mud, occasionally mud and vegetation, rarely vegetation without mud. The beaver obtains these materials from the stream or lake bottom and places them on the shore along the water's edge. Aleksiuk (1968a, p. 760) studied scent-mounds; he found that they varied in size from mounds that were "barely perceptible. . . to piles of mud 2 ft in height. . . and in number from 2 to 7 or more per colony." Although most scent-mounds are located along the edge of a colony, some are located near the dwelling, especially if the abode has been recently constructed. Young and old beaver, both males and females, regularly and frequently visit the scent-mounds to deposit mud and castoreum. Since a typical beaver colony consists of two parents and the young of the year, as well as the yearlings born the previous year, such behavior eliminates the necessity of actively defending territories. Such behavior removes antagonism between adjacent colonies while retaining the integrity of the resident colony (Aleksiuk 1968a, Bradt 1938). Strange castoreum on a scent-mound causes a resident beaver to immediately deposit its own castoreum. According to Aleksiuk (1968a) this emission produces a sound that can be heard 15 meters away. Strange castoreum on a scent-mound may also elicit aggressive behavior in the resident beaver as indicated by loud hissing.

Novakowski (1969) found the beaver to be a social and somewhat placid animal and attributed this calmness to its familial and colonial characteristics. He stated (p. 293) that:

BEAVER

Other than the untrained young, which might vocalize while outside the lodge, it appears that vocalization in the beaver chiefly occurs within the lodge, and is related to those behavioral characteristics in which sound or communication is of little survival value. The apparent lack of motivation for vocalization also appears to indicate that sound production in beaver does not have the same usefulness as in animals less secretive and which roam at large.

He found that vocalization was initiated by a visible physical act more associated with familial or colonial behavior than with social control. Beaver do, however, produce one sound with which many people are familiar-slapping their tails on the surface of the water just prior to quickly diving beneath it. Tail-slapping, which produces a resounding "smack," is usually considered a warning given to other beaver by a startled or frightened individual. The normal dive of an undisturbed beaver is quiet.

Food: Beaver are vegetarians and eat a wide variety of plants. Along the Oregon coast their main diet is the bark of red alder and willow, as well as salmonberry, salal, deer fern, swordfern, sedges, and during the spring and early summer, skunkcabbage. They also eat small quantities of bark from Douglas-fir, western hemlock, lodgepole pine, and Scotchbroom.

Although beaver may travel a kilometer or more to obtain a desired food, along the Oregon coast they were not found to travel more than 180 meters probably because of the lush vegetation. Beaver also construct canal systems inland from their ponds; in these they float food, such as small, trimmed trees, from the cutting sites to the pond. The canals are usually filled with 34 to 88 or more centimeters of water; frequently, underground chambers are constructed into the sides of a canal. A chamber often has a large hole penetrating the roof to the ground above. During the winter, the hole normally has food (cut sticks with the bark still attached) protruding from it; by spring, the sticks are usually gone. Beaver also store food on the bottom of a pond where it remains fresh and is available when the pond freezes over. Even though there is seldom freezing weather along the coast, the beaver still seem to store most of their winter food in ponds.

Perhaps the most visible signs of beavers' feeding activity are the stumps of trees they fall to obtain the bark (Warren 1926). The trees are cut by the beavers' sharp incisors which keep growing. In fact, if the front teeth are not constantly worn down, they grow so fast that the upper and lower teeth grow beyond each other, and the beaver, unable to open its mouth wide enough to eat, starves to death. See also Aleksiuk (1968b, 1970a, 1970b), Aleksiuk and Cowan (1969a, 1969b), Brenner (1982, 1967), Northcott (1971, 1972).

Reproduction: There is general disagreement about the age at which female beaver attain sexual maturity. Brenner (1984) reviewed this lack of agreement and indicated that females probably reach sexual maturity in their second summer. He suggested that although data indicate that males also reach sexual maturity at 2 years, they may be capable of reproduction late in their first summer. But those that he examined were sexually immature the first breeding season of the year after their birth.

The breeding season for beaver is normally from January through March; breeding activity peaks in early February. Litters range from one to nine offspring (Brenner 1964); the usual litter consists of two to four young called "kits." There is a single litter per year.

Beaver kits are born well haired and with their eyes open. At birth they weigh from 230 to 680 grams. Kits nurse for about 6 weeks and remain part of the family group until sexual maturity is attained. Beaver in captivity have lived more than 20 years (Walker et al. 1968).

Predation: Little evidence of actual predation on beaver could be found in the literature; however, the following animals are variously cited as probable predators of beaver: cougar, lynx, bobcat, wolf, coyote, bear, wolverine, and otter. In my opinion, the latter is questionable.

Beaver are also occasionally prone to accidents, such as having trees that they are cutting fall on them. On November 7, 1970, Thomas Herbst of the Oregon Wildlife Commission found a young beaver that had just drowned in one of the concrete fish-rearing ponds at the Oregon Game Commission Fish Hatchery at Bandon, Coos County. By far the greatest toll on beaver, however, is taken by humans in quest of their fine fur.

Economic status: More than any other animal, the beaver has had a drastic effect on North American history. The quest for its valuable pelt (often called a "blanket") stimulated much exploration; the fur trade was born; battles were fought; fortunes were made; a unique way of life evolved-the solitary trapper and Mountain Man. Overexploitation rapidly exterminated beaver over much of their range and severely reduced the populations. Today, through the efforts of Federal and State agencies, the beaver has increased in numbers and is once again found throughout most of its former range.

When the guard hairs are removed, a beaver pelt is thick and soft. The beaver is a valuable fur-bearing mammal, and many are trapped each year. For example, 6,539 beaver were trapped in Oregon in the 1971-72 trapping season, and 9,499 were trapped in the 1972-73 trapping season. During the 21-year period from the 1952-53 trapping season through the 1972-73 season, licensed trappers caught 207,496 beaver in the State of Oregon (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a). In addition to the value of their pelts, beaver are excellent to eat but are rarely used.

Although beaver dams do help to control water runoff, erosion, and maintenance of a good water table, at times they also cause considerable damage by blocking irrigation ditches and flooding roads and pastures. In addition, beaver kill commercially valuable trees, such as fruit trees. From April 1971 through March 1972 there were 688 complaints of damage caused by beaver in the State (Oregon State Game Commission 1972).

Disease: Beaver are susceptible to tularemia, a bacterial disease that is highly infectious to humans (Jellison 1970).

Selected references: Bailey (1936), Gill (1972), Jackson (1961), Johnson (1927), Leege (1968), Seton (1928), Warren (1926).

Family Cricetidae: New World Rats and Mice

Derivation: The familial name Cricetidae is derived from the Middle Latin word *cricetus* (the hamster) combined with the Latin suffix *idae* (family).

General description: Members of the family Cricetidae vary greatly in size, shape, and habitat requirements; most cricetids are terrestrial-they scamper or jump over or burrow under the surface of the ground. The scampering forms often are good climbers; some are cliff-dwellers, whereas others are semiarboreal. Some members of this family are even semiaquatic. Cricetids are primarily southern in distribution and are of slender proportions. They have pointed noses and large, sensitive ears that seldom are concealed in the body hair. These large-eyed mammals are primarily nocturnal. Their legs are usually long and slender, their tails long and well haired. Pelages are generally light in color, appearing rich and lax.

Cricetids eat mainly seeds and vegetables, but many members of the family are omnivorous

The gestation period in members of most genera of cricetids is 20 to 33 days, and the number of young per litter is 1 to 18. Young generally weigh less than 14 grams at birth. Females of some genera begin to breed at about 6 to 7 weeks of age. In warmer parts of their geographical distribution, cricetids apparently breed throughout the year provided temperatures are not excessively high; in colder regions, however, the breeding season is restricted. The length of daylight seems to be the major factor affecting the timing and the duration of the breeding season. In the wild, most individuals are victims of predation and probably live less than 2 years, frequently less than 1 year.

World distribution: Cricetids are nearly worldwide in distribution but are absent from certain islands, such as Ireland and Iceland, a few arctic islands, Antarctica, and the Austro-Malayan area.

Fossil record: The fossil record for the family Cricetidae in North America dates to the Oligocene period.

Number of species along the Oregon coast: Three.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus *Peromyscus*: Deer mice and white-footed mice

Derivation: The generic name *Peromyscus* is derived from the Greek words *peron* (something pointed) amd *myskos* (little mouse).

General description: Deer mice and white-footed mice are found in almost every habitat throughout their geographical distribution. Since these little mice are the most readily trapped of all North American mammals, they appear to be the most abundant.

Members of this genus vary in length of head and body from 8 to 17 centimeters and in length of tail from 4 to 20.5 centimeters. Adults weigh from 15 to 50 grams. They vary in color from nearly white, to gray, to yellowish or orangish brown, to dark brown, to black. The members of this genus inhabiting forested or wooded areas are generally darker with larger ears and longer tails than are those living in open or arid country.

They emit faint to shrill squeaks and "buzzes." When excited, members of many species produce a drumming sound by rapidly thumping their front feet against the substrate. These agile, nocturnal mice spend their days sleeping in clean, soft nests made of grasses, mosses, birds' feathers, shredded bark, string, or whatever is available. A nest may be in a burrow, hollow log, stump, or tree; under bark, boards, or stones; in rock crevices, nests of other small mammals, or human abodes. When a nest becomes soiled, it is abandoned and another nest constructed.

Their diets consist of anything edible.

In many areas, deer mice and white-footed mice breed throughout the year. The gestation period ranges from 21 to 27 days but may be longer. Litters vary from 1 to 11 young; average litters consist of 4.

When 3 to 6 weeks old, the young disperse. Although most of these mice probably live less than 2 years in the wild, in captivity they may live 5½ years.

Mice of the genus Peromyscus are widely used in laboratory studies because they are readily available in large numbers and they live well in captivity. They are clean, can be easily fed, and have a high reproductive rate. An excellent treatise on the genus is King (1968).

World distribution: Peromyscus is a New World genus occurring from southeastern Alaska, northern Canada, and Labrador south to extreme northern Columbia, South America.

General reference: Walker et al. (1968).

Species *Peromyscus maniculatus:* Deer mouse

Derivation: The specific name *maniculatus* is a New Latin word meaning "small handed."

Specific description: Total length, 149 to 228 mm; tail, 70 to 126 mm; hind foot, 20 to 28 mm; ear, 15 to 23 mm; weight, 12 to 32.5 g.

The deer mouse is a slender animal with large eyes, big ears, and a long tail. In summer, the back varies from brown to dark brown, but is darkest along the midline from the top of the head to the base of the tail. Some individuals are reddish brown, others grayish brown. The top of the tail is light brown to dark brown. The tops of the feet, the underside of the body, and the tail are clear white, There

is a sharp line of demarkation between the dark upper parts and the white under parts. In winter, the long, soft pelage is slightly brighter in color. An immature mouse is gray above and white below.

Distribution along the Oregon coast: Deer mice occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Deer mice occupy all habitats along the coast.

Habits: Almost strictly nocturnal, deer mice become active as soon as it is dark. Even though they are extremely graceful and agile, they can be noisy as they scamper through dry vegetation or investigate cooking utensils left on a camp table. The commotion would indicate a much larger animal abroad.

DEER MOUSE

Their domain includes the beach; the numerous subterranean burrow systems; brush piles; in, under, and on top of rocks, stumps, and logs; and the forest trees. On several occasions, after I disturbed these mice in their diurnal nests as high as 24 meters above the ground in Douglas-fir trees, they raced along the branches and up and down the trunks.

Along the coast are many streams and marshes but also many branches and logs spanning the water that the deer mice use as bridges instead of swimming. Nevertheless, they are good swimmers (Orr 1933).

Deer mice appear to be social. They are unrestricted by humans and roam more or less freely over most of their habitats. Home ranges shift and overlap loosely (Metzgar 1973, Morris 1967). Hooven (1958), working in the Tillamook Burn, Tillamook County, Oregon, cited 1.9 hectares as the average size of the home range for male mice and 1.4 for female mice.

Deer mice build nests from a variety of materials, such as grasses, mosses, root fibers, mattress stuffing, sheeps' wool, and even thistledown. Bailey (1936, p. 183) wrote that they also "build their nests under or in the great fleeces of moss that drape the trees in the coastal forests." I have found nests of these mice under boards and large slabs of bark; in hollow trees, woodpecker holes, seats of little used or abandoned automobiles, cupboard drawers and mattresses in abandoned buildings; and in the nests of squirrels, woodrats, red tree voles, and birds.

They are active throughout the year. During cold, wet weather activity on the ground is minimal, although they may be active underground (Stebbins 1971). As the weather moderates, the mice become active on the ground.

Food: Deer mice, usually considered herbivorous, are really omnivorous. They eat a wide variety of foods which they find by odor rather than sight (Howard and Cole 1967, Howard et al. 1968). Along the Oregon coast these mice eat seeds of such trees as Douglas-fir, lodgepole pine, Sitka spruce, bigleaf maple, tanoak, and California laurel; the fruits of salmonberry, skunkcabbage, salal, thimbleberry, three species of blackberries, blackcap, and four species of huckleberries; and a variety of underground fungi and many invertebrates, such as beetles and amphipods. (For more information on the food habits of deer mice, see Harling and McClaren (1970), Jameson (1952), Osborne and Sheppe (1971), Whitaker (1966), and Williams (1955).)

Reproduction: Although deer mice breed throughout the year in the Willamette Valley of Oregon, my data indicate a lull in breeding activity during the most inclement winter weather along the coast. Male deer mice with mature testes were caught from February through September. Pregnant females were found from March through September; only one pregnant mouse was captured in January. Litters range from three to eight offspring but were usually three to five. Within the species, however, litters range from one to nine young. Most mature females have more than one litter per year.

Deer mice are born helpless, naked, and blind. They weigh about 2 grams at birth, but they grow rapidly and in a few weeks are independent of their parents. The gray pelage of the youngsters makes them distinguishable from the adults which have a predominantly brown pelage. In late summer and early autumn, the young are more often captured than are the adults. In the wild, deer mice are probably short lived; however, one male lived about 32 months (Gashwiler 1960) (see also Drickamer and Bernstein (1972), Smith and McGinnis (1968)).

Predation: Deer mice are important prey for snakes, owls, weasels, skunks, mink, marten, bobcat, domestic cats, coyotes, fox and ring-tailed cats (a relative of the raccoon). At times, humans take a large toll on these mice through the use of poisons.

Economic status: More than any other small mammal, deer mice are blamed for the depredations on the reforestation of commercially important Douglas-fir because they consume its seeds. Thousands of dollars have been spent to control these mice. A few of the hundreds of articles written on the deer mouse and its perceived role in reforestation are: Gashwiler (1965b, 1969, 1971), Hooven (1955, 1956, 1958), and Pank and Matschke (1972).

Deer mice occasionally invade human habitations where they may damage foodstuffs and electrical wiring. On the other hand, they are important in the diets of some commercially valuable fur-bearing mammals, as well as other types of wildlife.

Selected references: Blair (1947), Bradley and Mauer (1967), Dice (1941, 1947, 1949), Dyer (1969a), Harris (1952, 1954), Horner (1954), Layne and Ehrhart (1970), Moore (1965), Orr (1957-58), Rasmussen (1964), Sadleir (1965), Terman and Sassaman (1967) Thomas (1972, 1973).

Genus Neotoma: Woodrats

Derivation: The generic name Neotoma is derived from the Greek words neos (new or recent) and *tomos* (a cut). The reference of this name is obscure.

General description: The length of head and body of woodrats ranges from 15 to 23 centimeters and the tail from 7.5 to 24 centimeters. Woodrats weigh from 156 to 444 grams. Their fur is long and soft to somewhat short and harsh. The pelage coloration is delicate, blending from pale tannish gray to dark gray or reddish tan to reddish brown above and almost pure white below. Adult woodrats have a prominent gland in the middle of their bellies that usually causes the hair to appear soiled. This is most noticeable in the males.

They build their nests on the ground around logs or stumps, in rock piles, talus, or the nooks and crannies of cliffs; some species construct nests in shrubs, trees, or cacti. The nests, or lodges, vary from a pile of sticks and assorted materials to a compact, conical structure that may reach 1.8 meters or more in height and 1.8 meters in diameter at the base.

A woodrat picks up materials while foraging, but if, on its way to the nest, a more "desirable" item is found, the new object will be taken in lieu of the original material. Around camp, woodrats often take shiny objects and leave old bones, dried pieces of dung, or whatever they had been carrying, earning them the names "traderat" and "packrat." As part of a study of the movements of woodrats, Ireland and Hays (1969) took advantage of this compulsion to collect or trade. They checked the movements of woodrats by using shiny balls of tinfoil with numbers coded inside. They stated (p. 379) that "The tinfoil ball method. . . may have caused the wood-rats to make unnatural trips back to the nests, and the shiny objects may have attracted some animals beyond their normal home range."

When woodrats are excited or alarmed, they drum their feet on the substrate; this may be a warning to other woodrats or it may be only a nervous reaction.

Their food consists of a wide variety of plant material as well as some invertebrates. They apparently glean enough moisture from their food so that they seldom need to drink. Woodrats occur from seacoasts to deserts or humid jungles up to and above timberline in the high mountains.

One to four young are born in a well-lined, warm, soft nest after a gestation period of 30 to 37 days. In the northern portions of their distribution, pregnant female woodrats apparently have a single litter per year, but they seem to breed throughout the year in the southern portions of their distribution.

World distribution: Woodrats *(Neotoma)* occur from southeastern Alaska and British Columbia, Canada, throughout most of the lower 48 United States, south as far as Nicaragua and Guatemala.

General reference: Walker et al. (1968).

Species *Neotoma fuscipes*: Dusky-footed woodrat

'Derivation: The specific name *fuscipes* is derived from the Latin words *fuscus* (brown, dark, dusky) and *pes* (foot).

Specific description: Total length, 400 to 475 mm; tail, 201 to 322 mm; hind foot, 41 to 46 mm; ear, 32 to 38 mm; weight, 233 to 267 g.

The dusky-footed woodrat's tail is almost as long as the head and body. The round, tapering tail is covered with short, blackish hairs on top and underneath. The ears are large and thinly haired. The pelage is moderately long and soft. The back is reddish to yellowish brown, darkened with numerous black-tipped hairs; it
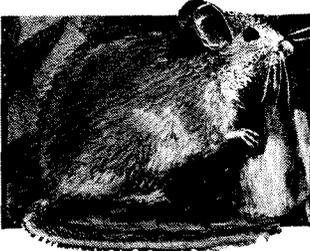
s darkest along the middle, sometimes appearing grayish. The sides are lighter than the back with fewer black-tipped hairs. The underside is whitish. The middle of the belly is washed with light tan in most individuals; this is the area of a large skin gland, The tops of the feet are grayish brown, but the toes and claws are white.

Distribution along the Oregon coast: Along the coast, the dusky-footed woodrat occurs from the California border north to the vicinity of Bandon and Coos Bay, Coos County. Inland, it occurs farther north and east.

DUSKY-FOOTED WOODRAT
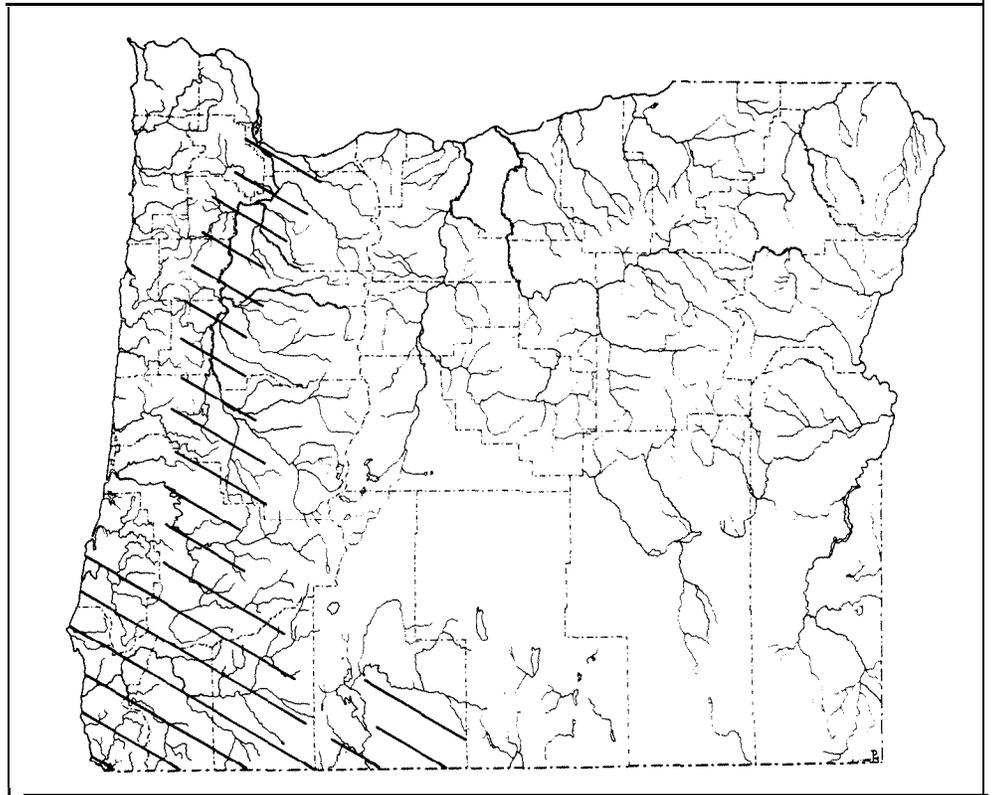
KNOWN DISTRIBUTION OF DUSKY-FOOTED WOODRAT

Habitat: The dusky-footed woodrat along the Oregon coast occupies the following habitats: mature conifer, immature conifer, riparian hardwood, lodgepole pine/rhododendron, lodgepole pine/salal, Sitka spruce/salal, headland shrub, mountain river, and tanoak.

Habits: Dusky-footed woodrats are primarily nocturnal, but English (1923) occasionally observed them foraging for food in daylight.

In the Willamette Valley of Oregon, these woodrats construct large, conical lodges from sticks and other materials. Such lodges are built on the ground at the base of trees, in dense brush or blackberry patches, on and over logs, or in trees. I have found them as high as 15.2 meters above the ground. A woodrat's lodge is normally the most conspicuous evidence of the animal's presence. Along the Oregon

coast, however, the lodges are usually small, well hidden, and difficult to detect-so much so that many people do not know they have woodrats as neighbors. Inland, the lodges become more visible, probably because the country is more open than the coast with its rank vegetation.

The outer lodge, which may measure 2.4 meters in height and 2.4 meters at the base (English 1923), is not considered a nest. The nest or nests are situated within the lodge. The lodge is composed of broken sticks or sticks cut by the rat itself, pieces of bark, or, as English (1923, p. 1) stated, "almost anything the animal is able to handle." He found such materials as "bones, the neck and skull of a dog with chain attached, cans, glass, old shoes, rubbers, and wire. . . ." Where sheep and cattle occur, wool, small horns, bits of hide, and dried dung are also used to embellish the lodge. English (1923) concluded, after 2 years of studying these woodrats in the Willamette Valley, that succeeding generations of young rats use the same lodge, annually adding more materials to it. More than one lodge may be used by a rat.

A lodge may have from one to five chambers or compartments, depending partly on its size. The various compartments are used as nursery, living room, storage room, and one as a toilet. The chambers are connected with one another and with the outside by runways. Except for the toilet, all the chambers are kept clean. They are made of dry grasses, mosses, shredded inner bark of trees, dry leaves or fern fronds, sheeps' wool, or feathers. English (1923) found that the nests of dusky-footed woodrats in buildings were made out of wallpaper, lace curtains, and, in one instance, the silk lining of a hat.

There are various exits from the lodges to the outside. These often are hollow branches or logs when available, or branches that interlace with nearby trees. Such routes offer quick retreats from enemies since these woodrats are expert climbers. Some lodges, built on the ground, have tunnels beneath them going down into the ground which, according to English (1923), are rarely more than 59 centimeters long.

In addition to the rats, other animals may inhabit the lodges. At times the woodrats apparently are evicted from their abodes, but this is not always the case. English (1923) found a striped skunk and a wren in woodrat lodges. I have found deer mice, house mice, red tree voles, spotted skunks, and tree frogs in the nests of these rats. In addition, a variety of invertebrates are harbored in old fecal chambers. (See also Gander 1929.)

English (1923) observed that, when a nest is disturbed or destroyed, the rat immediately looks over the situation and, if it does not abandon the nest, repairs it, sometimes changing the position of the living room. English wrote (p. 3):

> On one occasion. . .one rat was noticed cleaning out the living compartment of all little sticks and debris that had found their way in when the nest was destroyed. This rat was observed to carry a stick one-half inch in diameter and three inches in length out of the living den and to deposit it outside the nest. This same stick was replaced in the chamber from which the rat had just removed it, whereupon the rat promptly removed it again. This was repeated twelve times, the rat each time putting it on the outside of the nest.

When cornered, these woodrats can be savage fighters, but they appear to be more or less tolerant of one another when forced to be together. Dusky-footed woodrats are colonial in that several individuals usually occupy particular areas; the colonies wax and wane over the years (Murray and Barnes 1969). Where the habitats of the dusky-footed and the bushy-tailed woodrats overlap, the colonial nature of the dusky-footed woodrats apparently allows them to outcompete the more solitary bushy-tailed woodrats for nesting sites (Hammer and Maser 1973). This may be the case along the Oregon coast since the two species were not found together, which is not to say that they do not occasionally occur together along the coast. The dusky-footed woodrat is basically an invader from the chaparral type of vegetation from California and seems to be restricted along the immediate coast to the more southern type of vegetation that terminates in the Bandon-Coos Bay area of Coos County.

Food: Dusky-footed woodrats eat a wide range of plants which, undoubtedly, is an important factor in allowing this species to successfully occupy a variety of habitat types. English (1923) listed 37 species of plants eaten by these rats-see also Bailey (1936), Cameron (1971), Gander (1929), Hammer and Maser (1973). Along the Oregon coast they eat the leaves and inner bark of Douglas-fir and domestic apple trees; the leaves of western redcedar, Port-Orford-cedar, rhododendron, wax myrtle, salal, blackberries, and thimbleberries; the leaves and fruits of California laurel; acorns of tanoak; the fronds of bracken fern and deer fern; and the flowers of domestic roses. While living at Bandon, I received a call from a lady who said that blossoms of her prized roses were mysteriously disappearing and would I please look into the "thefts." The blossoms had been neatly cut off by a woodrat, leaving the bushes almost naked of flowers. After an hour's search, the well-concealed lodge of a dusky-footed woodrat was located within 15 meters of the edge of the lawn and the rose bushes. The storage chamber inside the lodge held 25 to 30 freshly cut rose blossoms.

Reproduction: English (1923) stated that, as far as he could determine, female dusky-footed woodrats mate with a single male per year; he found no evidence of polygamy. He also noted that, after mating, males became hermits, living alone in separate small nests which they usually constructed in trees.

Females normally bear their young from February to May, but one pregnant female was caught along the coast in July. Gander (1929) found a female with three fetuses near term on December 10. Although these rats usually produce only one litter per year, one female trapped along the coast had two litters in 1 year. Litters range from one to four young, usually two or three. English (1923) found an average of 2.8 young in 28 litters.

The young are naked, blind, and helpless at birth. Their eyes open at 17 days, and they are weaned in about 3 weeks (English 1923). Before they are weaned, woodrats remain firmly attached to their mothers' teats most of the time. Such firm attachment is possible because of the development of the deciduous incisors. These teeth curve sideways as they grow out from the jaws, forming a diamond-shaped opening when they are brought together and making a natural "locking mechanism" around the mother's teats. The locking nature of the front teeth has definite survival value in that a mother can carry the babies wherever

she goes, greatly reducing the chance of predation on the defenseless youngsters. It is not uncommon to see a mother with babies attached firmly to her teats, escape by moving from one tree to another along interlaced branches when her nest is disturbed. English (1923, p. 7) wrote,

> When one approaches a mother rat carrying the young. . . she endeavors to hide, but is not in the least bit cowardly and will try to bite if one gets close enough. The bite is sufficiently severe to draw blood. If a stick is put in front of her, she will push it out of her way, using her front feet and her mouth, at all times being careful of the young.

> Another way of protecting the young is for the mother to hover over them, young still attached, in a way similar to a hen with her chicks.

Predation: Dusky-footed woodrats have a number of enemies, such as hawks, owls, coyotes, long-tailed weasels, spotted skunks, and domestic dogs and cats. The two main predators, however, appear to be northern spotted owls and bobcats (Nussbaum and Maser 1975). In the vicinity of Port Orford, Curry County, along the Oregon coast in 1972, I found a pair of bobcats subsisting to a large extent on an ample supply of these woodrats.

Economic status: Bailey (1936, p. 176) wrote about the dusky-footed woodrat:

> Only in rare cases do these builders ever come in conflict with human interest. They generally prefer their own houses to ours, but sometimes explore outbuildings for any choice food or building material, and in certain places may appropriate more than a fair share of nuts, fruit, or vegetables growing near their homes. They are so easily destroyed, however, by traps or poison, or driven away by the destruction of their houses, that they cannot be considered as a serious pest.

Timber companies, on the other hand, are concerned about the damage that these woodrats cause to young Douglas-fir trees. Hooven (1959, p. 19), who studied damage by woodrats to Douglas-fir in the Willamette Valley, stated, "Damage. . . consisted largely of dead tops where bark removal was severe. Also. . . leaders had been cut, and. . . bark had been removed. . . but tops had not been killed outright. Minor barking and cutting of laterals. . . was difficult to assess."

I have found the dusky-footed woodrat excellent to eat. Bailey (1936, p. 176) went so far as to state that "their food and general habits are wholly exemplary for a game animal."

Disease: To my knowledge, the dusky-footed woodrat west of the Cascade Range in Oregon does not carry any disease communicable to humans. In other areas of its geographical distribution, however, it carries sylvatic plague. The dusky-footed woodrat is a potential source of plague in south-central Oregon, east of the Cascade Range (Hammer and Maser 1973). Murray and Barnes (1969) found this woodrat a main reservoir species of plague in northeastern California.

Selected references: Donat (1933), Hooper (1938), Lee (1963), Linsdale and Tevis (1951), Vestal (1938), Vogl (1967), Walters (1949), Wood (1935), Young (1961).

Species Neotoma *cinerea:* Bushy-tailed woodrat

Derivation: The specific name *cinerea* is the Latin word for "ash-colored." The first specimen of the subspecies *fusca,* which occurs along most of the Oregon coast, was collected at Fort Umpqua, near the mouth of the Umpqua River, Douglas County, Oregon, in 1859.

Specific description: Total length, 345 to 472 mm; tail, 165 to 236 mm; hind foot, 42 to 59 mm; ear, 25 to 38 mm; weight, 156 to 444 g.

The bushy-tailed woodrat is large and has a long, bushy tail, large ears with little hair, long whiskers, and a soft, almost woolly pelage. There is little seasonal variation in the color of the pelage. The back varies from a dark grayish brown to a somewhat reddish brown; the pelage is darkest along the middle of the back from the head to the base of the tail. The sides are lighter and more brownish. The underside varies from gray to light gray with areas of clear white. There is a prominent gland in the skin near the lower middle of the abdomen; it has shorter hairs and is stained yellowish. The tail has two types of hairs-short, woolly hairs interspersed with long, straight hairs. On the top of the tail the short, woolly hairs are light gray and the long, straight hairs dark gray to blackish. On the underside of the tail the hairs vary from light brown, light gray, to white. The tops of the feet and the toes, including the claws, are white.

Distribution along the Oregon coast: Bushy-tailed woodrats occur along the entire coast but apparently are less common along the immediate coast south of Coos Bay, Coos County. Sherrell (1970) cited only three records (two specimens) for this species in all Curry County.

Habitat: Bushy-tailed woodrats were found in the mature conifer (Douglas-fir variant), immature conifer, alder/salmonberry, lodgepole pine/rhododendron, and Sitka spruce/salal habitats; they probably occur in other habitats as well.

Along the Oregon coast, the bushy-tailed woodrat is most closely associated with the northern coniferous forests, whereas the dusky-footed woodrat is primarily associated with the southern brushy vegetation (chaparral). These northern and southern vegetation types merge in the Coos Bay-Bandon area of Coos County. Hence, the bushy-tailed woodrat is the only species known to occur north of Coos Bay, and the dusky-footed woodrat dominates the southwestern Oregon coast into California. Furthermore, where the habitats of bushy-tailed and dusky-footed woodrats overlap, the colonial nature of the dusky-footed woodrats appears to allow them to outcompete the more solitary bushy-tailed woodrats in occupancy of nesting sites (Hammer and Maser 1973).

Habits: The bushy-tailed woodrat is nocturnal in its foraging habits. Over most of their distribution in Oregon, bushy-tailed woodrats are directly associated with cliffs, rock outcroppings, natural talus, and talus along the banks of roads and railroad tracks. Along the Oregon coast, where suitable rocky habitats are scarce, they live in hollow trees and logs and build "outdoor" nests in trees or buildings. These woodrats are notorious along the coast because they frequently invade buildings, including houses occupied by people. In the dense forest, they are secretive and difficult to find. Unlike bushy-tailed woodrats living in rocky habitats,
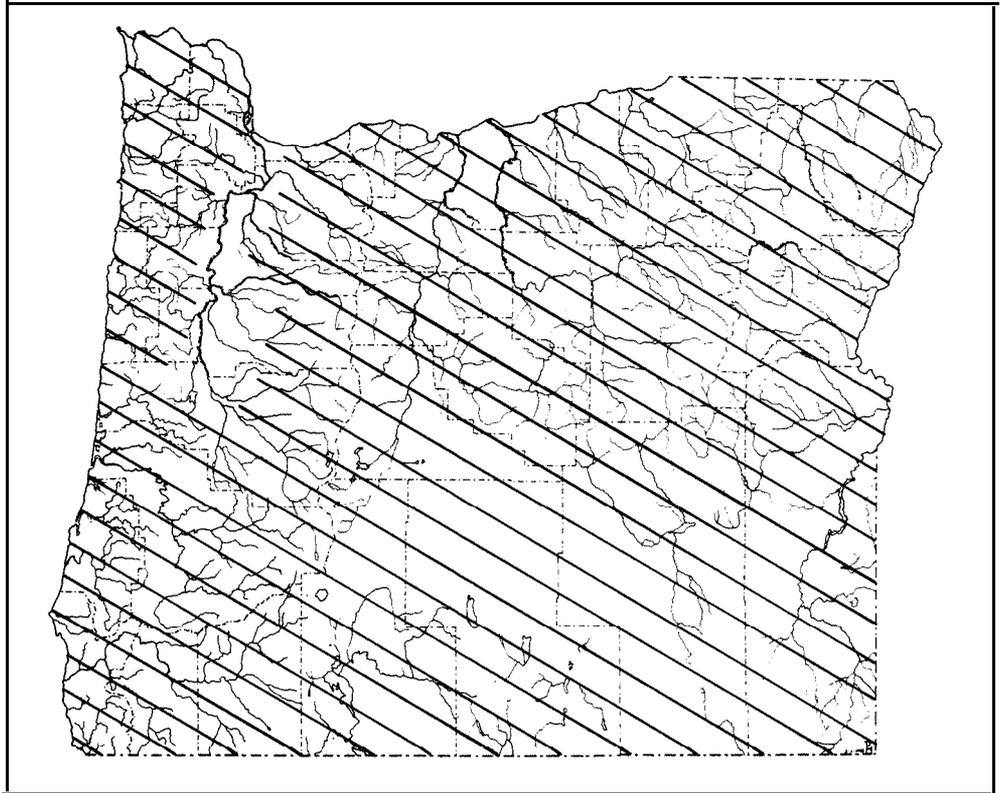
KNOWN DISTRIBUTION OF BUSHY-TAILED WOODRAT

the coastal bushy-tails seem neither to deposit their urine in such a way as to create white, calcareous deposits nor to produce the tat-like feces characteristic of woodrats that inhabit caves, rimrock, and cliffs. Their presence along the coast, therefore, is seldom detected unless they inhabit buildings.

Bushy-tails usually construct loose, sloppy nests; they do not build the compact, conical lodges characteristic of the dusky-footed woodrats. Bushy-tails normally make an open cuplike nest, 15 to 20 centimeters in diameter, in a hollow tree or log or in buildings. When room permits, they usually have a loose collection of "treasures" surrounding the nest. Taylor (1920, p. 91) listed the treasures secured by one bushy-tail in a dormitory near Snoqualmie Pass in the Cascade Range of Washington: chewed rags, grass and leaves, chewed paper, the thumb of a glove, pieces of string, thongs, an apple core, onion peel, bacon rind, raisins, 10 bars of chocolate, figs, oakum, puff balls, 1 dime, a newspaper clipping on prevention of forest fires, the lid of a coffee can 100 centimeters in diameter, paraffin from a jelly jar, bread crusts, bones, meat scraps, the rind of a cantaloupe, a scone, 19 pieces of candles, 4 potatoes, dried apricots, several cakes of soap, lemons, mushrooms, beans, peanuts, a banana, and 15 lumps of sugar. None of the nests that I found along the coast had so rich a treasure trove. Most nests in buildings were, to the human eye, piles of junk, but those on rafters and between double walls were simple cuplike structures without the usual pile of sticks, bones, and other materials.

In the Cascade Head Experimental Forest (between Otis, Lincoln County, and Neskowin, Tillamook County, Oregon) bushy-tailed woodrats lived in the hollow trunks of western hemlock trees (Maser and Franklin 1974). At times, these "nests" had small collections of sticks at their entrances. Although most entrances were at ground level, cavities in tree trunks had entrances 3 to 4.6 meters above the ground.

A few outdoor nests have been found as low as 4.6 meters and as high as 15 meters above the ground on limbs of living Sitka spruce and Douglas-fir trees. Tree nests, which are compact, are composed of dry sticks and freshly cut twigs, often from the tree in which a nest is built. One nest, in a Sitka spruce tree, was made from Sitka spruce, western hemlock, red alder, and elderberry twigs; another in a Douglas-fir tree, from Douglas-fir sticks. Such nests vary from 36 centimeters in diameter to 0.9 meter in diameter and 0.76 meter in height and have from one to six connected chambers. Living quarters are made from moss and shredded bark. The ground under a nest is often littered with cut twigs and rat dung (Maser 1965a, 1966b).

By day bushy-tails are quiet and usually in their nests, but at night these expert climbers can and often do make an amazing amount of noise as they rummage around in the darkness.

BUSHY-TAILED WOODRAT

Some years ago, Dr. Murray L. Johnson (curator of mammals, Puget Sound Museum of Natural History), had a gentle, captive bushy-tail at his home in Tacoma, Washington. On one occasion, I put my hand into the cage to scratch the sleeping bushy-tail's ear. On being touched, the bushy-tail opened its eyes, took my finger gently in its front teeth and carried the finger to the edge of the cage. With its forefeet, it pushed the finger out. After this expulsion, the bushy-tail went back to its nest and continued its nap. Shortly after going back to sleep, the rat defecated. Instead of soiling its cuplike nest, the bushy-tail grasped each pellet with its front teeth as it was expelled and, with a flip of its head, cast them away from the nest. By all appearances, its sleep was not interrupted by the procedure.

Bushy-tailed woodrats communicate with one another by thumping their feet on the substrate. On several occasions I have live-trapped bushy-tails in buildings. If a captured bushy-tail was removed immediately from the building in which it had been captured, another individual often was caught during the same night's trapping. When a live-trapped bushy-tail was not immediately removed and it started drumming while in the trap, no other bushy-tails would be caught that night.

Food: Bushy-tails are primarily vegetarians, eating a wide variety of plants, but they probably consume some meat. Along the Oregon coast they eat plants, such as the leaves and bark of Douglas-fir, Sitka spruce, western hemlock; the leaves of red alder; the green portions of Pacific bleedingheart, angled bittercress, red elderberry, waterleaf, trailing blackberry, and Himalaya blackberry (Maser 1965a, 1966b; Maser and Franklin 1974); see also Bailey (1936), Martin (1973).

Reproduction: Bushy-tailed woodrats along the Oregon coast begin breeding in January or February. The young are born from March (perhaps even earlier) through June or July. Although there usually is one litter per year, there may be two. Litters range from one to six young, but two to four offspring is probably the usual size.

Horvath (1966, p. 6) described the birth of a litter of bushy-tailed woodrats:

> When the rat was found, she was sitting on a piece of board that lay on the ground. She sat in a crouched posture with the top of her head pressed against the board. Her whole body trembled spasmodically. After the first young appeared, the trembling stopped for 2-3 minutes while the neonate [newly born young] crept under her body and attached itself to a nipple. The body trembling of the female started again for about two minutes and stopped when the second young was born. The process of their birth was identical. All of the four young crept under the mother and attached themselves to the nipples. About 12 to 14 minutes elapsed between the appearance of the first young and that of the last one. After the parturition the rat turned toward the four attached young and pulled them into the nest. . . . When the rat abandoned the site of parturition a small wet spot was left on it.

The young are naked, blind, and helpless at birth. Before they are weaned, woodrats remain firmly attached to their mothers' teats most of the time. Such firm attachment is possible because of the deciduous incisors; these teeth curve sideways as they grow out from the jaws, forming a diamond-shaped opening when they are brought together, making a natural "locking mechanism" around the mothers' teats. In addition to nursing, the locking nature of the front teeth have definite survival value in that a mother can carry the babies wherever she goes, greatly reducing the chance of predation on the defenseless young. Horvath (1966) observed that, when the mother bushy-tail escaped, she left the nest with a jump, pulling the babies with her by her teats. The young did not use their feet at all.

At 13 to 16 days of age, the young had their eyes open (Horvath 1966). They are apparently weaned when about 1 month old. Martin (1973) determined that the average gain in weight for baby bushy-tails per day for the first 11 days was 3.0 grams for males and 2.2 grams for females. The average gain per day for the first 25 days was 3.8 grams for males and 3.1 grams for females. (See also Egoscue (1962).)

Predation: The two main predators of bushy-tailed woodrats in Oregon probably are northern spotted owls and bobcats (Nussbaum and Maser 1975). Other predators include large owls, hawks, coyotes, marten, long-tailed weasels, spotted skunks, and domestic dogs and cats. Humans kill the greatest number of bushy-tails with traps and poisons.

Economic status: For the most part, bushy-tailed woodrats do not cause a great amount of disturbance to humans and seldom are of real economic importance. They do cause some damage to or "steal" items of food from cabins, camps, or other places, but they apparently cause little damage to timber interests. They are excellent to eat.

Diseases: To my knowledge, the bushy-tailed woodrat in western Oregon, west of the Cascade Range, does not carry any disease that is communicable to humans. In other areas of its geographic distribution, however, it carries sylvatic plague. Murray and Barnes (1969) discussed the relationship of this woodrat and the dusky-footed woodrat to plague in northeastern California.

Selected references: Bailey (1936), Dalquest (1948), Dixon (1919), Seton (1928), Sperry (1941).

Family Microtidae: Voles

Derivation: The familial name Microtidae is derived from the Greek words *mikros* (small) and *ōtos* (the ear) combined with the Latin suffix *idae* (family).

General description: Many members of the family Microtidae (microtines) are commonly called "meadow mice" or "field mice"; however, they are more properly termed "voles." The word "vole" (vol) is from a noun, "vole-mouse," of Scandinavian origin. Vole is also a French noun used in playing cards. "To go the vole" means to "hazard all for great gains," an apt description of the life of many members of this family.

Voles are primarily terrestrial in habits, occurring from the Arctic to the desert, from sea level to above timberline in the high mountains. Most members of this group burrow considerably beneath the surface of the ground. Others are mainly arboreal, and some are aquatic. Voles, primarily those in the northern part of their distribution, have stocky bodies. They have blunt noses and small, round ears that are usually concealed in the body hair. These small-eyed mammals are often active throughout the 24-hour cycle. Their legs are normally concealed within the contours of their bodies, making them appear short-legged. Their tails are usually short, with little hair. Pelages are normally dark in color, often appearing coarse in texture.

Voles are primarily vegetarians, but a few are known to be carnivorous on occasion.

The gestation period may be as short as 21 days or as long as 30 days; a female usually breeds within 24 hours after giving birth. Voles do not hibernate, and in mild climates, litters may occur throughout the year. Litters range from 1 to 11 offspring, usually 4 to 8. Babies usually weigh less than 14 grams at birth. Many females begin breeding when only 3 weeks old.

In the wild, most voles probably live less than 2 years because of predators. Some members of this family are famous for their cyclic fluctuations in numbers; a population builds up for 3 or 4 years and then "crashes." A population goes from one with few individuals, to one teeming with voles, to a population that may again appear to be all but nonexistent. The high populations are often referred to as "mouse plagues" (Elton 1942).

World distribution: Voles occur in Europe, Asia, and North America, extending south only into northern Central America and North Africa.

Fossil record: The fossil record of microtines dates to the Pliocene in North America.

Number of species along the Oregon coast: Seven.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus Clethrionomys: Red-backed voles

Derivation: The generic name *Clethrionomys* is derived from the Greek words *kleithrion* (a bar for closing) and *mys* (mouse). The reference of this name is obscure.

General description: Red-backed voles are attractive little mammals. They have thick pelages that are long and soft in winter but shorter and harsher in summer. The general coloration of the back is a pronounced reddish wash over dark gray hairs; the reddish wash is less pronounced on the grayish sides. Their undersides vary from dark gray to almost white. They have slender, relatively long tails. Their ears are moderately conspicuous through the body hair. The length of the head and body ranges from 7 to 11.2 centimeters; the tail, from 2.5 to 6 centimeters. These voles weigh from 15 to 40 grams.

RED-BACKED VOLE

Red-backed voles are active throughout the 24-hour cycle. They are good climbers, living around the stumps, logs, rocky outcroppings, cliffs, and rock slides of forested areas. Red-backs inhabit tundra, bogs, moist or dry forests, and woodlands. Some species burrow considerably. They do not hibernate.

Breeding usually begins in late winter and continues until late fall. After a gestation period of 17 to 21 days, one to eight, usually four to six, young are born in a nest of shredded vegetation.

World distribution: Red-backed voles occur throughout Canada, Alaska, and most of the Northern United States, extending south along the Pacific coast, and the highlands of the Rocky Mountains and the Appalachians. They also inhabit Europe and Asia, including Japan.

General reference: Walker et al. (1968).

Species *Clethrionomys californicus:*
California red-backed vole

Derivation: The specific name *californicus* is a proper name. The vole was named after the State of California combined with the Latin suffix cus, denoting possession.

Specific description: Total length, 120 to 187 mm; tail, 34 to 74 mm; hind foot, 17 to 22 mm; ear, 10 to 18 mm; weight, 16 to 32 g.

California red-backed voles are delicate little mammals of slender proportions. They have weak teeth, varying from light yellowish to whitish. Their ears protrude moderately beyond the body hair. They have a relatively long, thick, soft pelage. The upper parts are usually somber with an often poorly defined median dorsal stripe which is obscured by intermixed black hairs. The sides are light to dark gray washed with light brown to light yellowish brown; the venter is dark gray washed with light brown to light yellowish brown. (Juveniles are darker, duller, and do not have the brown wash.) They have a slender, long tail that may be sharply or indistinctly bicolored, light brown or blackish above and whitish below.

Distribution along the Oregon coast: California red-backed voles occur along the entire coast.
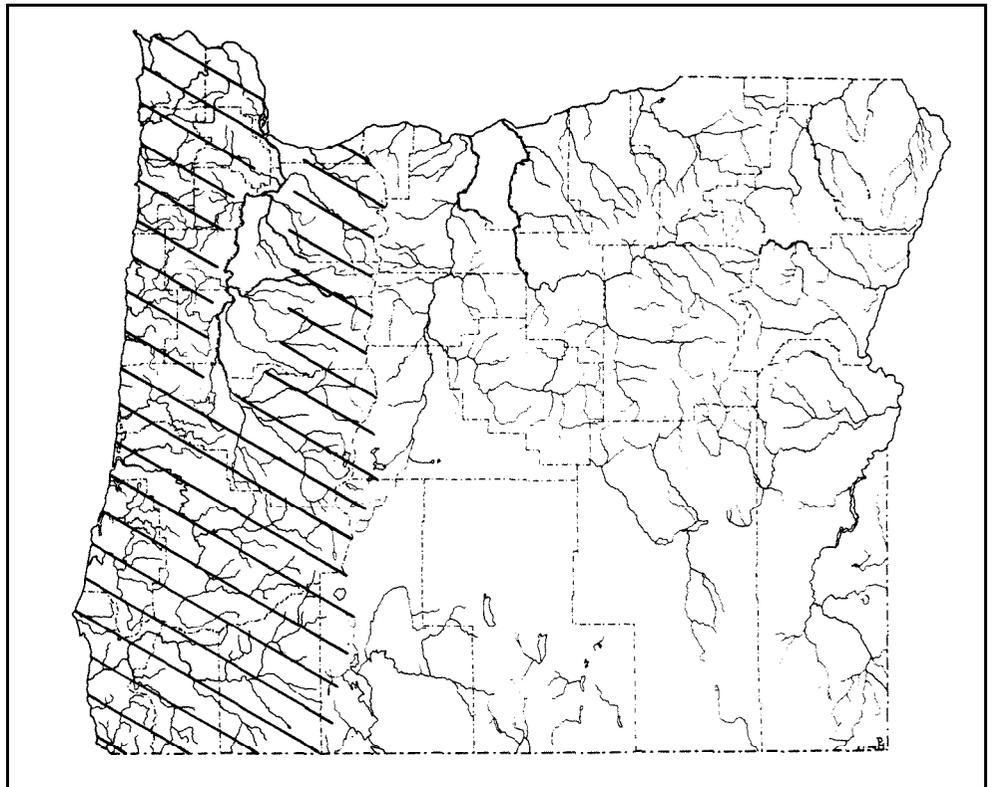
KNOWN DISTRIBUTION OF CALIFORNIA RED-BACKED VOLE

Habitat: These red-backed voles occupy the mature conifer, immature conifer, lodgepole pine/rhododendron, Sitka spruce/salal, and possibly the cedar swamp habitats.

Habits: California red-backed voles are inhabitants of the coniferous forest. They occur from the Columbia River, Oregon side, south into northern California, and from the coastal forests to the eastern flank of the Cascade Range. The red-backs west of the Cascades are secretive, whereas those in the mountains are much less so.

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Along the coast, within the forest, there appear to be two main, related factors that affect the presence or absence of red-backs. The first is the amount of light that reaches the forest floor which, in turn, controls the quantity and the variety of herbaceous plants and shrubs that survive. Red-backs apparently prefer dense forest with little or no ground vegetation. The second factor influencing the distribution of red-backs is the presence of rotting, punky logs. There seems to be a direct relationship between the number of rotting logs and the abundance of red-backed voles. The voles increase as the number of rotting logs increases."

The California red-backed vole (subspecies *californicus*) has long been considered uncommon west of the Cascade Range because of the difficulty of capturing them. Macnab and Dirks (1941, p. 175) stated that, "Until recently this mouse has been reported from only four localities in the state of Oregon. . . ." On the other hand, I have found these voles to be relatively common; selecting the right micro habitat (little or "restricted" habitat) within the forest is important, but so are the vole's habits-the California red-backed vole west of the Cascade Range is primarily a burrowing mammal. Most of its life is spent under the forest floor where it lives in a more stable temperature and humidity regime than that to which it would be subjected on the surface of the ground. Furthermore, this vole remains close to its subterranean source of food.

The aboveground activity of red-backs along the coast seems to be influenced by the weather. I had been trapping repeatedly 6.4 kilometers southeast of Bandon, Coos County, from July 1970 but had neither found a sign of nor captured a single red-backed vole. Then on November 28, 1971, there was a subtle change in the usual winter weather, and the red-backed voles suddenly became active on the ground. A cat killed the first red-backed vole seen. Aboveground activity continued until December 21 when there was again a subtle change in the weather. During this time, cats killed another red-backed vole, and I trapped nine voles. I trapped on and off in this location until June 9, 1972, but found no more evidence of red-backed voles. About 200 California red-backed voles (subspecies *mazama*) were captured in live-traps set on the forest floor in the H. J. Andrews Experimental Forest, Lane County, Oregon, in August and September 1972. (The H. J. Andrews Experimental Forest is located on the west slopes of the Cascade Range.) No special effort was made to capture these voles.[12]

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[11] C. Maser and M. L. Johnson. Unpublished data on file at Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington.

[12] R. A. Nussbaum and C. Maser. Unpublished data on file at Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington.

Another contrast between the subspecies of California red-backed voles, *californicus* and *mazama,* is their times of aboveground activities. The red-backs west of the Cascade Range are normally active during the night, whereas those in the mountains are active during the 24-hour cycle. Several years ago, while dozing on the ground next to a log on the crest of the Cascade Range, I felt a warm, furry, little creature invade the full length of one leg of my pants. After carefully evicting the sharp-toothed invader, I was surprised to see that it was a red-backed vole wandering around on a sunny afternoon. Since then, I have seen a number of "Mazama" red-backs scampering over the forest floor or scurrying in and out among the boulders of rockslides.

Nothing is known about the underground habits or the nesting habits of these voles.

Food: Bailey (1936, p. 191) wrote of the California red-backed vole, "They feed largely on green vegetation, grass, seeds, and various small plants. They are eager for rolled oats or any kind of grain used for trap bait." Although they do eat some green vegetation, especially in late winter, and they may be attracted to trap bait, their principal diet is a variety of underground fungi and some lichens (Maser et al. 1978). Captive voles exhibited some tendency to store fungi.

Reproduction: Not much is known about reproduction of California red-backed voles. They have a long breeding season which, according to Gashwiler (1959, p. 136) who worked in the western Cascade Range, begins as early as April and continues until late October and November, when there was "a marked decline in breeding activity." The red-backed voles west of the Cascade Range, however, breed throughout the year. Females that showed signs of having given birth (placental scars) and of nursing (development of the mammary glands) were caught in December, January, February, and March. Litters ranged from one to eight offspring, but the usual litter was two to four young.

Although little is known about the family relationships of the California red-backed vole, Roest (1951, p. 348), at Oregon Caves National Monument, Josephine County, observed an adult red-back carrying a "hairless young across the trail. . . holding it by the abdomen, its feet pointing upward."

Predation: The main predators of the California red-backed vole are marten, short-tailed weasels, long-tailed weasels, and spotted skunks. Nussbaum and Maser (1975) found that these red-backed voles composed a portion of the diet of bobcats in western Oregon. Along the coast, the domestic cat also is a serious predator. In addition, great horned owls, saw-whet owls, and northern spotted owls prey on these voles (Forsman and Maser 1970).

Economic status: Present study of the foods (underground fungi) of the California red-backed vole has proved these voles to be an essential component in the health of our commercially important coniferous forests, and therefore, economically beneficial to the timber interests (Maser et al. 1978).

Selected references: Bailey (1936), Gashwiler (1959, 1970), Johnson (1968), Johnson and Ostenson (1959), Macnab and Dirks (1941).

Genus *Arborimus:* White-footed vole and tree voles

Derivation: The generic name *Arborimus* is derived from the Latin words *arboris* (tree) and *mus* (mouse).

General description: Voles of the genus *Arborimus* have been separated only recently from the genus *Phenacomys* in which they were originally placed. They are considered among the most primitive members of the vole family; see Johnson (1968, 1973), Johnson and Maser (in press), and Taylor (1915). The genus consists of three species; one is terrestrial and two are arboreal.

Members of the genus *Arborimus* have long, soft pelages that vary dorsally from rich brown to bright orangish red. They have long, hairy tails, small eyes, and pale, almost-naked ears. These secretive voles are nocturnal, uncommon to rare, and difficult to obtain; thus they are seen by few people.

Although they breed throughout the year, they have small litters ranging from one to four young, usually two to three offspring per litter. Tree voles, and presumably also white-footed voles, grow and develop slowly compared with members of the other genera of voles.

Tree voles and white-footed voles probably evolved in the ancient Klamath Mountains of southwestern Oregon. Johnson (1973, p. 240) stated,

> Geologic history provides data for an attractive hypothesis: *Arborimus* evolved in this region from some primitive microtine during the Pliocene, adapting to a habitat of mixed deciduous and coniferous forest during a time of moderate temperature and high rainfall; consistent climatic conditions along the Pacific Coast have maintained the restricted habitat.

World distribution: Voles of the genus *Arborimus* have a very restricted geographical distribution. They occur from the Columbia River in Oregon south into Sonoma County, California, and from the Pacific Ocean east to the crest of the Cascade Range but do not, as far as is known, reach the crest.

Species *Arborimus albipes:* White-footed vole

Derivation: The specific name *albipes* is derived from the Latin words *albus* (white) and *pes* (foot).

Specific description: Total length, 149 to 182 mm; tail, 57 to 75 mm; hind foot, 18 to 21 mm; ear, 12 to 16 mm; weight, 17 to 28.5 g.

White-footed voles have long, soft pelages. Dorsally, they are a rich, warm brown; ventrally, they are gray or gray washed with light brown. These voles have relatively long, distinctly bicolored tails-blackish above and white below. They have very small eyes; their ears, although usually concealed in the pelage, are naked of hair. The tops of the feet are usually white.
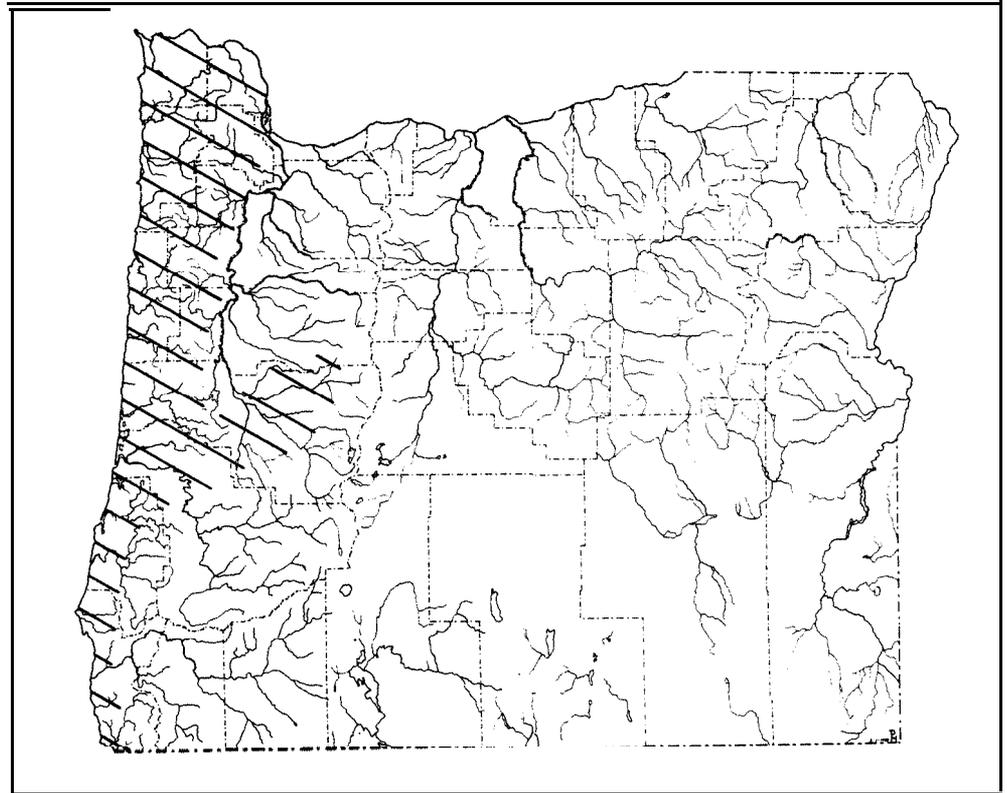
KNOWN DISTRIBUTION OF WHITE-FOOTED VOLE

Distribution along the Oregon coast: White-footed voles occur along the entire Oregon coast.

Habitat: Along the Oregon coast they are associated with the riparian aider/small stream habitat.

Habits: The first white-footed vole known to be trapped was taken near Arcata, Humboldt County, California, on May 24, 1899; on May 18, 1914, a second specimen was caught at the fish hatchery 3.2 kilometers west of Vida, Lane County, Oregon. In 74 years (1899-1973), only 72 of these rare voles have been captured, 63 in Oregon and 9 in California. Although the white-footed vole is still considered the rarest member of the vole family in North America, it is more common than previously thought; of those collected in Oregon, 22 were secured during this study along the coast from November 3, 1970, to August 19, 1972. The geographical distribution of the vole is from the Columbia River in Oregon south to Arcata, Humboldt County, California, and east from the Pacific Ocean to 26.8 kilometers southeast of Vida, Lane County, Oregon. Most of the white-footed voles that have been captured, however, have been taken along the Oregon coast where the species is generally distributed.

Little is known about the habits of these nocturnal voles, but their small eyes and their claws, which are more of a digging than a climbing type, suggest a burrowing habitat. They are gentle mammals.

Food: Howell (1928) reported that the stomachs of three white-footed voles trapped at Trinidad, Humboldt County, California, in 1926 contained finely chewed roots of some unidentified herbaceous plant. A current study of their food habits suggests that a variety of green herbaceous plants are normally eaten (Voth et al., in press).

Reproduction: White-footed voles breed throughout the year. Although females have three pairs of teats, litters range from two to four, but three offspring is the usual size.

Predation: Owls, weasels, mink, spotted skunks, and domestic cats are probably the main enemies of white-footed voles.

Economic status: Economically, white-footed voles are unimportant.

Selected references: Bailey (1936), Howell (1928), Maser and Johnson (1967), Olterman and Verts (1972), Taylor (1915).

Species *Arborimus longicaudus:* Red tree vole

Derivation: The specific name *longicaudus* is derived from the Latin words *longus* (long) and *cauda* (tail). There are two subspecies of red tree voles along the Oregon coast—*longicaudus* and *silvicola* (Johnson 1968). The first specimen of the red tree vole, *A. longicaudus,* was captured at Marshfield (now Coos Bay), Coos County, Oregon, in 1890. The first specimen of the subspecies *silvicola* was found dead in a log 8 kilometers southeast of Tillamook, Tillamook County, Oregon, on October 25, 1916.

Specific description: Total length, 158 to 206 mm; tail, 60 to 93.5 mm; hind foot, 18 to 24 mm; ear, 10 to 13 mm; weight, 25 to 47 g.

Red tree voles have a thick, relatively long, soft pelage. Dorsally, the pelage varies from brownish red in voles along the northern Oregon coast, to brighter brownish red in voles on the middle coast, to more orangish red in voles along the southern coast. The dorsal pelage contains many black-tipped hairs, affecting the overall coloration. Ventrally, the pelage is light gray, but the gray of voles along the southern portion of the coast may be washed lightly with reddish orange. The tail is long and hairy; it is not distinctly bicolored, varying from black in voles along the northern coast to rich medium brown in voles along the southern coast. (Juveniles are duller, with less red and more brown; their tails are black.) Red tree voles have small eyes and pale, almost hairless ears. Their claws are sharply pointed and well curved, aiding them in climbing. See Johnson (1973) for a description of the more specialized characters.
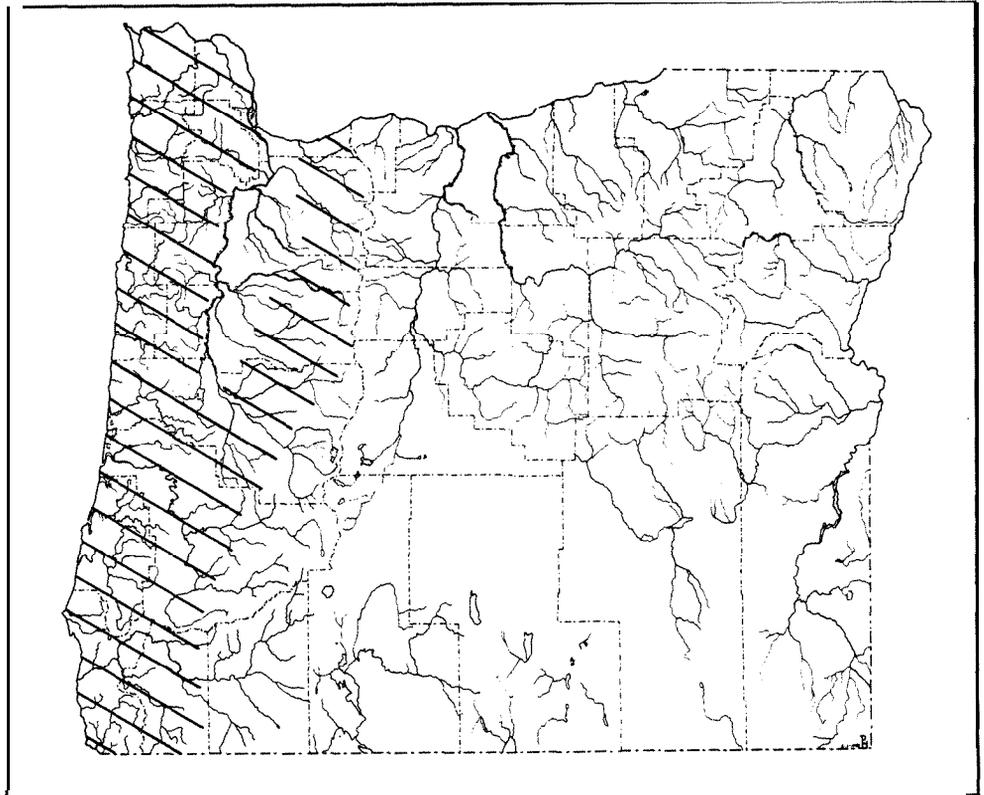
KNOWN DISTRIBUTION OF RED-TREE VOLE

Distribution along the Oregon coast: Red tree voles occur along the entire coast.

Habitat: Red tree voles are primarily associated with the mature conifer (Douglas-fir variant) and immature conifer habitats; they also occur in the mature conifer (redwood variant) and Sitka spruce/salal, provided sufficient Douglas-fir is present.

Habits: Unless otherwise stated, the following account is from field notes[13] and from Maser (1965b).

The red tree vole is the most highly specialized vole in the world. Although not as rare as the white-footed vole, *Arborimus albipes,* the populations of red tree voles are widely scattered; furthermore, they are disappearing in many localities because of extensive logging and land development.

Red tree voles are not seen by many people because, in addition to being strictly nocturnal, they are difficult to obtain. These voles cannot be trapped but must be evicted from their arboreal nests, often as high as 15 meters above the ground, and captured by hand.

[13] C. Maser, E. W. Hammer, and M. L. Johnson. Unpublished field notes on file at the Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington.

Tree voles build their nests from as low as 1.8 meters to as high as 48 meters above the ground. Nests are usually built in Douglas-fir trees and, to a lesser extent, Sitka spruce and western hemlock. Occasionally they are found in other trees, such as grand fir. Active nests are located within the green, living foliage of the tree. A nest often is situated on a whorl of limbs against the trunk, but in large, old-growth trees a nest is most frequently located among the living boughs, at the outer limits of the branches. In young, second-growth Douglas-fir, the voles tend to select the broken-out tops of the trees for nest sites whenever possible. Most of the broken-out tops are the result of snow and wind; when this happens, the small side branches grow up and out, becoming bushy and forming a thick, protective cover.

For the most part, a nest is constructed from twigs that the voles cut from the tree in which the nest is situated; however, they also take over the nests of birds, squirrels, and woodrats. The outer nest is made of twigs, whereas the inner nest chambers are lined with the discarded resin ducts from the needles of the coniferous trees that constitute the voles' diet. (Each needle has a resin duct along each outer edge that is bitten off by the vole and discarded as refuse; the middle portion of the needle is consumed.)

To determine which animal has built a nest being used by a red tree vole, a person must examine the nest construction carefully and must be thoroughly familiar with the materials generally used and with tooth marks, feces, hair, and feathers of the various animals involved. The situation can be scrambled since the western gray squirrel, chickaree, northern flying squirrel, dusky-footed woodrat, bushy tailed woodrat, deer mouse, and a variety of birds use nests interchangeably (Maser 1965b).

A nest constructed entirely by a tree vole is a more or less haphazard affair. The nest begins as a platform of food twigs on which the vole feeds; as additional twigs are carried to the foundation, food refuse accumulates. The vole's movements, along with the deposition of feces and urine, continuously pack the material down. As larger twigs collect, the vole crawls under them to feed. The discarded resin ducts are pushed and pulled around as the vole moves, making a small cavity for itself. It pushes and scratches the resin ducts up and over the sides and top until a completely enclosed chamber is formed. Food twigs are brought to the nest nightly, and although some are stripped of their needles, others are not. As the vole alternately feeds in the nest and on top of it, the nest gradually increases in size and settles until it becomes firmly packed and well anchored. From this point on, the growth of the nest appears to be incidental, but the stages of growth are fairly standard. The nest changes from the original, small structure to a fairly large, roundish structure, situated on one side of a tree. As growth progresses, the nest spreads out, continuing around the trunk until it connects with its beginning. Thereafter, growth of the nest is up and out. Rain and the constant movement of voles inevitably packs the structure. As generation after generation of voles inhabit the nest, a thick layer of fecal material accumulates, further anchoring the nest firmly to the tree.

The various portions of the interior of a nest are connected by a series of tunnels with exists leading to the outside. Although there is no predictable pattern to the system of tunnels, one particular tunnel exists in every nest; this is an escape tunnel leading from the interior of the nest to an exit at the bottom of the nest next to the trunk of the tree through which a vole can escape undetected.

There are usually one or two tunnels leading to the top of the nest and the daily food supply. These tunnels are normally situated in such a way that a vole can reach food without exposing itself for any length of time.

The system of tunnels within a nest changes constantly as the nest is altered. If a nest is large enough to surround the trunk of the tree, however, a circular runway going around the trunk is normally present; at times, such a runway is found both inside a nest and on top of it.

In old, long-established nests with a thick layer of decomposing, earthlike manure, tunnels and chambers lined with resin ducts penetrate the fecal mass. These tunnels and chambers are dry and appear relatively permanent. Possibly such a nest could be inhabited constantly, irrespective of changes in the weather.

All inner nest chambers are lined with resin ducts. The chambers are of two types, nest chambers and fecal chambers (toilets). Old nest chambers become toilets, and new living quarters are established. The toilets become filled with feces and urine which gradually decompose, along with the resin ducts, forming a soillike layer typifying nests of long use. Tree voles are clean mammals and do not defecate or urinate in their sleeping quarters or the tunnels that are being used; they do defecate on top of the outer nest, however, probably while feeding during the night.

Red tree voles, for the most part, are gentle creatures that seldom bite, but pregnant females can be quite nippy. Some tree voles are sensitive and leave their nests at the slightest provocation. Most seem to leave their nests reluctantly and must be forcibly evicted. On the whole, tree voles are relatively slow and cautious in their movements, but there is considerable variation among individuals. One generality does exist-red tree voles proceed head first when moving, even going down a tree.

TREE VOLE

On being evicted from their nests, the voles often move down the trunk of the tree, seldom up, and if they reach the ground, either go into a handy burrow or under any available debris. Or they may go out onto a limb, cross to an adjoining tree, and suddenly stop, crouch, and remain motionless. In this position, they often can be slowly and carefully approached and picked up. They seem reluctant to move. Such behavior appears to be a protective adaptation because their reddish pelage blends into the dimly lighted surroundings so well that they are difficult to see when not in motion. In this respect, their small size also seems to be a decided advantage. During twilight hours a motionless tree vole is almost impossible to see among the branches of a fir, spruce, or hemlock tree because red is one of the first colors to fade or become neutral as darkness approaches. (One can test this by going out during twilight with pieces of cloth, blue and red, mixing them up, and as the light fades, trying to select the red cloth.)
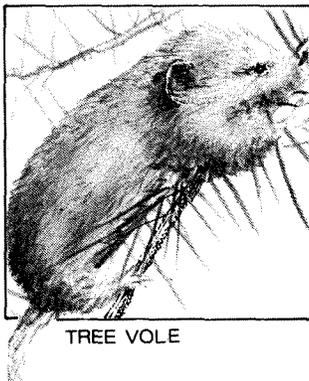
Some tree voles, usually adults, launch themselves into space instead of going onto a limb or down the trunk. Although many have their falls broken by lower limbs to which they are adroit at clinging, others merely "free-fall" to the ground. In so doing, they almost invariably land on their feet-uninjured. During free-fall, they spread their legs out, much as do "flying" squirrels, appearing to use their tails for balance. Tree voles, however, just fall straight down. They have been observed to fall for 15 to 18 meters, land, and head for the nearest cover. Age, and perhaps a degree of learning, seems necessary before such a feat can be accomplished successfully, since young voles seldom land on their feet. They appear to lack the ability to spread their legs and do not seem to have control of their tails; thus, they land on their backs.

Food: Douglas-fir needles are the chief food of the red tree voles throughout their geographical distribution, but they also eat the needles of grand or lowland white fir, Sitka spruce, and western hemlock. In addition to the needles, they eat the tender bark off the twigs, and some individuals split the twigs open, apparently to obtain the pithy center.

Twigs are cut by a vole during its nightly twig-gathering forays. Some feeding is done away from the nest, but the nest seems to be the main dining area, both in it and on top of it. Twigs, 2.5 to 23 centimeters long, are cut and carried to the nest by the vole; the bulk of them are stored on top the dwelling. Other, shorter twigs are often partially or completely pulled into the nest and stored in the tunnels.

A tree vole bites the needles off near their bases, one at a time. Holding a needle with one forefoot or both forefeet, a vole rapidly and mechanically "strips" off one of the resin ducts with its incisors, flips the needle over, strips off the other resin duct, and then consumes the remainder of the needle. Young, tender needles are often eaten entirely. Although a vole spends much of the day sleeping, it periodically arouses and goes to the store of food for a snack.

Tree voles probably obtain most of their moisture requirements from their food, but they also lick dew and rain off the needles of coniferous trees in the vicinity of their nests. See Maser (1965b) for a more detailed discussion of the food habits of red tree voles.

Reproduction: Except when a female is receptive, male and female red tree voles lead separate lives, each having its own nest. The large, relatively permanent nests usually are "nursery nests" occupied by females and their offspring. Normally a nursery nest contains a single litter at one time, but occasionally two litters, of two different ages, occupy a nest simultaneously. Tree voles breed throughout the year. Females usually breed within 24 hours after giving birth. Litters range from one to four young, but two to three babies is the usual size.

The young are naked, blind, and helpless at birth; they develop more slowly than do the ground-dwelling members of the vole family. They do not appear to leave the nursery nest until they are a month or more in age, at which time they construct their own nests. There would seem to be a definite survival advantage in slow development of tree voles. By leaving the nursery nest at a more advanced

age, they have relatively good balance in addition to more self-sufficiency. Extensive wandering outside a nest before they are adequately developed would increase accidental mortalities-such as fatal falls-and predation.

Predation: The northern spotted owl is the main predator of red tree voles throughout their geographical distribution (Forsman 1976); however, saw-whet owls (Forsman and Maser 1970) and long-eared owls (Reynolds 1970) also prey on these voles. In addition, the Steller jay and, in some areas, the racoon and marten, are potential predators,

Besides predation, there are three sources of mortality, other than disease and old age-storms, forest fires, and logging. Severe storms often destroy nests, undoubtedly killing some voles. Forest fires and logging operations take the greatest toll of tree vole populations in specific areas. Since red tree voles seldom inhabit trees under 25 years of age, clearcut logging decimates entire populations and is responsible for the disappearance of tree vole populations in many areas and, in large measure, for their widely scattered present distribution.

Economic status: Red tree voles have not been found to damage trees (on which they depend for their livelihood) or their seeds. Therefore, these voles are not economically detrimental.

Selected references: Johnson (1973), Maser (1965b). There are several references on tree voles in California, but they refer to a sibling species that was originally thought to be the same species as the red tree vole in Oregon. Some of these references are: Benson and Borell (1931), Hamilton (1962), Howell (1926), Taylor (1915). The species of tree vole in California is being evaluated and described by Dr. Murray L. Johnson, Museum of Natural History, University of Puget Sound, Tacoma, Washington.

Genus *Microtus:* Small-eared voles

Derivation: The generic name Microtus has the same meaning as the familial name.

General description: Voles of the genus *Microtus* vary greatly in size. The length of the head and body ranges from about 8.5 to 17.5 centimeters; the length of the tail, from 1.5 to 11.5 centimeters. Small-eared voles weigh up to 128 grams. Their pelages are usually fairly long and lax. The general color of the upper parts is grayish brown, but the darker members of the genus are blackish and the lighter members more reddish or yelfowish. Their underparts range from grayish through light brownish to whitish. They have small eyes, and their ears normally are concealed in the body hair.

Small-eared voles do not hibernate; they may be seen at any time. Most species make well-defined, often elaborate, runways through and under low vegetation. Where ground cover is scant, they may dig extensive underground burrow systems. A used runway appears to be a neat path with all the vegetation clipped to the ground; an abandoned runway, however, usually has vegetation growing in the middle and looks unkempt. Small-eared voles do not walk along these runways—

they dash. When observed, they seemingly are as programed to their runways as a slotcar is to its track. When startled, a vole may emit a high-pitched squeak, gnash its teeth, and either flee or "freeze," depending on its location and previous activity.

Small-eared voles are promiscuous breeders. Females may begin mating when about 3 weeks old and produce up to 13 litters per year, usually ranging from four to eight young per litter. The gestation period is about 21 days. In the southern part of their range, they breed throughout the year, but breeding in the northern portion is limited to the summer months. The amount of daylight probably limits breeding in winter. Young are weaned at about 2 weeks and are thought to live for a little more than a year in the wild.

World distribution: Small-eared voles occur throughout most of North America south to Guatemala and throughout most of the northern two-thirds of Europe and Asia.

General references: Maser and Storm (1970), Walker et al. (1968).

Species *Microtus townsendi:* Townsend vole

Derivation: The specific name *townsendi* is a proper name; this vole probably was named in honor of J. K. Townsend. The first specimen was obtained on the "Lower Columbia River," near the mouth of the Willamette River, according to Bailey (1936), "on or near Wapato or Sauvie Island." The species was described in 1839. John Kirk Townsend, primarily a naturalist, was in charge of the hospital at Fort Vancouver the winter of 1835-36 (Johnson 1943).

Specific description: Total length, 169 to 238 mm; tail, 48 to 85 mm; hind foot, 20 to 28 mm; ear, 14 to 20 mm; weight, 42 to 103 g.

Townsend voles have harsh pelages. The dorsum is dark brown to dark reddish brown in summer and dark brown to blackish brown in winter. There are many black-tipped guard hairs mixed in the dorsal fur. The venter is grayish to grayish brown. The tail is blackish to black above, a little lighter below; the feet are gray to dark gray above.

Distribution along the Oregon coast: Townsend voles occur along the coast as far south as the vicinity of Port Orford, Curry County. Sherrell (1970) obtained Townsend voles 13 kilometers south of Port Orford. I trapped south of Port Orford to the California border but did not find any of these voles. Farther inland, however, the Townsend vole's distribution extends into California.

Habitat: The Townsend vole primarily occupies the deflation plain, willow/sedge marsh, wet pastureland, and tideland river habitats. They are occasionally found in the riparian alder/small stream habitat when sufficient grassy meadow exists along the edge of it.
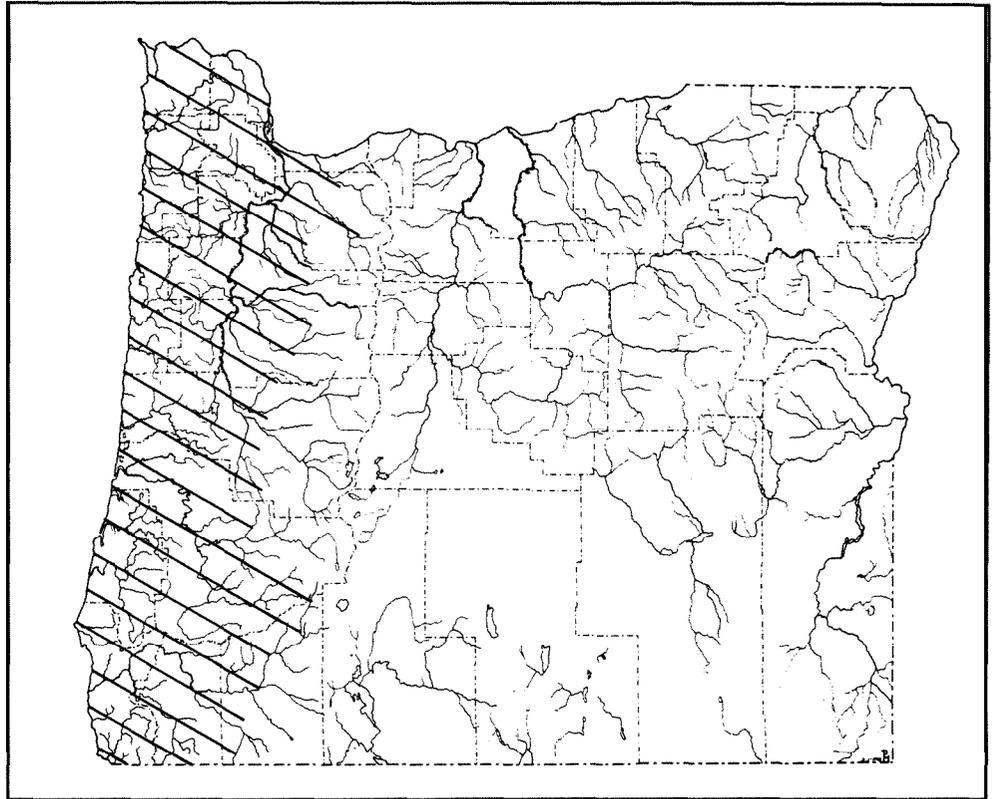
KNOWN DISTRIBUTION OF TOWNSEND VOLE

Habits: Although Townsend voles are often abundant, little is known about them. They normally are inhabitants of rank grasses, rushes, and sedges. Along the edges of lawns, where adequate protective cover is lacking, they have extensive underground burrows with the entrances close together. These large voles are active at any time and are highly dependent on their runways and burrows. In areas that are free of winter flooding, the same runways may be used by several generations of voles, eventually being worn into ruts 2.5 to 5 centimeters or more deep.

Townsend voles are good swimmers and divers. They readily enter the water when pursued. Along the coast, they swim across small streams with ease. Voles inhabiting the deflation plain habitat often had the entrances of their burrows under water. Their nests were located within the small hummocks that protruded above the standing water. Although some of these deflation plains dry out in the summer, others are flooded throughout the year; nevertheless, Townsend voles inhabit them. These voles were also found in the salty areas of thick vegetation along the edges of the mouths of some rivers.

Food refuse and droppings are often found in their runways. Heaps of droppings form at runway intersections that are used continuously. After repeated deposition of feces, these heaps reach 15 to 18 centimeters in length and 5 to 8 centimeters in width; some may attain 13 centimeters in height and resemble a road overpass in shape (Maser and Storm 1970).

During the drier portion of the year, Townsend voles usually construct their nests underground, but during the winter with its high water table, these voles often locate their round, grass nests on the ground, frequently on high points.

Food: Townsend voles are vegetarians, eating the succulent stems and leaves of a wide variety of green plants: velvet grass, horsetail, and cattail (Dalquest 1948); clovers and alfalfa (Bailey 1936, p. 207); rushes and blue-eyed and purple-eyed grasses-both irises (Maser and Storm 1970). Along the coast, Townsend voles also ate false dandelion, sedges, buttercups, other forbs, and grasses. Couch (1925) discovered that these large voles store food in "caches" under protective cover. The caches were simply piles of gathered food; one cache contained 13.2 liters of mint roots. These voles occasionally eat the bark of young trees, killing them.

Reproduction: Townsend voles inhabiting lowlands apparently breed throughout the year. Litters range from 2 to 10 offspring, but the usual number is from 4 to 6 per litter, at least along the Oregon coast. Babies are naked, blind, and helpless at birth. They are born in warm, dry nests made of grasses.

Predation: Owls and hawks probably are the main predators of Townsend voles. Bobcats, foxes, coyotes, weasels, mink, skunks, and snakes also take a toll. In the marshy areas near the mouths of the large rivers along the Oregon coast, great blue herons often hunt Townsend voles. The herons appear to stab the voles with their long beaks as the voles dash along their runways. Domestic cats and people also kill many of these voles.

Economic status: Townsend voles eat the bark of seedling Douglas-fir and ponderosa pine (Maser and Storm 1970), as well as various orchard trees. These voles tend to girdle the seedlings near the ground, killing many of them. During years of high populations, the voles cause considerable damage to seedlings and other crops that they include in their diet.

One of the first things I heard when I arrived on the Oregon coast to study the mammals was about the "bog rats." The "bog rats" range from 12.5 centimeters to well over a meter in length and had either long tails or extremely short tails. They are good swimmers and divers. The "bog rats" inhabiting the cranberry bogs along the southern coast are Townsend voles. They were often seen swimming and diving when the cranberry bogs were flooded in October to float the berries to one end of a bog to harvest them. One cranberry grower told me that his "bog rats" had tails of various lengths; I suggested that these differences in length were likely the results of his cat! Nevertheless, Townsend voles do damage cran- berry bogs by eating their way through the plants and by burrowing into the bogs along the banks of ditches. On the other hand, these voles are an important source of food for beneficial wildlife.

Selected references: Bailey (1936), Couch (1925), Dalquest (1940b, 1948), Goertz (1964), Howell (1919).

Species *Microtus longicaudus:* Long-tailed vole

Derivation: The specific name *longicaudus* is derived from the Latin words *longus* (long) and *cauda* (tail). There are two subspecies of *longicaudus* along the Oregon coast—*abditus* and *angusticeps.* The first specimen of *abditus* was captured at Pleasant Valley, 12.8 kilometers south of Tillamook, Tillamook County, Oregon, on September 8, 1920. The subspecies *angusticeps* was first caught at Crescent City, Del Norte County, California, in 1889.

Specific description: The subspecies of long-tailed voles that occur along the Oregon coast are quite different-abditus is large, whereas *angusticeps* is small. *Abditus* measures: Total length, 186 to 265 mm; tail, 68 to 115 mm; hind foot, 24 to 29 mm; ear, 13 to 21 mm; weight, *36* to *87 g. Angusticeps* measures: Total length, 152 to 187 mm; tail, 51 to 75 mm; hind foot, 20 to 24 mm; ear, 12 to 19 mm; weight, 22 to 47 g.

The pelage is relatively short and coarse. The back varies from grayish brown to brown to dark brown. There are many black-tipped hairs mixed in the dorsal pelage. The sides are slightly lighter, and the venter is gray to dark gray-sometimes washed with white or light brown. The tail is distinctly or indistinctly bicolored, brownish to blackish above, whitish, grayish, or brownish below. The tops of the feet vary from grayish to dark grayish or from brownish, dark brownish, to blackish.

Distribution along the Oregon coast: The long-tailed *vole Microtus longicaudus abditus* occurs from the Columbia River in Oregon south to about Reedsport, Douglas County. The long-tailed vole *Microtus longicaudus angusticeps* occurs from 8 kilometers north of Port Orford, Curry County (Sherrell 1970) south into California. No long-tailed voles are known to occur in the area between those occupied by the two subspecies.

Habitat: Although the long-tailed vole *abditus* occupies the riparian alder and willow/sedge marsh habitats, it undoubtedly occurs in other habitats as well. On the other hand, the long-tailed vole *angusticeps* primarily occupies the headland prairie and headland shrub habitats but also occurs in the riparian hardwood habitat provided there are enough grassy areas. Grassy areas appear td be an important component of the habitat requirements of *angusticeps.*

Habits: The occurrence and abundance of long-tailed voles in western Oregon vary greatly-abditus more than *angusticeps.* Little is known about the habits of long-tailed voles in Oregon, particularly about these subspecies.

Abditus is more active at night than during the day and does not make runways readily. *Angusticeps* is active at any time and makes well-defined runways. Both of these long-tailed voles occasionally occur with the Townsend vole, which is more aggressive and, therefore, usually more common.

Food: Little is known about the diet of long-tailed voles except that both subspecies eat green vegetation.
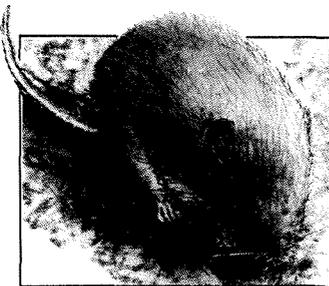
LONG-TAILED VOLE
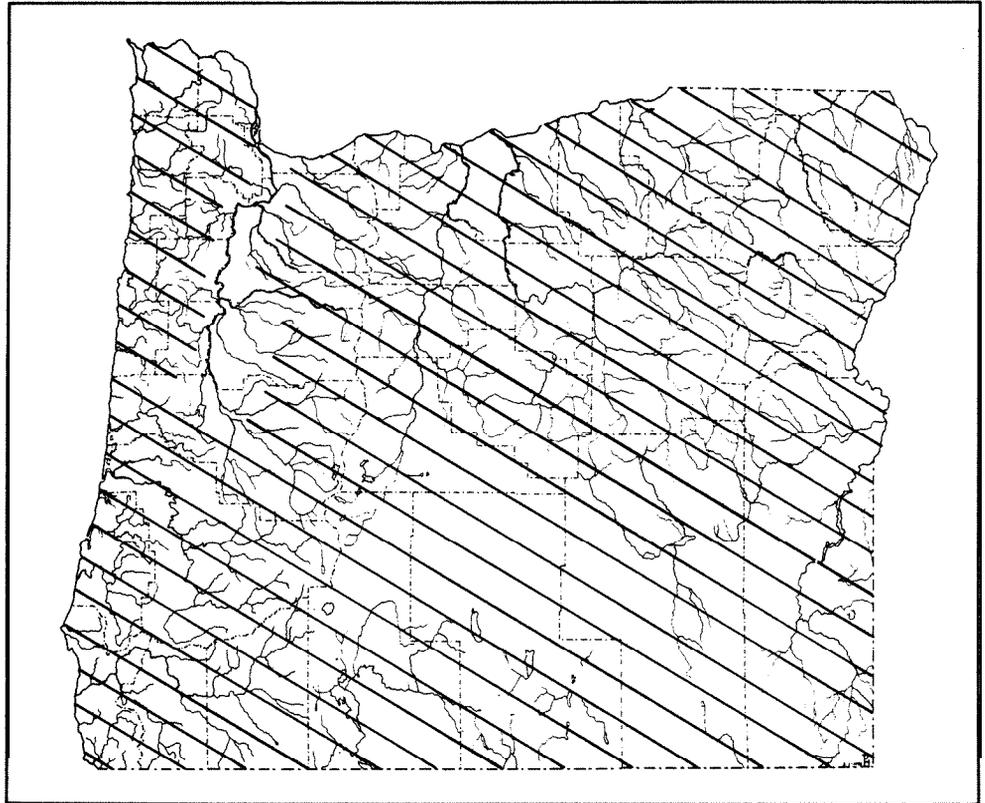
KNOWN DISTRIBUTION OF LONG-TAILED VOLE

Reproduction: Male long-tailed voles are sexually active from February through October. Pregnant females have been captured from March through November. Litters range from 2 to 10 offspring, but 3 to 6 young appears to be the usual size of a litter.

Predation: Little is known about predation of these voles in Oregon, but domestic cats do prey on the long-tailed vole.

Economic status: In Oregon, long-tailed voles are not detrimental enough to human's interests to be economically important.

Selected references: Bailey (1936), Beck and Anthony (1971), Dalquest (1948), Howell (1923).

Species *Microtus oregoni*: Oregon or creeping vole

Derivation: The specific name *oregoni* is a proper name. The first specimen of this vole was captured at Astoria, Clatsop County, Oregon, in 1836; the vole was named after the State of Oregon.

Specific description: Total length, 120 to 156 mm; tail, 30 to 52 mm; hind foot, 14 to 21 mm; ear, 9 to 14 mm; weight, 14 to 31 g.

Oregon voles have tiny eyes and long, thick, soft pelages. Dorsally, the pelage varies from grayish or yellowish brown to reddish or blackish brown. Ventrally, the underfur is gray washed with whitish or light brown. Their tails are indistinctly bicolored, brownish to blackish above, dark to light gray below. The feet of most individuals are grayish on top, but some are white. Juveniles are more gray or black in overall coloration.

Distribution along the Oregon coast: Oregon voles occur along the entire coast.
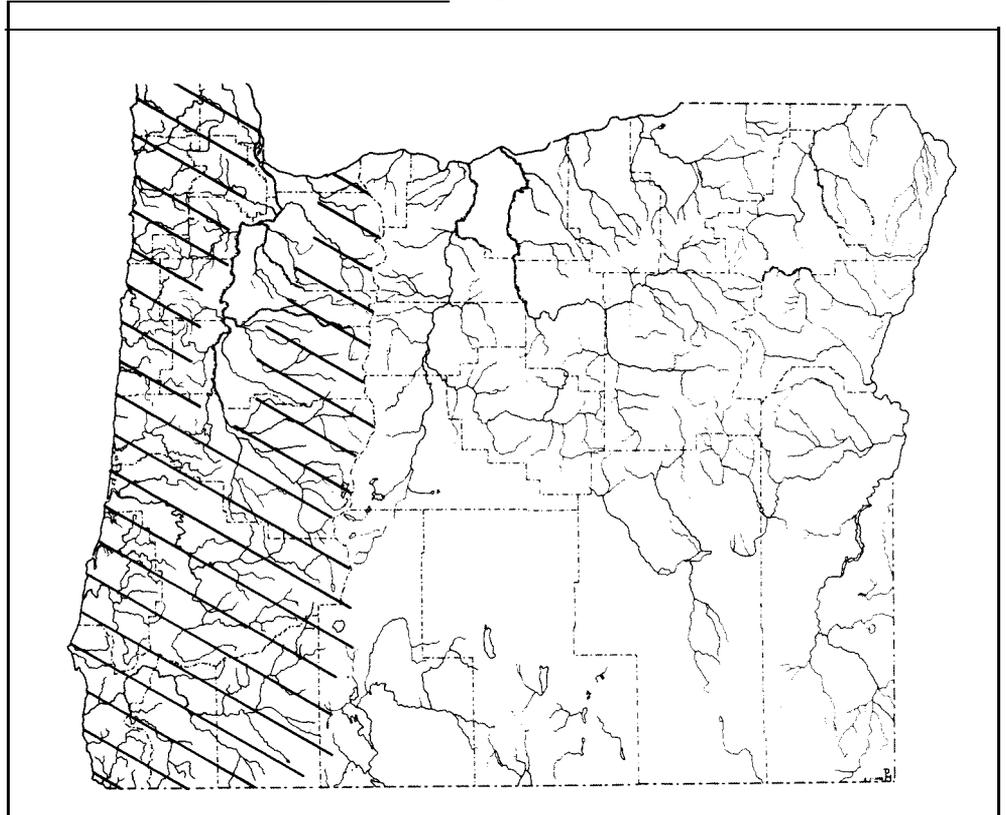
KNOWN DISTRIBUTION OF OREGON VOLE

Habitat: Oregon voles occupy the mature conifer, immature conifer, alder/salmon-berry, riparian alder, Sitka spruce/salal, and tanoak habitats. They are occasionally found in the riparian hardwood, deflation plain, stabilized dunes, lodgepole pine/rhododendron, lodgepole pine/salal, wet pastureland, headland prairie, and mountain river habitats.

Habits: Oregon voles are more accurately called "creeping voles" because they appear to creep when they move. These little voles have tiny eyes and slightly curved claws; they are primarily burrowers in the mellow soils of developing forests. Gashwiler (1972) found that these voles were generally more abundant in areas where the timber had been totally removed (clearcut), even during the early stages of plant growth, than in the virgin forest. The populations of voles increased on the clearcut areas until 4 years after the areas had been burned to remove excess debris from logging operations. There was no consistent relationship, however, between the age of the clearcut area and the abundance of voles. Goertz (1964) also found Oregon voles more abundant in clearcut areas than in virgin timber.
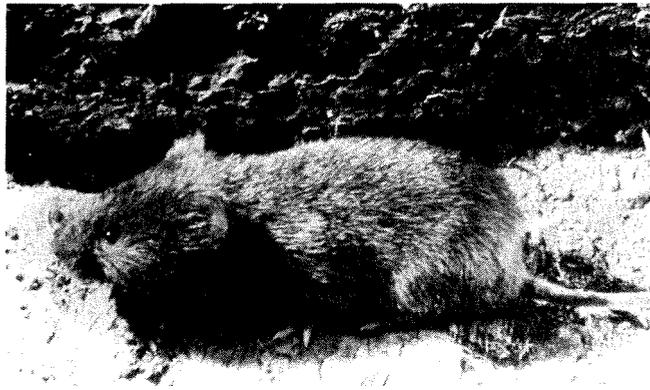
Photo courtesy Douglas Ure

These voles appear decidedly "uncomfortable" when they are exposed. In captivity they seem to prefer protective cover low enough that their backs are in almost constant contact with it. It is not surprising, therefore, to find them closely confined to such protective cover as logs and dense vegetation. Along the coast, Oregon voles inhabit a few of the drier meadows provided they are close to the forest and have enough dead grass to afford cover over the voles' runways. In such meadows, they can occasionally be seen during the day along their runways. Although active at any time, they are more active at night.

Gashwiler (1972) found that the largest average home range of the Oregon vole was 0.12 hectare. In addition, the longest average home range was 67.6 meters, both occurring at onset of the breeding season. An average summer home range was 0.04 hectare and 32.9 meters long. Whereas the summer home range was the smallest, in autumn and winter both size and length of home ranges were intermediate. Gashwiler stated that adult males had the largest average home range (0.09 hectare) and range length (54.3 m), followed by juvenile males (0.08 ha and 46 m), adult females (0.06 ha and 33.5 m), and juvenile females (0.05 ha and 30.5 m). He thought (p. 565) Oregon voles were "relatively mobile animals"-their home ranges seemed to increase in size the longer they lived, those of adult males by 41 percent and those of females by 31 percent from the first time until the last time they were captured-a span of 5 months. According to Gashwiler, the majority of these voles probably visit most of their home range within a 5-month period.

Although Oregon voles normally construct their small round nests underground, nests are occasionally found above ground inside rotten logs and stumps or under such things as large slabs of bark and boards. Nests are made of grasses but apparently are not lined inside with finer materials.

Food: Little is known about the food habits of Oregon voles. They eat green vegetation and some huckleberries but also substantial amounts of a variety of underground fungi (Maser et al. 1978) which is not surprising since they are burrowers.

Reproduction: Gashwiler (1972) found that the Oregon voles he studied were sexually active from February through September:

Males		Females	
Month	Percent	Month	Percent
February	75	March	75
March	33	April	88
April to June	loo	May	50
July	50	June and July	100
August and September	100	August	50
		September	100

He determined that the average breeding season spanned about 7 months. On the other hand, I have records of pregnant voles in December, January, and February, indicating that at least some voles breed throughout the year.

Females bear four or five litters annually; the average is 4.8 litters. A litter ranges from one to eight young but usually consists of three offspring (Gashwiler 1972). Cowan and Arsenault (1954) determined that the average gestation period was 23.8 days. At birth Oregon voles are naked, blind, and helpless. Females reach puberty at 22 to 24 days, whereas males do not become sexually mature until 34 to 48 days of age. After puberty is reached, both sexes have a period of sterility that lasts from 5 to 14 days. Cowan and Arsenault (1954) observed that Oregon voles that attained adult size and age later than July did not breed until the next year.

Predation: Owls and weasels are the main enemies of Oregon voles; however, snakes, marten, spotted skunks, mink, coyotes, foxes, bobcats, and domestic cats also prey on them. Humans, at least in the past, may have taken a considerable toll on these voles by spreading poisons over thousands of hectares of commercially important timberlands to control various rodents.

Economic status: Oregon voles may consume some seeds of commercially important trees, but present studies of food habits of individuals caught in the wild indicate that these voles are not economically important in a detrimental sense (Maser et al. 1978).

Selected references: Cowan and Arsenault (1954), Gashwiler (1972), Goertz (1964), Taylor (1919).

Genus *Ondatra*: Muskrats

Derivation: The generic name *Ondatra* is a North American Indian name for "muskrat."

General description: Muskrats are the largest voles in the world. The length of the head and body ranges from 22.9 to 32.5 centimeters and the length of the tail from 18 to 30.7 centimeters. Adults weigh from 0.54 kilogram to 1.816 kilograms. The pelage is composed of two types of hair-underfur and guard hairs. The underfur is short, thick, fine, and very soft, whereas the guard hairs, which are interspersed throughout the underfur, are long, coarse, dark, and shiny. It is the long guard hairs that produce the dominant coloration of the back and sides. The throat, chest, and belly are dominated by the underfur and are lighter in color and duller because there are few shiny guard hairs. Although a muskrat's upper parts are usually dark-varying from "silvery" brown, reddish brown, dark brown, to black-an occasional individual is whitish. A muskrat's underparts are the same general color as the back and sides and may be very light to fairly dark.

Muskrats are well adapted for swimming. They have "swimming fringes" of short, stiff hairs along the margins of each hind foot, including the webs between the toes. These fringes increase the surface area of the feet and aid in propelling the animals through the water. Their scaly, almost hairless tails are vertically flat and act as rudders.

Muskrats get their name from the pronounced, sweet, musky odor from the secretion of glands in the anal area.

These aquatic voles live in lakes, ponds, marshes, roadside ditches, irrigation ditches, rivers, and streams. They either construct houses of vegetation in open water or dig burrows in banks. They are expert swimmers and divers and eat a wide variety of vegetation and some meat.

In the northern portions of their geographical distribution they breed from early spring to autumn, but in southern areas they breed throughout the year. Most young, however, are born from November to April. After a gestation period of 22 to 30 days, from 1 to 11 youngsters are born. A female breeds again while she is still nursing; several litters are produced annually. Young are weaned when they are about 1 month old.

Muskrats are widely trapped for their pelts, and North American fur trappers make more money selling muskrat pelts than any other fur.

World distribution: There are two species of muskrats. One species, *obscurus,* is confined to Newfoundland. The other species, *zibethicus,* occurs from Alaska to Labrador, south to Texas and northern Baja, Mexico, and from the Pacific coast **east** to the Atlantic coast, but is absent from Florida and most of California. Although native to North America, this wide ranging species of muskrat has been extensively introduced into Europe.

General reference: Walker et al. (1968).

Species *Ondatra zibethicus:* Muskrat

Derivation: The specific name *zibethicus* is derived from the Greek word *zibeth* (the civet) which gave rise to the New Latin word *zibethicus* (civet- or musty odored). The subspecies *occipitalis,* the only subspecies found in western Oregon, was first described from a specimen caught at Florence, Lane County, Oregon, in 1901.

Specific description: Total length, 409 to 620 mm; tail, 180 to 307 mm; hind foot, 64 to 90 mm; ear, 18 to 35 mm; weight, 0.541 to 1.575 kg.

The muskrat has small eyes and small ears; the ears are nearly concealed in the pelage. There is a swimming fringe on each hind foot. The long, almost naked, scaly tail is vertically compressed. The pelage is composed of thick, soft, underfur and long, coarse, shiny guard hairs. Dorsally, the pelage varies from glossy dark brown to almost black, becoming more reddish brown on the sides. Ventrally, the pelage is light reddish brown across the chest and belly but light gray on the throat and anal areas.

Distribution along the Oregon coast: Muskrats occur along the coast from the Columbia River, Clatsop County, south (Sherrell 1970), at least to the Pistol River, Curry County; also see Wood (1974).

Habitat: Muskrats occupy the coastal lake and tideland river habitats, and to a lesser extent, the mountain river habitat. Occasionally they are found in the riparian alder/small stream, riparian alder/large stream, and willow/sedge marsh habitats. They also occupy human-made habitats, such as reservoirs, roadside ditches, and irrigation ditches. Muskrats occur in appropriate habitat throughout the State.

Habits: Muskrats are active throughout the year. Although they may be seen at any time, they are mainly active at twilight and throughout the night. Muskrats are not particularly sociable, even with one another. They are quiet mammals, both vocally and in motion, seldom attracting attention by making noise. When startled, however, they enter the water with a loud splash and may swim a long distance under water before coming to the surface.

On warm, sunny days, a muskrat may sun itself on a bank. In July 1971, I observed a muskrat, apparently sunning itself, on the leaning trunk of a large willow tree '4.6 meters above the Coquille River in Coos County, Oregon. On being disturbed, the muskrat leaped into the water and disappeared.

In western Oregon muskrats seldom build the conical or dome-shaped houses of vegetation for which they are famous throughout most of their geographical distribution. Instead, they dig burrows into the banks of whatever water they are inhabiting. These bank-burrows are evident where muskrats are living in "tidewater" near the mouths of rivers, such as the Salmon River, in Lincoln County, Oregon. When the tide goes out, many of the burrow entrances are exposed until the tide comes in again. A bank-burrow may be simply a burrow leading into an enlarged chamber that is the living quarters, or there may be a series of chambers and tunnels. In some instances, a bank is so riddled by tunnels and chambers that it

might collapse if a person stood on it. Dalquest (1948) found that burrow entrances usually entered a bank from 15 to 38 centimeters below the surface of the water, but some were as deep as 0.9 meter below the surface. Burrows were 12.7 to 20 centimeters in diameter and from 1.8 to 9 meters in length, terminating in a spherical nest chamber 30.5 to 38 centimeters in diameter. The nests proper were composed of bulky, loose masses of cattail leaves.

East of the Cascade Range in Oregon, muskrats may construct bank-burrows or houses of vegetation, depending on the depth of the water and the home range of the individual. A muskrat house is built in shallow water and is supported by a broad base resting on the bottom. It is built from leaves, stems, and roots of plants, as well as mud, and may extend 1 meter to even 1.5 meters above the water. A single chamber in the middle of the house just above the water can accommodate six to eight individuals. The walls of a house, although frequently 30 centimeters thick, are porous enough to maintain a sufficiently ventilated interior, even when covered by snow. There are usually two or three underwater entrances leading into the living quarters (Bailey 1936, Jackson 1961).

Little is known about the muskrat in Oregon. Because of its economic importance as a fur-bearing mammal, however, many studies have been made of the various aspects of its life history throughout much of its geographical distribution-see the selected references.

Food: Muskrats eat a wide variety of plants. In Oregon they eat such plants as cattails, rushes, sedges, skunkcabbage, pondweeds, water lilies, deerfern, and swordfern. In addition to plants, muskrats occasionally eat small turtles, freshwater snails and clams, crawfish, fish, and some salamanders (Bailey 1936, Hollister 1911, Jackson 1961). Dalquest (1948) found that muskrats along Puget Sound, in Washington, even ate marine mussels.

MUSKRAT

Reproduction: In Oregon adult male muskrats with enlarged, descended testes have been trapped from March through November. Reproductively active females have been captured from May to October. The usual size of a litter is 6 to 8, but Bailey (1936) recorded as many as 13 embryos in one female and I have a record of a female's having given birth to 15 young. Jackson (1961, p. 248) stated that in Wisconsin the averge size of a litter is 7 or 8 young, but litters may range from 2 to 16. "A single pair will raise at least two, and sometimes as many as three or four litters in a year, and under very favorable conditions may raise 16 to 20 young in one season."

The gestation period is about 29 days. At 2 weeks of age the youngsters can swim, dive, and eat green vegetation. Although young muskrats grow rapidly, they do not breed until the year after their birth (Jackson 1961).

Predation: Mink are the principal enemies of muskrats, but red fox, coyotes, bobcats, otter, and great horned owls also prey on them[14] (Brodie and Maser 1967, Jackson 1961).

[14] C. Maser. Unpublished data on file at Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington.

Muskrats fall victims to accidents and diseases, as well as to predation. For example, Kebbe (1955) reported finding 287 dead muskrats on a 53-kilometer stretch of highway near Klamath Marsh, Klamath County, Oregon. Bailey (1936, p. 217) gave an account of mass muskrat mortalities:

> In the winter of 1914-15 for some unknown cause most of the muskrats left the lake [Malheur Lake, Harney County, Oregon] as soon as it froze over and scattered out for miles over the sagebrush valley where they died and were killed by hundreds. They were poor and possibly diseased, but more probably starving, as their regular food supply had been destroyed by unusually high water that summer. Many of the ranchers killed 100 or more of the animals around their places and found others dead in the sagebrush, on the ice, and even in Spring Creek, which never freezes. Many thousands were estimated as killed outside of the lake, and many more died that were not recovered.

Economic status: Economically, the muskrat is one of our most valuable native mammals. Thousands of these large voles are trapped annually for their pelts and flesh. The pelts are made into garments, and the flesh is eaten. Many muskrat carcasses are sold in food markets in eastern cities, usually under the name of "marsh rabbits." Jackson (1931, p. 251) stated that "The final money distribution value will average not less than $100,000,000 annually. . . ." Undoubtedly the annual value of muskrats has averaged higher in recent years.

Although I do not know the average price per muskrat pelt for the 1972-73 trapping season, a total of 37,468 pelts was reported to have been taken in Oregon. During the 1971-72 trapping season, 23,584 muskrat pelts were sold at an average price of $1.27 for a total of $29,951.68. Furthermore, in Oregon, over the 20-year period from the 1952-53 trapping season through the 1971-72 trapping season, 732,986 muskrat pelts were reported to have been taken. In this time, the price per pelt fluctuated from $0.55 to $1.27, averaging $0.87 per pelt; the pelts brought $635032.89 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a).

When the economic value of muskrats is considered, the damage they may cause is comparatively minor. Perhaps most of the damage is caused by their digging holes into irrigation ditches, allowing the escape of the water which, in turn, may weaken or break down the banks of the ditches.

Diseases: Muskrats are susceptible to tularemia, a bacterial disease that is highly infectious to humans (Jellison 1970). In addition, they are occasional carriers of the parasitic roundworm *Trichinella spiralis* that causes trichinosis in humans (Harley 1972); therefore, muskrats should be thoroughly cooked before they are eaten.

Selected references: Anderson (1969), Cosgrove et al. (1968), Dozier (1950), Errington (1963), Grundmann and Tsai (1967), Hansen (1965), Johnson (1925), Judd (1970), Karstad et al. (1971), Kelsall (1970), Knight (1951), Paul et al. (1972), Pelikan et al. (1970), Peterson (1950), Sather (1958), Seton (1928), Svihla and Svihla (1931a), Winecoff (1933), Wood (1974).

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Family Muridae:
Old World Rats and **Mice**

Derivation: The familial name Muridae is derived from the Latin word *murinus* (mouselike) and the Latin suffix *idae* (family).

General description: Old World rats and mice are often referred to as "murid" rodents or "murids." They range in total length from about 11.1 to 80 centimeters and weigh from 5 to 1 500 grams. The tail is usually naked and scaly; in a few climbing members of this family, it is semiprehensile. Members of one genus have hairy tails. The feet of murid rodents have naked soles. Tree-dwelling forms have opposable first digits on the forefeet or hind feet, with nails on some of the digits instead of claws. A few members of the family have cheek pouches. Some have spiny pelages.

The habitats and habits of murid rodents vary greatly. Some murid rodents are terrestrial and usually are good climbers; others burrow, dwell in trees, or are semiaquatic. A few species hop and jump. These rodents live in tunnels, hollow logs, crevices, holes in the trunks of trees, abandoned nests of birds, or buildings made by people. Some species construct their own abodes of sticks. Murids are active day or night. They may be gregarious, living in groups or colonies, or they may live in a family group, as a pair, or alone.

Most murids eat plants and invertebrates; some include small lizards, snakes, and the eggs and nestlings of birds in their diets. The semiaquatic members of the family feed extensively on mussels, crustaceans, snails, and fish, whereas those that live in close association with humans eat almost anything. Although murid rodents are not known to hibernate, some store food, presumably for use during the winter.

Gestation periods range from 18 to 42 days. The size of litters varies from 1 to 22. In the warmer parts of their geographical distribution, most murids breed throughout the year, often with several reproductive peaks. Most individuals in the wild live less than 2 years, and many less than 1 year. In captivity, they may live longer; one individual lived for 6 years 8½ months.

World distribution: The natural geographical distribution of this family is Africa, Europe, Asia (except in the extreme north), the Malayan region, Australia, Tasmania, and Micronesia. Through introduction by humans, however, the genera *Rattus* and *Mus* are nearly worldwide in distribution.

Fossil record: The family Muridae is believed to have emerged late in the Miocene. The geological range of this family is the Pliocene in Europe and Asia, the Pleistocene in Australia, and the Recent in Africa, and throughout the world after introduction by humans.

Number of species along the Oregon coast: Three.

General references: Anderson and Jones (1967), Walker et al. (1968).

Special note: Since the members of this family are not native to North America and were not an integral part of my study, my sketches of their life histories are brief.

Genus Rattus: Old World rats

Derivation: The generic name Rattus is the Latin word for rat.

General description: The genus Rattus is difficult to define; it has more named species and subspecies than any other genus of mammals-about 570. They range in head and body length from 8 to 33 centimeters. The tail may be shorter or longer than the head and body and is usually scantily haired. In some species the pelage is soft and in others it is coarse; still other species have the hairs enlarged and stiffened into bristles or spines. The upper parts are black, grayish, dark brown, yellowish brown, or reddish brown, and the underparts are usually gray or white. External appearance differs greatly. The body may be stocky or slender. Certain digits are short in members of some species but long in others. The feet of some members of the genus are modified for a terrestrial existence, others for an arboreal existence.

In most members of this genus, the gestation period varies from 21 to 30 days. Most species are prolific breeders, and at times a population may increase to "plague" proportions. Such drastic increases in populations are caused, in part, by human removal of the natural enemies of the species by altering the habitat of predators.

Except for the black rat and the Norway rat, most species should not be considered serious pests.

World distribution: The genus Rattus has the largest number of species living in tropical southeastern Asia and Africa, but some members of the genus are found in nearly all parts of the world and in practically all terrestrial habitats.

General reference: Walker et al. (1968).

Species Rattus *rattus:* Black rat

Derivation: The specific name *rattus* has the same meaning as the generic name.

Specific description: Total length, 325 to 455 mm; tail, 160 to 255 mm; hind foot, 30 to 40 mm; ear, 18 to 28 mm; weight, 115 to 350 g.

There are two subspecies of the species *rattus* along the Oregon coast—*Rattus rattus rattus* (black rat) and *Rattus rattus alexandrinus* (roof rat). Their pelages are coarse and harsh, with long spinescent hairs. Dorsally, they vary from grayish brown to gray to black; and ventrally from whitish to yellowish white to gray. Their tails are long, slender, and nearly naked. Their ears and the soles of their feet are naked.

Distribution along the Oregon coast: The species *rattus* has been captured at Netarts Bay, Tillamook County (Bailey 1936); 11.2 kilometers south of Florence, Lane County (Pimentel 1949); Tahkenitch Lake, Douglas County (Pimentel 1949); Empire, Coos County (Bailey 1936); Bandon, Coos County (this study). Undoubtedly they can be found along most of the coast.
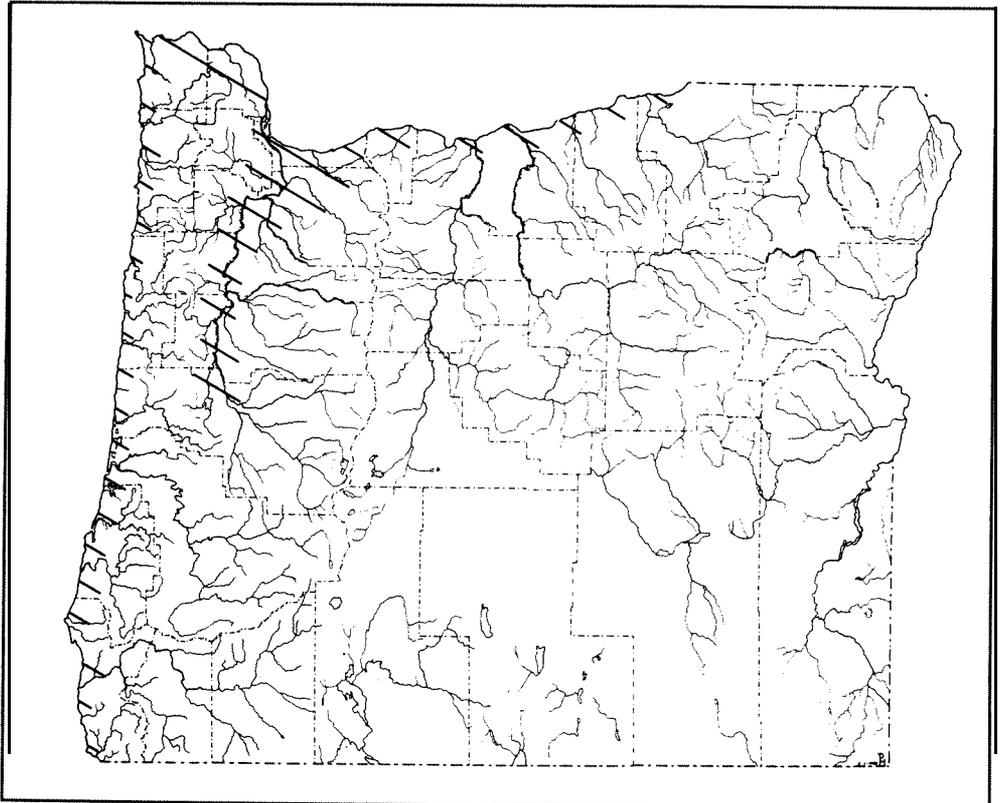
KNOWN DISTRIBUTION OF BLACK RAT

Habitat: These rats have been captured in towns as well as in the riparian alder/
small stream, lodgepole pine/rhododendron, lodgepole pine/salal, Sitka spruce/
salal, and willow/sedge marsh habitats.

Habits: The black rat, a native to Asia Minor and the Orient, was brought to
Europe during the Crusades. It is thought to have been first introduced into North
America on the ships of the early explorers (Walker et al. 1968). According to
Bailey (1936), black rats were abundant in North America before Norway rats were
introduced, but they have mainly disappeared because they cannot compete with
the larger, more aggressive Norway rats.

Black rats are expert climbers, often building their nests in vines, trees, or the
roofs of buildings; hence, often called "roof rat" or "barn rat." Piles of driftwood
along the banks of rivers sometimes shelter and protect colonies of these rats.

Black rats are found on ships far more commonly than are Norway rats; therefore,
they have been introduced and reintroduced into most seaports. In the northern
seaports, the Norway rat is dominant and has evicted the black rat, but in the
southern seaports the black rat is most common. Where they occur together, the
more aggressive Norway rat forces the black rat, the better climber, to live in the
upper portions of buildings (Hall and Kelson 1959).

Food: Black rats eat almost any edible matter they can cut with their teeth.

Reproduction: Most studies on reproduction by the species *rattus* are about its rate of increase in different environments. These rats breed throughout the year and have litters consisting of two to eight young (Asdell 1964). There may be two peaks of reproductive activity, one in February and March and the other in May and June. The period of least reproductive activity is July and August. After a gestation period of about 21 days, young rats are born naked, blind, and helpless. They mature rapidly, however, and are weaned in about 3 weeks. Young rats become sexually mature and are capable of reproducing at about 3 months (Davis 1966).

Predation: Large snakes, large owls, and domestic dogs and cats are predators of these rats. Humans also take a considerable toll with traps and poisons.

Economic status: Although black rats may be widely distributed in North America, they appear to be abundant only in relatively local areas. Where these rats are abundant, they damage food crops and stored foodstuffs. They are extremely wasteful and destroy far more food than they eat (Dana 1970). On the other hand, an albinistic strain of the black rat is used as a laboratory animal in many phases of biological, medical, and genetic research.

Diseases: The species *rattus* harbors and carries such diseases as bubonic plague (also called "Black Death"), typhus, *Salmonella* food poisoning, rabies, tularemia, trichinosis, and rat-bite fever.

Selected references: The *Journal* of *Mammalogy* has published many articles on the species *rattus.*

Species *Rattus* norvegicus: Norway rat

Derivation: The specific name *norvegicus* is a proper name; this rat was named after the country of Norway, where the first specimen was described in 1777. Combined with the Latin suffix *cus,* the name denotes possession.

Specific description: Total length, 316 to 460 mm; tail, 122 to 215 mm; hind foot, 30 to 45 mm; ear, 16 to 24 mm; weight, 195 to 458 g.

NORWAY RAT

Norway rats are large and heavy-bodied, with tapering, scaly tails almost naked of hair; the tail is dark gray to dark brown. Their ears, usually less than 20 millimeters long, are nearly naked. The soles of their feet are naked. They have a coarse, harsh pelage. Dorsally, they vary from reddish brown to grayish brown to black. Ventrally, they vary from soiled yellowish white to a "dirty" gray. Young rats are dark gray above and a little lighter below. White, black, or mottled individuals are occasionally found.

Distribution along the Oregon coast: Bailey (1936, p. 167) wrote of the Norway rats: "They have kept close behind the vanguard of civilization in its progress across the continent of North America and were probably taken to Oregon on ships in the early part of the last century." Army Lieutenant Trowbridge captured a Norway rat at Astoria, Clatsop County, as early as 1855 (Baird 1857). Today the Norway rat occurs along the entire coast wherever humans live.
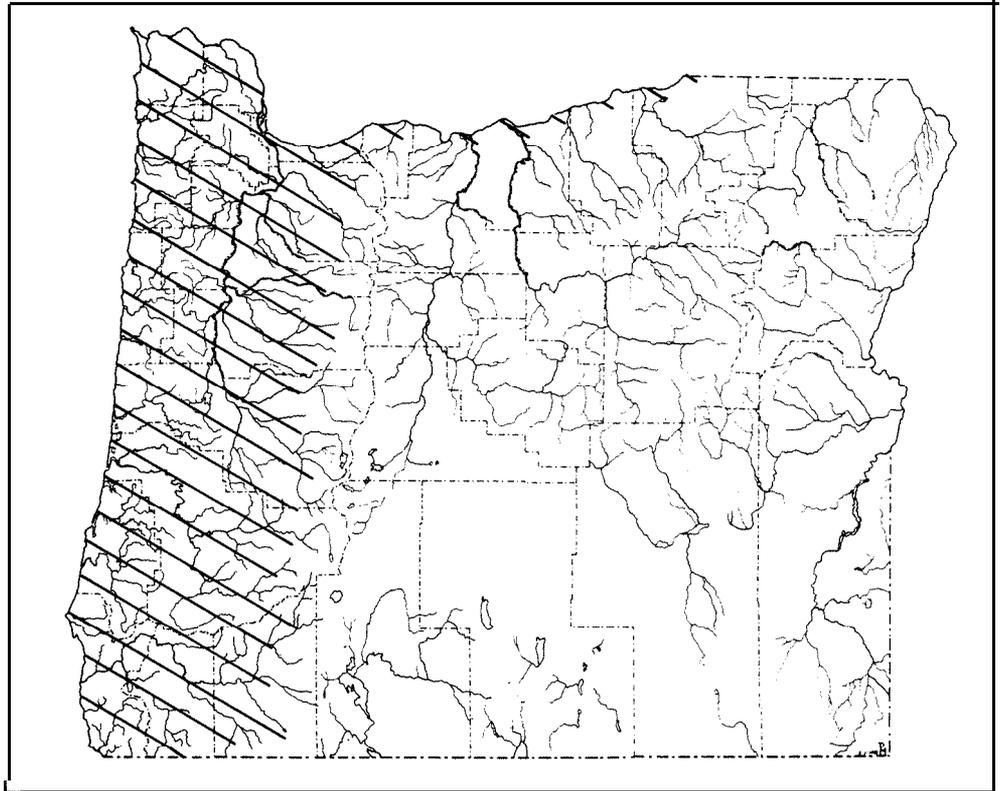
KNOWN DISTRIBUTION OF NORWAY RAT

Habitat: So far as is known, along the Oregon coast these rats are associated only with humans and do not, to any extent, inhabit areas away from human abodes.

Habits: The Norway rat, which lived along the banks of streams in Asia, spread rapidly into the canals and rice paddies. The species was first recorded in Europe about 1553; it probably reached western Europe by ships instead of overland caravans. The first Norway rats arrived in North America about 1775 (Walker et al. 1968).

Norway rats inhabit so many areas in and around towns and cities that they have several common names: brown rat, house rat, barn rat, wharf rat, sewer rat. Bailey (1936, p. 168) summarizes their habits:

> Wharf rats usually enter a new region on vessels or railway trains and then spread rapidly from place to place, concealed in boxes, crates, or household goods on trains or freight wagons, or for short distances on foot. They are secretive animals, keeping much under cover or in burrows that they dig in banks or under buildings, rocks, or logs. From one stronghold to another they make short trips in the open, mainly at night, although they are often active in the daytime as well as in the dark. They

seem to prefer the filth of stables, manure heaps, garbage, and trash piles where they can burrow and revel in dirt and decaying food. They swim well and haunt the wharves and sewer pipes, traveling thence into markets, cellars, and pantries if these are not ratproofed with concrete, brick, stone, or metal.

Because of improved sanitation, better construction of buildings, and a continuous eradication campaign against it, the Norway rat apparently is less abundant in the United States than it was at the beginning of this century. Nevertheless, it has been estimated that the United States harbors between 150 million and 175 million of these rats (Jackson 1961).

Food: Bailey (1936, p. 168) wrote,

Scarcely a food or food product can be mentioned that rats will not eat and many nonedible materials are cut, gnawed, and injured in efforts to get at food stores or in burrowing or making nests. They are filthy and wasteful and often destroy far more than they can eat. They kill and eat chickens or any young animals they can get, and even gnaw the feet of and injure many kinds of livestock.

When Norway rats become established around poultry houses, they feed extensively on eggs and young chickens; they even have been known to kill lambs and piglets (Davis 1966).

Reproduction: Norway rats are prolific breeders, raising young throughout the year. A female normally bears 6 to 8 litters annually but may produce as many as 11 or 12. Although the usual size is 6 to 8 young, as many as 22 offspring per litter are known. After a gestation period of 21 to 23 days, the young are born naked, blind, and helpless. They grow rapidly and their eyes open in 14 to 17 days. Weaned when 3 to 4 weeks old, young rats become sexually mature at 3 to 4 months of age. Their lifespan is 2 to 3 years (Davis 1966, Hall and Kelson 1959, Jackson 1961).

Predation: Most animals seem to have an aversion to Norway rats and kill them whenever possible. Large snakes, barn owls, and great horned owls (Maser and Brodie 1966), as well as other large owls and hawks, prey on them. Spotted skunks, long-tailed weasels, and domestic dogs often are excellent ratters. Even some domestic cats are good ratters, but most seem to be afraid of these large, vicious rodents. Although a variety of animals kill Norway rats, not all eat the rats they kill. A number of years ago, just south of Yachats, Lincoln County, Oregon, I heard snarling and squealing in the tall grasses along the side of the highway. Approaching the source of the sound quietly, I observed an almost incredibly swift, savage fight between a large Norway rat and a large male mink. The fight lasted more than 5 minutes and covered a fairly large area of open sand and clumps of grass. Even after the apparent death of the rat, the mink continued to "worry" it. Finally, the mink inspected the rat and, seemingly satisfied, disappeared. I remained motionless for about 30 minutes, but the mink did not reappear.

Economic status: Rats, particularly Norway rats, have been called the most destructive of all animals. They are responsible not only for the destruction of more food and property than any other animal but also for the deaths of more humans in the last 10 centuries than many of the wars and revolutions. Throughout most of the world millions of dollars have been spent to control rats and the diseases they spread.[15] Jackson (1961, p. 257) wrote of the Norway rats:

> The only answer to a malicious enemy is to destroy it as completely as possible, and take preventative measures against its return or increase. It has been said that five cents worth of poison or other protection will return five dollars if used to keep rats out of a storehouse. One rat will destroy five to ten dollars worth of grain a year. The same five cents might also save human lives. The owner of a building destroyed by fire gets little consolation from the knowledge that the rat which short-circuited the electric current was probably killed.

One favorable comment can be made about Norway rats, however; albinistic strains of this rat are used for biological, medical, and genetic research, as pets, and for education.

Diseases: Rat-borne diseases have been summarized by Jackson (1961, p. 253):

> Of all mammals, the Norway rat is the greatest pest to mankind. It has long been known not only as a destroyer of crops, buildings, and storage supplies, but as a factor in the spread of disease. The tenth-century physician Avicenna wrote that when rats died in numbers or migrated there was danger of an outbreak of plague. As far back as the beginning of the Christian era a connection between human life and rats was realized. Rats are now recognized as vectors [carriers] of such human and animal diseases as leprosy, typhus in various forms, paratyphoid, glanders, spotted fever, cholera, tuberculosis, tularemia, dysentery, foot and mouth disease, rabies, rat-bite fever, Haverhill fever, epidemic jaundice (Weil's disease), trichinosis, and mange.

They also carry bubonic plague.

Selected references: Calhoun (1962), Dana (1970); such journals as Journal *of Mammalogy.*

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[15] In the United States, bulletins on rat control or extermination are available from County Extension Agents and from the Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C.

Genus *Mus*: House mice

<u>Derivation</u>: The generic name *Mus* is the Latin word for mouse.

<u>General description</u>: There are about 16 species of mice in the genus *Mus.* Although the length of the head and body for most members of the genus is less than 10 centimeters, it may be as long as 12.5 centimeters. The length of the tail varies depending on the species. Some African and Indian members of this group are among the smallest living rodents; their heart beats range from 620 to 780 per minute.

The pelage may be soft, harsh, or spiny. The tail appears naked but is covered with fine hairs. Dorsally, the pelage varies from tan or pale gray through dull grayish browns, grays, to dark gray or dull brownish gray. The sides may be slightly lighter than the back, and the venter is usually lighter than the dorsum.

Most members of this genus are active primarily at night, but some are active any time. These mice generally are good climbers; some also swim well.

Nests are constructed of soft, shredded materials wherever adequate shelter and food are available.

The food of these mice consists of a variety of plant materials, such as fleshy roots, stems, leaves, and seeds, as well as insects and meat when it is available. At times, food may be stored.

Mice of the genus *Mus* breed throughout the year in the warmer parts of their geographical distribution and may produce more than five litters per year. The gestation period ranges from 18 to 21 days. Litters vary from 3 to 12 young, but the usual size of a litter is 4 to 7. These mice are prolific breeders, and populations occasionally attain plague proportions.

<u>World distribution</u>: Through introduction by humans, the genus *Mus* is found throughout most of the world.

<u>General reference</u>: Walker et al. (1968).

Species *Mus musculus:* House mouse

<u>Derivation</u>: The specific name *musculus* is the Latin word for "a muscle." The reference of this name is obscure.

<u>Specific description</u>: Total length, 130 to 198 mm; tail, 63 to 102 mm; hind foot, 14 to 21 mm; ear, 11 to 18 mm; weight, 18 to 23 g.

House mice are small and slender with relatively long, tapering, scaly tails. They have large ears that appear to be almost naked. The pelage is thin and coarse, varying dorsally from light brown to grayish brown to black. Ventrally, the pelage is light brown, brownish gray, or whitish. The tail varies from brown to gray to dark gray above and is slightly lighter below.

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Distribution along the Oregon coast: House mice occur along the entire coast wherever people live. They also occur in appropriate habitat throughout the State.

Habitat: House mice along the Oregon coast seem to be more or less localized in and around human abodes. A few occupy the riparian alder/small stream and willow/sedge marsh habitats, provided these habitats are adjacent to human habitations. They probably also occur in other habitats close to people.

Habits: The house mouse was a pest in England at the beginning of the 17th century, but when it was introduced into North America is not known. Arriving in North America with the early settlers, this mouse may have appeared about the time of the American Revolution, or even earlier. Nevertheless, the house mouse has closely followed the advance of civilization across the continent (Bailey 1936, Jackson 1961).

Bailey (1936, p. 170) summarized the habits of these mice:

HOUSE MOUSE

> House mice are largely dependent on the works of man, occupying houses, barns, and outbuildings, feeding largely on stores of grain and foods of any kind within their reach, hiding in rooms, cellars, and boxes and making long journeys from place to place in boxes of household goods or loads of supplies. Once established they multiply rapidly, and with the protection afforded by buildings, often become so numerous as to extend out into the fields and meadows, under cover of grass and grain, until they overrun the most fertile parts of the valley country. They burrow into banks, under walls, rocks, or logs, and establish safe retreats of their own and show more skill than most of our native mice in avoiding enemies. While largely nocturnal, they are often out voluntarily searching for food in daylight and seem to see equally well in light or dark. They climb and dig and gnaw holes through boards and walls and are not easily restrained from getting at supplies.

House mice may even take over buildings completely. They are not confined to one runway or one corner, but once they have become established, they remain within a small, general area, seldom traveling more than 15 meters from their home base, whether it is in a house, barn, yard, or field (Jackson 1961).

According to Jackson (1961, p. 259):

> Although the house mouse usually keeps out of sight, it often announces itself by its persistent gnawing and scampering in the partitions of a building, and by its characteristic little black pellets left on shelves and elsewhere. It is active the year round. It does most of its pilfering at night, particularly during early evening. Sometimes it forages in daylight. It runs rather than gallops from place to place, but when foraging usually walks, wandering here and there, usually close to objects, and stopping and sniffing for food evidences as it progresses. In its food-searching it walks slowly, only a few inches a minutes. When it runs, its maximum speed is about eight miles an hour. It climbs rough surfaces fairly well, and can easily jump upward eight inches. It is a moderately good swimmer for only a few feet, but soon drowns when it falls into water.

House mice in Oregon are sometimes trapped away from human habitations. They have been caught while using the runways of other small mammals and in the lodges of dusky-footed woodrats. Their nests, usually well hidden, are composed of whatever materials are handy, such as paper, cloth, grasses, and leaves. The inner nest is lined with finer materials than those used for the outer portion. Orr (1944) found that house mice occupy communal nests when sites for nests and materials to construct them are scarce.

Food: House mice are essentially omnivorous, consuming almost anything that is deemed edible. They even drink milk, fresh or sour, and eat soap. Because these mice seem to survive on little sustenance, they have generated the phrase "poor as a church mouse."

Reproduction: In the warmer portion of their geological distribution, such as western Oregon, house mice breed throughout the year, but there appears to be a slight peak in reproductive activity in April and May and again in August and September. The gestation period is 18 to 21 days. Litters range from 3 to 16 young, but 4 to 7 is the usual size. A female's first litter is normally smaller than subsequent litters. House mice are naked, blind, and helpless at birth but in 10 days are covered with hair and in 14 days open their eyes. They are weaned and begin to disperse in 3 weeks and may begin to breed at 35 days. In captivity they have lived as long as 6 years, although their lifespan in the "wild" is undoubtedly much shorter (Bailey 1936, Jackson 1961, Walker et al. 1968).

Because house mice are prolific breeders, their populations occasionally attain "plague" proportions.

Walker et al. (1968, p. 922) said:

> Population increases of *M. musculus* occurred in 1926-27 and 1941-42 in the Central Valley of California. A population of more than 82,000 per acre was estimated in the first of the "ecological explosions," and the mice had worked the sparsely vegetated soil until it appeared to be recently cultivated. Millions of mice were swarming around the area until the population trend was reversed.

Predation: House mice are controlled to some extent by snakes, owls, hawks, shrikes, weasels, skunks, foxes, and other predators. Spotted skunks and striped skunks are good mousers, and domestic cats kill many mice around and in buildings.

Economic status: These mice probably are the most annoying and destructive rodent of their size in North America. Concentrated in and around buildings, granaries, and grainfields, they constantly devour valuable foodstuffs and feed for livestock; what they do not eat, they damage or destroy with their filth. In addition to gnawing on buildings, furniture, and storage boxes, they start fires by chewing on electrical wiring. They also carry and spread diseases. In North America, house mice cause millions of dollars of damage annually.[16]

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[16] For information on control or eradication of house mice, contact a County Extension Agent or the Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C.

Albinistic strains of the common house mice are used extensively in biological, medical, and genetic research. Probably more is known about the genetics of the house mouse than of any other mammal.

Diseases: House mice carry such diseases as murine typhus, rickettsialpox, spotted fever, and trichinosis.

Selected references: Dice (1932), Ernst et al. (1971), Ewing and Studier (1973), Frye et al. (1964), Goehring (1971), Gruneberg (1943), Laurie (1946), Schwarz and Schwarz (1943), Sheppe (1966, 1967), Snell (1943), Strecker and Emlen (1953), Whitaker (1970).

Family Zapodidae: Birch Mice and Jumping Mice

Derivation: The family name Zapodidae is derived from the Greek words *za* (an intensive meaning "very") and *podos* (foot) combined with the Latin suffix *idae* (family).

General description: These small mice, with elongated hind limbs and very long tails, are modified for jumping. The length of the head and body ranges from 5 to 10 centimeters and the length of the tail from 6.5 to 16 centimeters. The mice weigh from 6 to 38 grams and are heaviest just before entering dormancy.

Most species have narrow, long hind feet, ranging from 25 to 38 millimeters in length. The long tail is used for balance while jumping. Most members of this family can jump about 2 meters when startled. They generally do not make runways but may climb into low vegetation. Some are good swimmers. Most of these mice are nocturnal and either are solitary or associate in pairs. They seek shelter in subterranean burrows which they either dig or appropriate from some other animal; such burrows are inconspicuous because they do not have loose earth around the entrances. Shelter also may be sought under newly fallen or rotting logs. These mice inhabit forests, thickets, meadows, swamps, and bogs. Zapodids gain weight in the fall because of the thick layers of fat they accumulate before hibernation. They spend 6 to 8 months of the year hibernating in warm subterranean chambers lined with plant materials.

Members of the family Zapodidae eat berries, seeds, certain fungi, and small invertebrates (mainly insects); they are not known to store food.

Gestation periods of jumping mice vary from 18 to 23 days. One to two litters are raised annually. Litters range from one to eight young. The offspring become independent in about 1 month but are not sexually mature until the following year.

World distribution: Mice of the family Zapodidae occur in northern and eastern Europe and middle and eastern Asia. In North America they are found from subarctic Canada south to about latitude 35" N.

Fossil record: The fossil record of this family in North America dates to the early Miocene.

Number of species along the Oregon coast: One.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus *Zapus*: North American jumping mice

Derivation: The generic name *Zapus* has the same derivation as the familial name and refers to the exceptionally large hind feet of these mice.

General description: Jumping mice are small and brightly colored. Their pelage is somewhat stiff, almost brittle in appearance. Dorsally, the pelage is grayish brown to brown; the sides are yellowish to orangish brown, and the venter is clear white. The shades of overall coloration vary somewhat in different species. The length of head and body ranges from 7.6 to 11 centimeters and the tail from 12.6 to 16.5 centimeters.

The rear portion of the body is much heavier than the forepart, and the hind limbs are much larger and more powerful than the forelimbs. These mice have internal cheek pouches; and their upper incisors are narrow, each with a longitudinal groove its full length.

Jumping mice prefer moist areas; some select forests close to streams, whereas others frequent grassy places. When alarmed, they leap about 1.8 to 2.4 meters— sometimes as far as 4 meters. Their long tails help them keep their balance when leaping. These mice are excellent swimmers.

During the summer, one or two adults may occupy a compact, globular nest made of grasses woven together, with an entrance on the side. Summer nests are usually located on the ground or in vegetation near the surface. Throughout the remainder of the year they are snug in nests of mosses, grasses, and plant fibers in chambers from a few centimeters to about 1.8 meters under the surface of the ground. They become fat as autumn approaches and enter hibernation at the onset of freezing weather. When hibernating, each mouse curls into a ball, with its nose and feet tucked on its abdomen and the tail curled around its body.

North American jumping mice eat seeds, acorns, fruits, and certain fungi, as well as insects, particularly beetles and the larvae of butterflies and moths.

Litters of three to eight young are born from May to September, but usually early in the season. Late litters may represent second families.

World distribution: North American jumping mice occur throughout most of the forested parts of North America as far south as North Carolina, Missouri, New Mexico, and California.

General references: Walker et al. (1968), Krutzsch (1954b), Preble (1899), Whitaker (1963, 1972b).

Species *Zapus trinotatus*: Pacific jumping mouse

Derivation: The specific name *trinotatus* is derived from the Latin word *trims* (triple) and the Greek word *nótos* (the back) combined with the Latin suffix *atus* meaning "provided with"). The name probably alludes to the distinctly tricolored pelage of this mouse.

Specific description: Total length, 205 to 252 mm; tail, 126 to 160 mm; hind foot, 28 to 38 mm; ear, 12 to 20 mm; weight, 12 to 38 g.

Pacific jumping mice have long, slender, tapering tails that are sparsely haired. Their hind feet are long and narrow with long, slender toes, and their ears are long and narrow. The upper incisors are dark orange, and each tooth has a deep, longitudinal groove. Pelages, composed of stiff, bristly hairs lying close to the body, are strongly tricolored. Dorsally, they are brown with an infusion of many yellowish-tipped hairs. The sides are yellowish-orange with many scattered brownish- and blackish-tipped hairs. Ventrally, they vary from clear white to white washed with light orange. Their tails are distinctly bicolored, brown above and white below.

Distribution along the Oregon coast: The Pacific jumping mouse occurs along the entire coast.
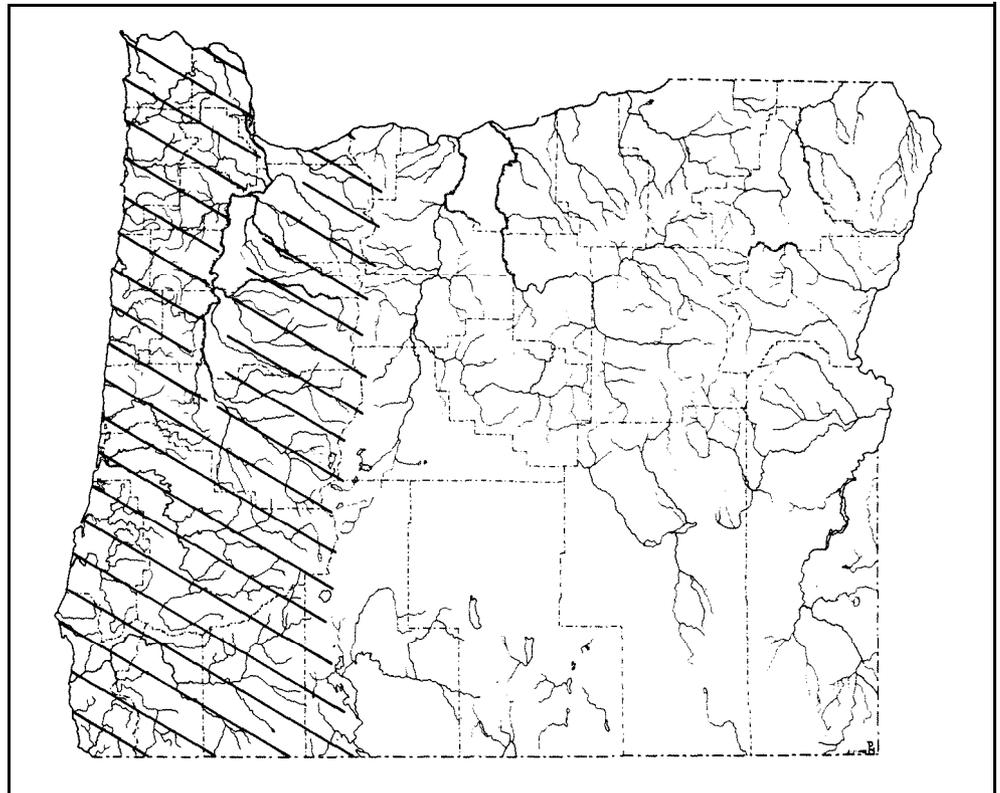
KNOWN DISTRIBUTION OF PACIFIC JUMPING MOUSE

Habitat: Along the coast, Pacific jumping mice were found primarily in the aider/salmonberry, riparian aider, and skunkcabbage marsh habitats, and to a lesser extent, in the lodgepole pine/rhododendron, lodgepole pine/salal, Sitka spruce/salal, headland prairie, and headland shrub habitats. They occasionally may be found around the edges of other habitats.

Habits: Although Pacific jumping mice are generally distributed along the Oregon coast, they are common only locally in specific habitats-riparian alder/small stream and skunkcabbage marsh. They are active throughout the 24-hour cycle but are more easily trapped at night.

Most often noticed when startled into making their long leaps, these graceful mammals may be mistaken for frogs. Because of their jumping habits, they are called "kangaroo mice" by residents along the coast.

Jumping mice occasionally walk on all four feet, but they normally progress in short hops in an upright position, solely on their hind feet. They steady themselves by using their long, strong tails as braces. When pursued, they propel themselves through the air in long leaps, covering 1 to 1.8 meters in a bound. After a few rapid leaps, they stop suddenly, crouch slightly, and remain motionless. If further pursued, they take flight in earnest. At the height of a jump, a mouse turns its head down, arches its back, and dives headlong into vegetation. Even though it may strike thick vegetation, it lands on its feet. Landing on the forefeet, then bringing the long hind legs well forward beneath the body, it leaps again (Dalquest 1948, Taylor and Shaw 1927).

A motionless mouse, if startled, may suddenly leap forward or to one side and just as suddenly disappear into a clump of vegetation. On a number of occasions, I have watched a jumping mouse go into a small clump of low vegetation surrounded by open ground, but when I inspected the vegetation closely, failed to find the mouse-it simply vanished. The mouse did not leave the protective cover of the plants, nor could I find a burrow down which it might have escaped. The "vanishing act" is still a mystery.

Jumping mice are noisy as they rummage in vegetation; their rustling can be heard for several feet. During my studies along the coast, I frequently heard rustling and scurrying sounds in small thickets of low-growing salal along the edges of roads and in open, dry meadows. At first I thought these sounds were those of lizards that frequented these brushy thickets, but after several hours of concentrated observation, I saw Pacific jumping mice foraging in the salal thickets, often 15 centimeters or more above the ground. The dense, brushy nature of salal thickets, as well as the long hind feet and long tails of the mice, allowed the mice to move freely in or on a thicket. When startled, they either dove headfirst into a thicket or escaped by leaping across the surface of the springy top of the thicket. When resting on top of a salal thicket, a mouse normally has its tail braced across the upper surface of the broad, stiff leaves.

The large hind feet of a jumping mouse equips it for jumping, but the long tail that acts as a counterbalance to the forward thrust of the body during a leap is equally important, as was illustrated by Svihla and Svihla (1933). They released a jumping mouse from a trap that had dismembered the mouse's tail at the base. The mouse made several desperate leaps to escape, but instead of landing upright on its feet, it turned somersaults and landed on its back. Without a tail it had no compensation for the vigorous thrust of its long hind limbs. It is possible, however, for a jumping mouse to lose a portion of its tail and learn to compensate for the loss, provided a sufficient amount of tail remains intact.

Pacific jumping mice do not make runways, not even in rank vegetation, but appear to roam at will. They do, however, use the runways of voles and other mammals, including the large open burrows of mountain beaver.

Jumping mice are good swimmers (Bailey 1936, Walker et al. 1968), yet along the Oregon coast, there appears to be little need for these mice to swim across the streams along which they live. The coastal vegetation is lush enough that many dead limbs and trees span the streams, forming bridges over which the jumping mice pass. They even use branches and logs to get across marshy areas.

During the summer, jumping mice construct their well-hidden, fragile, spherical or dome-shaped nests on the ground; some may be in slight depressions that appear to have been dug by the mice. Summer nests are composed of coarse or broad-leaved grasses that are loosely interwoven. Nests located in bogs may be made of sphagnum moss and lined with grasses or sedges. The nests are about 15 centimeters in diameter and about 9 to 10 centimeters in height. Each nest has a single opening in the side and appears to belong to only one individual (Taylor and Shaw 1927; also see footnote 14, page 217).

Svihla and Svihla (1933, p. 133) wrote of the Pacific jumping mouse: "On several occasions these rodents were seen to make a drumming noise by rapidly vibrating their tails against some resonant body such as the bottom of a tin can trap or shreds of paper used for nesting purposes. They also make a squeaking noise when fighting."

As autumn approaches, the jumping mice begin to accumulate layers of fat under the skin, over the muscles of the body, and around their viscera and reproductive organs. These accumulations of fat sustain them during their winter hibernation. Although some individuals begin to accumulate fat as early as the latter part of August, most do not until the latter part of September. Along the coast in 1970 and 1971, jumping mice entered hibernation in late October and early November. About hibernation, Svihla and Svihla (1933, p. 133) stated:

> During September and October the mice gained perceptibly in weight until they were extremely fat. As their weight increased, they became more and more listless and drowsy, often spending days curled up in their characteristic hibernating position, bent over so that the head is between the legs and the long tail curled completely over the head and body. When taken in the hand or into a warm room they uncurled and began to move about slowly. When the temperature rose in the room, they became active. . . but when the temperature dropped again they went back into hibernation.

Jumping mice caught alive in traps during the night are often found cold and immobile in the morning; they appear to be dead or nearly so. When warmed up, however, they become active.

The mice pass the cold, wet winter months in underground nests. "If unearthed during the quiescent period it is found rolled up in a little furry ball, to all appearances quite dead, but, given warmth, the latent spark of life in its body soon responds and in half an hour it is fully awake. If exposed to a low temperature it dozes off again" (Taylor and Shaw 1927, p. 84); (also see Flahaut 1939, Preble 1899, Svihla 1941).

Food: Pacific jumping mice appear to be mainly vegetarians. Dafquest (1948) found velvet grass and the seeds of grasses and broad-leaved dock to be the principal foods of these mice near Seattle, King County, Washington. He also stated that blackberries are eaten and that occasionally individuals have their chins "stained a deep purple from the juice." Bailey (1936, p. 233) wrote: "These mice are dainty feeders, living mainly on small seeds of grasses and other plants which they reach by cutting off the stems, drawing them down and biting off the lower sections until the seed-laden heads are reached." Maser and Franklin (1974) found that along the coast these jumping mice eat the fruits of thimbleberry, salmonberry, and evergreen huckleberry, and the seeds of skunkcabbage, the pinnae of some mosses, and some subterranean fungi. They also consume the fruits of Himalaya blackberry and stinking currant. The mice consume most fruits along the coast as they ripen and fall to the ground.

JUMPING
MOUSE

Reproduction: Most male Pacific jumping mice become sexually mature in June, but occasionally a sexually mature individual has been trapped in late May. Some individuals still have maximum-sized, descended testes as late as the first half of August.

Females become receptive in June and give birth in July or August; but one female trapped on October 26, 1971, near Bandon, Coos County, had recently given birth. Litters range from three to eight young, but the usual size is four to six.

Svihla and Svihla (1933) found that newborn Pacific jumping mice are pink and hairless; they do not even have visible whiskers. Their eyes are closed and their ears still folded; they have short, stubby heads, but their tails are relatively long. They weigh from 0.7 to 0.9 gram.

Youngsters born early in the season are nearly as large as the adults by the time they enter hibernation, and their bodies have had time to accumulate a sufficient store of fat to last through the winter. Offspring born late in the breeding season, on the other hand, may have trouble surviving the winter.

Predation: Barn owls, great horned owls (Maser and Brodie 1966), long-eared owls (Reynolds 1970), and northern spotted owls prey on Pacific jumping mice. In addition, bobcats eat these mice when they are available (Nussbaum and Maser 1975), as do domestic cats. Some snakes, marten, mink, weasels, spotted skunks, foxes, coyotes, other owls, and hawks undoubtedly catch them when the opportunity exists.

Economic status: Although Pacific jumping mice may cause some damage by eating the seeds of grasses, it is doubtful that these small rodents are numerous enough to be considered economically important in a detrimental sense. Further, their beauty and grace are an esthetic addition to the natural beauty of Oregon.

Selected reference: Krutzsch (1954b).

Family Erethizontidae: New World Porcupines

Derivation: The familial name Erethizontidae is derived from the Greek word ērithizon (to provoke) combined with the Latin suffix idae (family).

General description: New World porcupines are large, heavy-set rodents. The length of the head and body is 30 to 93 centimeters and the tail 7.5 to 45 centimeters. Adults weigh from 3.5 to 18 kilograms. Their feet are modified for an arboreal life. The sole of the foot is wide, and each foot has only four functional digits, with strong, curved claws. In members of one genus, the tail is prehensile. The limbs are fairly short. Most of the body and tail hairs are modified into short, sharp spines (quills) with overlapping barbs; spines vary in distribution on the body, depending on the species of porcupine. There are long, bristlelike hairs on the back. The pelage is marked with blackish to brownish, yellowish, or whitish bands.

Of the four genera of New World porcupines, only the habits of the North American porcupine have been documented,

World distribution: The North American porcupine occurs from the treeline of arctic North America south throughout Canada and the United States (except the southeastern portion), into Sonora, Mexico; members of the other three genera occupy southern Mexico, Central America, and South America on the eastern side of the Andes.

Fossil record: The fossil record for the New World porcupines dates to the Oligocene in South America and to the later Pliocene in North America.

Number of species along the Oregon coast: One.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus *Erethizon*: North American porcupine

Derivation: The generic name *Erethizon* has the same derivation as the familial name.

General description: Since there is only one species in this genus, refer to the species description.

World distribution: The distribution of the North American porcupine is the same as that given under the family.

General reference: Walker et al. (1968).

Species *Erethizon dorsatum:*
North American porcupine

Derivation: The specific name *dorsatum* is the Latin word for "the back."

Specific description: Total length, 648 to 930 mm; tail, 148 to 300 mm; hind foot, 86 to 125 mm; ear, 20 to 37 mm; weight, 3.5 to 18 kg.

The porcupine is the second largest native rodent in North America and one of the most distinctive. It is **a** heavy-set animal with short legs and relatively short, but very strong tail. The ears are small and hidden in the body hairs. The porcupine has small eyes and a soft, furry nose. Its feet are unique among all North American mammals in that the oval soles are covered with small, fleshy knobs. The claws are sharply curved and heavy. The pelage in winter consists of a thick, somewhat woolly coat of long, soft, black underfur beneath an armor of stout, sharp, barbed quills from 2.5 to 10 centimeters long. The quills, which cover the back, sides, and tail, are partly concealed on the back and sides by a loose outer coat of stiff, erect, yellow or yellow-tipped guard hairs, 15 to 25 centimeters long. The underside is covered with underfur and coarse, short guard hairs. The under surface of the tail is covered with rigid bristles that serve as a prop when the animal climbs. During the summer, its pelage is composed primarily of naked quills and long outer guard hairs but little underfur. When erected, the blackish-tipped whitish quills are fully exposed. The young are blackish in overall coloration. For a detailed discussion of the porcupine's pelage, see Po-Chedley and Shadle (1955).

Distribution along the Oregon coast: Although porcupines are most abundant along the southern coast in Coos and Curry Counties, they occasionally are seen along most of the coast, at least as far north as Otis, Lincoln County (Maser and Franklin 1974). They appear to be spreading geographically and increasing in numbers-see Dodge and Canutt (1969) and Yocom (1971). They occur in appropriate habitat throughout the State.
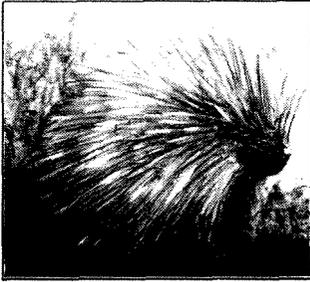
PORCUPINE

Habitat: Along the Oregon coast, porcupines are found in the mature conifer, alder/salmonberry, lodgepole pine/rhododendron, lodgepole pine/salal, Sitka spruce/salal, willow/sedge marsh, and mountain river habitats. They undoubtedly wander through other habitats also.

Habits: Porcupines are essentially solitary mammals, active mainly at night. They are cautious, slow, deliberate, and unaggressive.

Porcupines are deliberate but excellent climbers, spending much of their time in trees; however, they appear to be equally at home on the ground. They are active throughout the year but may "hole up" during inclement weather. Slow and deliberate, they walk flatfootedly, often leaving their lines of oval tracks in dusty trails, or mud, or snow.

Along the Oregon coast, porcupines usually retire to the comparative safety of a tree to rest and sleep but occasionally may select a hollow log or stump, or a pile of logs or debris from logging operations. In other parts of their geographical distribution, they have regular retreats in large crevices and small caves, among boulders and talus, and in particular, large, limby "rest-trees." Such regularly used retreats can be identified by an accumulation of feces. A retreat usually houses a single individual, but during the winter more than one animal occasionally may occupy an especially favorable den.

Porcupines seem to be calm, methodical animals that would rather retreat passively under cover or up a tree than confront an enemy. They do not attack, nor can they "shoot" or "throw" their sharply barbed quills. If confronted in the open, their only defense is to erect their quills, giving the appearance of a gigantic, living pincushion. The combination of sharp, barbed, loosely attached quills and a strong, flexible tail gives a porcupine ample defense in most instances. Should an adversary ignore a porcupine's weapons and approach too closely, the porcupine flicks its tail strongly from side to side and up and down, depending on the need, driving the quills into the assailant.

The defense afforded by the quills is a product of their structure. Mature quills, like mature feathers, are dead structures. The great reduction of the surface area of a quill's root, and the correspondingly reduced tension that the follicle exerts on the root, is an important factor in the ease with which a quill becomes detached from the animal's skin. Furthermore, each barb or scale along the tip of a quill may act as a small anchor holding the quill in the tough skin or tissue of the adversary. The barbs also increase the penetration of the quill because, when they engage the enemy's muscle, the pulling action of the muscle against the backward-directed, overlapping barbs draws the quill farther into the tissue, at a rate of about 1 millimeter or more per hour (Po-Chedley and Shadle 1955, Shadle 1947, Shadle and Po-Chedley 1949).

Although a porcupine's complement of quills is usually thought of as purely a defense mechanism, it also serves other purposes. The backward orientation of the quills, as well as the body hairs, facilitates passage through underbrush; moreover, the denseness of the general pelage prevents the penetration of rain and snow, effectively screens the sun's burning rays, and in varying degrees, conserves body heat. In addition, the long, outer guard hairs, extending well beyond

the ends of the general hair and quill coat, arise from sensitive follicles and thus keep the individual aware of the conditions in its immediate surroundings. They enable a porcupine to maintain an acute, peripheral sensitivity to touch 15 centimeters or more beyond the surface of the skin; in fact, the follicles are so sensitive that even a gentle touching of these hairs on a resting or sleeping animal stimulates a prompt erection of the quills so that their effective points are prominently exposed in all directions. If a porcupine is in a deep sleep, however, it takes stronger stimulation to bring about this reaction. The vibrissae are also extremely sensitive to touch and, together with the long guard hairs, effectively guide their owner safely through night wanderings and dark hiding places (Po-Chedley and Shadle 1955).

Although porcupines seem to wander aimlessly, there is some indication of seasonal migrations. They move to localized shelters during long periods of inclement weather and disperse again during fair weather (Gabrielson 1928). They sometimes establish home ranges. Krefting et al. (1962) found that 54 percent of the porcupines studied in Wisconsin had a home range of about 0.6 kilometer and 23 percent, from 1.6 to 2 kilometers; during a 2-year period, however, the average movement was 0.8 kilometer. The longest movement, 2 kilometers, was accomplished during a 14-month period.

Porcupines, often thought to be silent or even voiceless, make a variety of squeaks, moans, whines, wails, grunts, and coughs (Saunders 1932; Seton 1928, 1932). Some of these sounds are termed "songs" and are thought to be "love songs" since they are heard most often during the mating season.

Food: Porcupines appear to be strictly vegetarians. They eat a wide variety of plants and exhibit definite seasonal preferences. During the spring and summer months, most of their diet is low-growing vegetation, such as skunkcabbage, sweet coltsfoot, clovers, lupines, geraniums, asters, sedges, and grasses, as well as the twigs and leaves of a variety of shrubs. During the fall and winter months, porcupines depend on the cambium (inner bark) of such trees as ponderosa pine, lodgepole pine, sugar pine, whitebark pine, and curlleaf mountainmahogany. Along the Oregon coast, they use the following trees for food: Douglas-fir, western hemlock, lodgepole pine, western redcedar, and Port-Orford-cedar-called white cedar by local residents.

When eating bark, porcupines scrape off the rough, dead, outer bark and eat only the living cambium. They consume tremendous quantities of food; Gabrielson (1928), weighing the contents from the stomachs of 14 individuals, found as much as 1.4 kilograms of food. (Most reports on damage caused by porcupines review various aspects of their food habits.)

Reproduction: The breeding season begins in September and may last into January, but the peak of reproductive activity occurs during October and November. A female loses interest in the male 4 to 6 hours after breeding; she may even become antagonistic toward him. After a while, each porcupine goes its own way (Shadle 1950a).

After a gestation period of 205 to 217 days, or about 7 months, a single young is born, usually in May or June. The young may nurse 4 months or longer. "The statements that they are almost on their own from birth and are weaned by the mother in ten days are not true" (Shadle 1950a).

A newborn porcupine exhibits the following characteristics (Shadle 1950a):

> Birth weight usually varies from 12 to 20 oz. The hair coat is generally long, thick and black or gray-being longer and thicker in more northern forms. The spines are ¼ or 1 inch or longer and cover most of the dorsal portion of the head, body and tail, and they are perfectly functional as soon after birth as they dry out and sometimes even while still wet. The eyes are open and are thoroughly functional in locating moving objects. The animal responds to the movement of other animals or things in its range of vision. The erection of quills as a defense appears perfectly executed. The reaction of turning its head away from and its tail toward a moving object is displayed within minutes to hours after birth. The defense tail stroke which drives tail quills into an adversary is well performed from the first hours. The crowding reaction by which the porcupine withdraws his feet and rolls to one side, thus pushing side quills into an adversary, is well timed and very well done. The reaction to protect the head by sticking it into a corner, or under something, is well developed and functional within minutes to hours after birth.

Male porcupines may attain sexual maturity at 16 months (Shadle 1952); although nothing was found on the time of sexual maturity for females, they probably are not sexually mature until their 2d year.

Porcupines are fairly long lived, even in the wild; one female was nearly 11 years old when last captured and released (Brander 1971; Shadle 1944, 1946, 1948, 1950a, 1951, 1952; Shadle and Ploss 1943; Shadle et al. 1946; Struthers 1928).

Predation: Despite the armament of quills, porcupines are preyed on by a number of animals, most notably the fisher (Cook and Hamilton 1957). Consequently, 24 fishers were imported into Oregon and released in 1961 as part of a "porcupine control program" (Hooven 1971b). Puma, bobcat, and coyote also prey on them to some extent (see footnote 14, page 217). Domestic dogs frequently have rash, painful encounters with porcupines, usually resulting in a faceful of quills, a bad temper, and occasionally increased respect for porcupine. (Quills should be pulled out with a quick, straight jerk using the fingers or a pair of pliers, gripping the quill as close to the skin as possible. A person should be extremely careful not to break the quill off, leaving part of it in the wound. Wounds should be allowed to bleed, provided bleeding is not excessive, and then cleansed with soap and water.) Humans undoubtedly kill more porcupines with poisons, guns, traps, clubs, and automobiles than do predators. When a porcupine is struck by an automobile, the quills may embed themselves in a tire, work their way in, and cause the tire to go flat. It is wise, therefore, to stop and withdraw any quills from a tire.

Economic status: American Indians used the quills of the porcupine for decorating shirts, pouches, moccasins, bowls, and many other items. The quills were often dyed different colors. Many Indians also ate porcupines which, according to Bailey (1936, p. 231), they cooked by "roasting them whole, quills and all, in a camp fire until nicely done, and then breaking open the charred crust and eating out the juicy flesh. . . ." Although they are occasionally described as tasting like an "old pine tree," I think they are excellent. Furthermore, when cut into short lengths and attached to the shank of a fishhook, their quills make nonsinkable bodies for fishing flies.

Porcupines are destructive at times. They can cause considerable damage around cabins and camps by gnawing on doors, floors, furniture, saddles, harnesses, handles of tools, and many other items. Much of this type of damage is probably brought about by a search for salt which is deposited through perspiration on the handles of tools and other items. Their fondness for tender alfalfa, as well as their liking for the bark of domestic fruit trees, often stimulates the ire of landowners; however, their punishment of inquisitive dogs probably arouses more dislike for them among people than anything else.

These prickly rodents are reputed to cause much damage to commercially valuable timber, but the actual damage may be overestimated. Nevertheless, there may be considerable local damage. Many studies of their damage to timber have been conducted, and many "control programs," including bounties paid for their noses, have been initiated. At one time there were signs along some highways in central Oregon saying, "Please kill all porcupines." Following are a few studies of porcupine damage to commercial timber: Benson (1961), Dodge and Canutt (1969), Evans and Matthews (1972), Gabrielson (1928), Hooven (1971b), Storm and Halvorson (1967).

Selected references: Brander (1973), Couch (1932), Gill and Cordes (1972), Reynolds (1957), Sackett (1913), Shadle (1950b), Shapiro (1949), Taylor (1935), Woods (1973).

Family Myocastoridae: Coypu or Nutria

Derivation: The familial name Myocastoridae is derived from the Greek words *mys* (mouse) and *kastōr* (beaver) combined with the Latin suffix *idae* (family). The name probably alludes to this animal's mouselike or ratlike appearance and beaverlike habits.

General description: Since there is only one living genus and species in the family Myocastoridae, refer to the species description.

World distribution: Nutrias are native to Central America and South America, but they have been widely introduced into North America and Eurasia.

Fossil record: The fossil record of the family dates to the early Miocene in South America.

Number of species along the Oregon coast: One.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus Myocastor: Coypu or nutria

Derivation: The generic name *Myocastor* has the same derivation as the familial name.

General description: Since there is only one living species within the genus *Myocastor,* refer to the species description.

World distribution: The geographical distribution of the genus is the same as that of the family.

Species *Myocastor coypus:* Coypu or nutria

Derivation: The specific name *coypus* is the South American native Indian name for this rodent. Although "nutria" is the name most widely used for these South American rodents, "coypu" is probably a better name since "nutria" means "otter" in Spanish.

Specific description: Total length, 671 to 1400 mm; tail, 300 to 440 mm; hind foot, 112 to 140 mm; ear, 28 to 30 mm; weight, 2.3 to 11.4 kg. These measurements are less standardized than those for other terrestrial mammals because few nutria have been measured and weighed in the Pacific Northwest, and the information available in the literature is cited only as approximations.

Nutria are large rodents with long, round, sparsely haired, scaly, ratlike tails. They have small eyes and ears, the ears almost naked of hair. The incisors are dark orange and protrude noticeably beyond the lips. The tip of the muzzle and the chin are definitely white. The hind feet of nutria are much larger than their front feet and have four of the five toes connected by a web of skin that aids in propelling them through water. The fifth, outer toe is free of the web and may be used in combing the pelage.

Pelages are composed of thick, soft underfur that is largely obscured by the long, coarse, stiff, protective guard hairs. The guard hairs give these rodents a shaggy appearance. Dorsally, the pelage varies from light yellowish brown, light reddish brown, dark reddish brown, to black, depending on the nutria's environment and ancestry. The overall coloration is darkest on the back and lightest on the belly.

Evans (1970, p. 11) said:

> In general, nutria who live in densely vegetated marshes, croplands, or swamps are darker than those who live in open marshes. In some of the open areas, nutria are quite bleached by the sun and appear light brown or light rusty blond. Wild nutria have been trapped or seen with patches of white fur scattered over their body; this is apparently a carry-over from ranch breeding.

Distribution along the Oregon coast: Larrison (1943, p. 6) said:

> Stanley G. Jewett writes that about 1937 a number of coypus kept by a fur
> farmer in Tillamook County, Oregon, were liberated from their pens during
> a flood. These became established at or near Garrison Lake on the northern
> coast of Lincoln County, Oregon. One or more were trapped during the fall
> or winter of 1938. Frank B. Wire, State Game Supervisor for Oregon, in-
> forms the writer that there are a number of coypu in the wild state along
> the Nestucca River in Tillamook County and that these animals appear to
> be doing well. A trapper at Tillamook sent a coypu pelt to Sears, Roebuck
> and Company on December 20, 1940. Although definite data is lacking a
> "wild" coypu is known to have been caught in a marshy area in Portland,
> Oregon, in 1936 or 1937.

Since the release of nutria along the Oregon coast in Tillamook and Lincoln Coun-
ties about 1937, they have spread north to the Columbia River, Clatsop County,
and south to Waldport, Lincoln County. They are also established in Lane County,
in the vicinity of Florence, south to the vicinity of Coos Bay, Coos County. I found
no indication of nutria south of Coos Bay, but that does not mean they are not
there or that they will not eventually spread south. For records on the distribution
of the nutria of Oregon, see Oregon State Game Commission (1962), Kebbe (1959),
Larrison (1943).
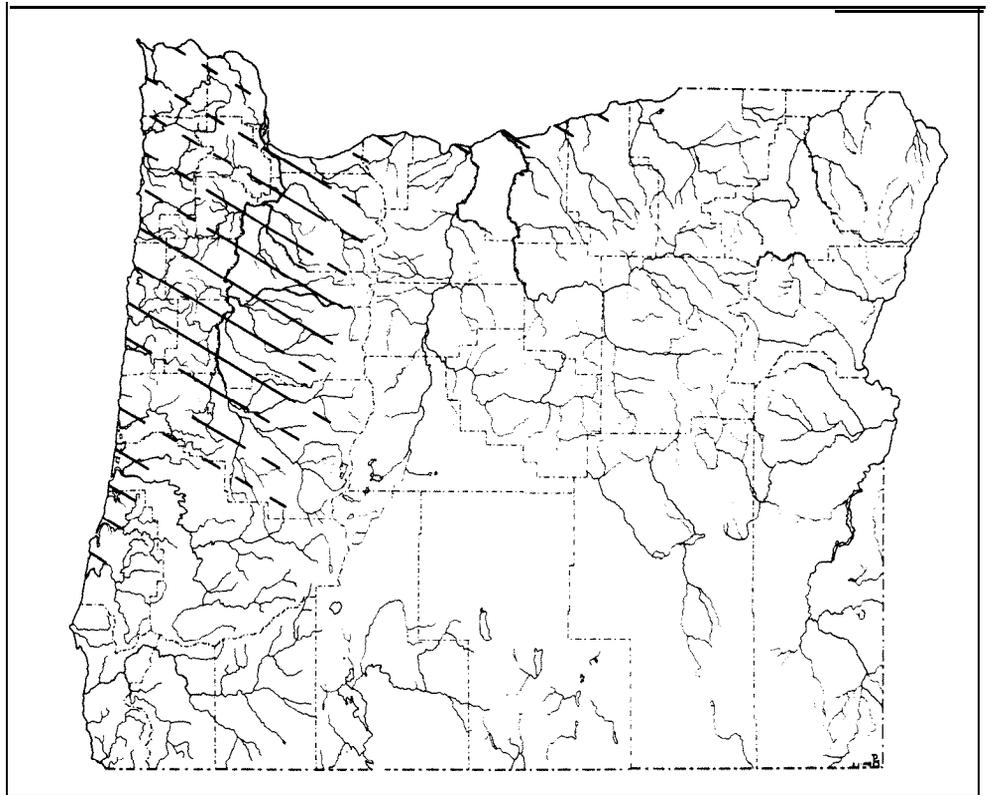
KNOWN DISTRIBUTION OF NUTRIA

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Habitat: Nutria along the Oregon coast occur in the coastal lake, tideland river, and mountain river habitats.

Habits: Unless otherwise stated, the following information on the habits of nutria is from Evans (1970). Nutria are almost strictly nocturnal, but an occasional individual may be seen during daylight hours. Normally, however, daylight hours are spent resting, grooming, and playing.

Although nutria are adept on land, they are more at home in water. They are slow and cumbersome on land, usually ambling here and there with a high-rumped, waddling movement. When disturbed or frightened, however, they move rapidly in a waddling, bounding, or low-bellied, creeping motion. Nutria are reasonably efficient climbers, able to negotiate steep banks, root entanglements, gently sloping trees, and wire fences.

Nutria have an acute sense of hearing, but their senses of sight and smell are poorly developed; thus, they depend primarily on their hearing to detect danger. When frightened while on shore, they enter the water with a loud splash and swim rapidly for cover while under water or simply remain submerged for several minutes. They can maintain perfect buoyancy with little or no body motion and can stay well hidden under very sparse vegetation with only their noses and eyes or the tops of their heads above the water. If undisturbed, they are methodical, unhurried swimmers, with most of the head and back above the water and the tail floating freely at the surface. During long-distance swims or when mildly disturbed, only the head is visible above the surface.

Wild nutria generally are phlegmatic, unwary rodents. In recent years, however, people have eliminated many "fearless" nutria, leaving the wariest individuals to reproduce. Even though this wariness becomes instilled in successive generations, some individuals remain indifferent toward humans. For some unknown reason, nutria exhibit periodic changes in behavior; their phlegmatic indifference gives way to extreme alertness, or viciousness, or both, only to change again to phlegmatic indifference. Nevertheless, when cornered or captured, they can be aggressive and can inflict serious injury.

Because they are aquatic mammals, it is vital that they keep their pelages clean or their insulation against the water is lost. Consequently, they almost ritually scratch and groom themselves. Their forefeet are used for both scratching and grooming whereas the hind feet are used only for scratching. Nutria, unlike beaver, do not have split toenails or combing claws on the hind feet; instead they use the fifth, outer toe, which is free of the other four, webbed toes, for combing themselves and for cleaning their ears.

Nutria often use platforms of vegetation for feeding, resting, nesting, and for escaping danger and inclement weather. Since most platforms appear to result from piles of uneaten portions of plants at favored feeding sites, they most likely are accumulations of vegetative materials rather than "purposefully" built structures. Platforms, which may be 1.5 to more than 1.8 meters in diameter, often serve several generations. Generally occurring wherever nutria live or feed, such platforms vary in size and density, depending on the coarseness of the vegetation. They appear to consist of the most available vegetation, rather than of a preferred type of building material.

Ordinarily, nutria living in marshes are not extensive burrowers but make their homes among dense vegetation on top of the ground. They also appropriate the burrows of other animals, as well as the lodges of beaver and muskrats. Burrows constructed by nutria are usually situated in steep or vertical earthen banks offering a protective cover of rank vegetation. Generally speaking, they are located adjacent to watercourses, but now and then may be a kilometer or more away from the nearest water.

Burrows vary from simple structures with one entrance and short tunnels to very complex units with several multilevel entrances, tunnels, and living compartments which are variously used, depending on the level of the water. Tunnels usually extend from 1.2 to 1.8 meters into a bank but may extend from 15 to 46 meters. Living compartments range from small ledges, about 30 centimeters in width, to large family units, 0.9 meter or more in width; they are covered either with earth or with plant debris, apparently food refuse.

Most nutria have a definite home range. Within a home range, there is a central area in which an individual spends most of its time, not leaving it for days or even months. As opposed to nutria inhabiting marshes, nutria living in agricultural areas move much farther during a lifetime. Marsh-dwelling nutria had an average home range with a radius of approximately 1 097 meters, whereas the average distance covered by nutria inhabiting sugarcane fields was almost 4.8 kilometers. Several moved over 56 kilometers, and one individual even traveled 82.4 kilometers. Nutria living in ricefields did not move as far as did those in sugarcane fields; nevertheless, they covered more area than did the marsh-dwelling animals.

NUTRIA

Food: Unless otherwise stated, the following information is from Evans (1970). Nutria are almost exclusively vegetarians, daily consuming several meals amounting to a total of 1.1 to 1.6 kilograms of food. They eat while on land, on floating objects, or in the water. On land, they either graze on grasses or clip tall vegetation and manipulate it with their forefeet. Their usual method is to hold the vegetation with their front feet and lean forward, resting on their elbows, or to sit upright, using their tails as braces. Because of their remarkable buoyancy, they also can float freely in the water for long periods, all the while shoving floating plants into their mouths with their forefeet. Nutria often pull up underwater vegetation with their forepaws or cut it off with their front teeth, but seem always to bring it to the surface to be chewed and swallowed. They sometimes wash their food, but this usually does not happen until feeding has progressed well into the night.

The nutria's sense of touch plays a major role during mealtime. Their forefeet are both sensitive and dextrous, enabling them to locate food items, to pick up "handfuls" of plants or grains, or to manipulate a single kernel of grain or an individual stem of clover. It is evident that nutria use their sense of smell to locate feeding sites that have been used by other individuals, and although they seem to be continuously sniffing their food, neither their sense of smell or taste appears to play much of a role in the final selection.

These rodents generally eat the soft, succulent, basal portions of plants, but they also eat several different parts, or an entire plant. Coarse plants, such as cattails and rushes, are commonly consumed when they are available, but soft, floating

plants, such as duckweed, are eaten also. Nutria, often exhibiting definite seasonal variations in their food habits, depend on cattails and sedges for their dietary staples, and where these plants are abundant, nutria seem reluctant to greatly alter their diet, regardless of the season.

Reproduction: Unless otherwise stated, the following information is from Evans (1970). There are many factors-such as the kind and the amount of available food, the weather, and the prevalence of enemies and of diseases-that influence the reproductive capacity and the survival of nutria in the wild.

Female nutria usually come into estrus (heat) every 24 to 26 days and remain in estrus from 1 to 4 days. In the wild, most females come into estrus 1 or 2 days after giving birth or after having aborted. Males, on the other hand, can breed at any time.

Courtship is common just before the onset of estrus; it consists of vocalizations by both sexes, chases on land or in the water, playful fighting, wrestling, and biting. A male occasionally will squirt urine or seminal fluid on the female during courtship. Once estrus commences, courtship is brief or disregarded. Breeding is prompt and takes place almost anywhere, in or out of water. A female may breed with one to several males during each estrus; inbreeding also is common.

Gestation, lasting about 130 days, varies slightly. Litters range from 1 to 11 offspring (Davis 1966), but the usual size is 4 to 6. (The size of a litter shows a correlation with the quality and quantity of food-the better the food, the larger the litter.) The young are born with their eyes open and are fully haired; they are ready to swim shortly after drying off. Babies weigh from 170 to 226 grams at birth, depending on the abundance and nutritional value of the mother's diet. Females may begin producing milk as early as 1 to 2 weeks before giving birth and may continue for 6 to 8 weeks thereafter. Although most young are weaned at about 5 weeks, some may nurse for a few weeks longer. A female's teats are situated so high on her side that the babies can nurse even while in the water or while the mother lies on her stomach. The age of an offspring's sexual maturity depends on the quantity as well as the quality of its food. Where the supply of food is good, sexual maturity is reached at about 4 months, but where the supply of food is poor, sexual maturity is not attained until a young is about 5 or 6 months old. Regardless of the age at which sexual maturity is reached, most nutria do not breed until they are about 8 months old. As with many rodents, a female's first litter is usually smaller than subsequent litters. In captivity, according to Davis (1966), nutria have lived 12 years, but their lifespan in the wild is probably much shorter.

Females about to give birth, and for about 4 to 6 weeks thereafter, frequently appear to be in a "tranquilized" state. They freely allow themselves, as well as their young, to be handled, making no effort at defense. They will not tolerate the intrusion of a strange young nutria, however, and become vicious. After they repulse a stranger, their tranquility returns. Such tranquility normally remains until the young are weaned, after which the female reverts to her usual "wildness."

On the average, only about 60 percent of the embryos survive to be born; many are either aborted or absorbed within the uterus.

"Mass breeding" follows "climatic catastrophes," such as severe storms, periods of extreme heat, droughts, and periods of extreme freezing.

Predation: Because of their large size, adult nutrias probably have few enemies other than parasites, diseases, and humans. Since most females readily abandon their young when approached by people or domestic dogs (Evans 1970), it seems likely that other, wild predators may also cause a female to abandon her litter. If such is the case, and if the abandoned young are small enough, then such predators as mink, long-tailed weasels, otter, raccoons, bobcats, coyotes, and large owls and hawks could add young nutria to their diets. Humans, however, with traps, guns, and poisons, are the main enemy of nutria.

Economic status: The 1930's are generally considered the boom years for the establishment of nutria ranches in the United States. During World War II, the nutria fur industry virtually collapsed. Dejected nutria farmers released many of their animals and did nothing to recapture or dispose of those that had escaped-thus began in earnest the "wild" nutria populations. An estimated 1,000 Oregon nutria farmers were disillusioned, and many turned their stock loose, despite State laws prohibiting such unauthorized releases. The largest, general dispersal occurred in the late 1940's as a result of a widespread swindle in which promoters sold nutria as "four-legged weed cutters" which were supposed to prevent aquatic plants from choking waterways. By 1966, through many accidental and purposeful releases, as well as natural dispersal, nutria occurred in 20, or perhaps 23, of the States (Evans 1970, Laycock 1966).

Over most of the United States, nutria are generally considered undesirable because of the damage they cause to crops and canals, but in recent years, at least 14 States-principally Louisiana, Texas, and Oregon-have cashed in on the several millions of dollars paid annually for the pelts of "wild" nutria (Evans 1970).

During the 1957-58 trapping season, 1,010 licensed Oregon trappers caught 29 nutria which sold for $37.41. During the 1971-72 trapping season, however, 731 licensed Oregon trappers reported taking 5,950 nutria pelts which were sold for $12,316.50. The price of nutria pelts in Oregon has varied from $0.52 to $2.07, with an average of $1.19 per pelt (Oregon State Game Commission 1972). During the 1973-74 trapping season, 5,141 nutria were caught. The average price per pelt was $3.96, which, based on the average price, brought $20,358.36 to Oregon trappers (Oregon Wildlife Commission 1974a). In addition to their value for pelts, nutria are excellent to eat.

For a brief history of the introduction of nutria into North America, see Laycock (1966). Evans (1970) discussed the history of the nutria and establishment of this mammal in the fur industry in Louisiana.

Selected references: Adams (1956), Atwood (1950), Babero and Lee (1961), Guenther (1950), Hillbricht and Ryszkowski (1961), Kinsel (1958), Schitoskey (1971, 1972).

Order Carnivora: Flesh Eaters

Derivation: The ordinal name Carnivora is derived from the Latin word *carnis* (flesh) and *voro* (to devour). The term "carnivore" is somewhat misleading because many members of this group are omnivorous. Two common household pets—dogs and cats-are carnivores.

General description: Some carnivores, such as dogs and cats, walk on their toes (digitigrade), whereas others, such as bears and raccoons, walk on the soles of their feet with heels touching the ground (plantigrade). Intermediate conditions also exist. Members of this group have at least four digits or toes on each foot. On those that have five, the first digit is sometimes smaller and located higher on the foot than the others. All digits terminate in claws. Cats, except for cheetahs *(Acinonyx),* are the only carnivores with fully retractable claws; their claws can be retracted into sheaths.

Carnivores have heavy skulls and strongly developed facial muscles. The articulation of the lower jaw has evolved to permit only open and shut movements. Carnivores have well-developed canine teeth (fangs) that are strong, elongated, and curved, with pointed tips. In cross-section the shape varies from round to oval. Canines are adapted for seizing and holding prey. The last upper premolar (a premolar is not a true molar because it is preceded by a deciduous tooth, whereas a true molar is not) and the first lower molar are often specialized shearing teeth called carnassials. Carnassials are most highly developed in carnivores with strictly carnivorous diets, such as the cats; they are least developed in carnivores with omnivorous diets, such as bears.

Carnivores are a highly variable order. Some are primarily arboreal; some are semiaquatic; one species is truly marine; most are terrestrial. Most carnivores are good climbers; in fact, two genera have prehensile tails. Some carnivores are strictly nocturnal; some are strictly diurnal; others are abroad day or night. They find shelter in caves, burrows, hollow trees, and hollow logs. Although some bears are dormant during winter, most carnivores are active all year. The dark summer pelages of some species become white in winter. Some carnivores are adapted to arctic regions, some to deserts, and others to humid jungles.

Carnivores have a variety of methods for securing food. Cats stalk and then pounce unexpectedly on their prey. Dogs swiftly chase their prey, whereas the tire less weasels pursue their quarry in a bounding chase. Some species, such as martens, pursue their prey swiftly through the trees; others, such as river otters, are adept at catching prey under water; and some species, such as badgers, dig their prey out of burrows. Although some carnivores live almost solely on freshly killed prey, many are scavengers.

Carnivores generally have one or two litters per year, but a few have three. Gestation periods range from 49 to 113 days; however, the delayed implantation of the fertilized egg in bears and some mustelids (such as weasels, minks, martens, and otters) makes gestation periods considerably longer. Litters range from 1 to 13 offspring. The young are usually born blind and helpless but with some hair on their bodies. The young are normally cared for by their mothers, but in some species both parents share the responsibility. Sexual maturity is usually attained by 1 to 2 years in smaller species-later in larger species.

World distribution: Distribution of carnivores is worldwide except for Antarctica and some islands, such as New Zealand, Melanesia, Polynesia, Formosa, and Madagascar. Humans have introduced carnivores on some islands where they were not native.

Fossil record: Carnivores date to the early Paleocene in North America.

Number of species of terrestrial and semiaquatic carnivores along the Oregon coast: 16.

General references: Anderson and Jones (1967), Walker et al. (1968).

Key:

la Tail inconspicuous (may appear to be absent), shorter than length of hind foot; weight more than 34 kg; appearance bearlike—*EUARCTOS AMERICANUS* (North American black bear), page 269

lb Tail conspicuous, longer than length of hind foot, weight less than 34 kg; appearance not bearlike.. 2

    2a Tail with conspicuous, alternating light and dark rings; dark rings are complete (going all the way around the tail) or incomplete (going three-fourths of the way around the tail). 3

    2b Tail without alternating light and dark rings. 4

        3a Face with distinct black mask; tail generally has six complete blackish rings, including the tip-PROCYON *LOTOR* (raccoon), page 280

        3b Face without black mask; tail generally has eight incomplete blackish rings, including the tip—*BASSARISCUS ASTUTUS* (ringtail), page 275

            4a Claws retractile, completely concealed by the hair of the toes; appearance catlike.................................,. 5

            4b Claws not retractile, not completely concealed by the hair of the toes; appearance not catlike. 6

5a Tail less than 203 mm in length; pelage marked with con-
spicuous dark, irregular spots, blotches, and bars or short
stripes; hair on sides of face long and "sideburnlike"; weight
less than 18.5 kg-LYNX RUFUS (bobcat), page 347

5b Tail more than 305 mm in length; pelage without markings; hair
on sides of face short, not "sideburnlike"; weight more than
22.7 kg—*FELIS CONCOLOR* (puma or mountain lion), page 340

6a Pelage black and white.   7

6b Pelage not black and white.   8

7a Dorsal surface with incomplete white stripes and
spots; tail with white tips-SPILOGALE *PUTORIUS*
(spotted skunk), page 320

7b Dorsal surface with two complete white stripes (no
spots) from top of head to base of tail; tail without
white tip—*MEPHITIS MEPHITIS* (striped skunk),
page 327

8a Tail with mane of stiff hairs on dorsal surface;
appearance doglike or foxlike.   9

8b Tail without mane of stiff hairs on dorsal surface;
appearance neither doglike nor foxlike. 11

9a Tail with distinct black stripe along top and a
black tip; length of hind foot less than *145*
mm- *UROCYON CINEREOARGENTEUS* (gray
fox), page 263

9b Tail without distinct black stripe along top,
without black tip (if tip blackish, then top
without black stripe); length of hind foot more
than 150 mm. 10

10a Tip of tail white; tail without conspicuous black spot on top near base; hind
foot usually less than 177 mm in length-VULPES *VULPES* (red fox), page 258

10b Tip of tail blackish; tail with conspicuous black spot on top near base; hind
foot usually more than 177 mm in length-CAN/S *LATRANS* (coyote), page 252

11a Tail with a distinct black tip.   12

11b Tail without a black tip. . . . , ...   13

12a Tail less than 44 percent of the head and body length; underside clear white, including the insides of the hind legs and the tops of the feet— MUSTELA *ERMINEA* (short-tailed weasel), page 300

12b Tail more than 44 percent of the head and body length; underside whitish to yellowish, but this color does not extend down the insides of the hind legs; tops of feet usually brown-MUSTELA *FRENATA* (long-tailed weasel), page 307

13a Tail tapering, merging gradually into the body; all four feet with distinct webs between the toes. 14

13b Tail not tapering in such a way as to merge gradually into the body; feet without noticeable webs between toes.. 15

14a Hind foot more than 150 mm in length, broad, flat flippers; tail little longer than extended hind legs-ENHYDRA *LUTRIS* (sea otter), page 429

14b Hind foot less than 150 mm in length, not broad, flat flippers; tail much longer than extended hind legs-LUTRA *CANADENSIS* (Canadian river otter), page 333

15a Total length more than 750 mm; head and shoulders appearing frosted because of white-tipped hairs—*MARTES PENNANTI* (fisher), page 294

15b Total length less than 750 mm; head and shoulders without white-tipped hairs, without frosted appearance. 16

16a Throat and chest yellowish, yellowish orange, or orange- MA RTES AMERICANA (North American marten), page 289

16b Throat, chin, and sometimes chest and abdomen, with white spots (not yellowish, yellowish orange, orange)— MUSTELA V/SON (North American mink), page 314

Family Canidae: Dogs and Foxes

Derivation: The familial name Canidae is derived from the Latin word *canis* (dog) combined with the Latin suffix *idae* (family).

General description: Most members of this family have lithe, muscular, deep-chested bodies, with long, slender limbs, and bushy tails. Their muzzles are long and slender (except in some domestic varieties), and the ears are relatively large and erect. The claws are blunt and the first digit on both the forefeet and the hind feet is smaller than the other digits. The average male is larger than the female. The length of their heads and bodies ranges from 34 to 135 centimeters and their

tails from 11 to 54 centimeters. Adult canids weigh from 1 to 79 kilograms. Although most members of the family are either uniformly colored or speckled, one species has stripes on the sides of its body and another is covered with blotches.

In the more northern portions of their geographical distribution, these alert, crafty mammals are active at any time, provided they are not molested by humans; in the tropics, however, they are more active at dusk and at dawn. They use burrows, caves, and hollow logs and trees for dens. With the exception of the raccoon-dog (*Nyctereutes*), which sleeps most of the winter, members of this family are active throughout the year. Apparently, the coyote is the swiftest wild canid, reaching speeds of 62 to 64 kilometers per hour. Gray foxes often climb trees.

Some canids hunt in family groups or in packs, sometimes forming a relay system to bring down prey; others hunt singly. Although hunting is done mainly by scent, canids have acute hearing and good sight. Prey normally is subdued by an extended open chase. Their habits and habitats are varied, extending from the Arctic, throughout the forest, prairies, and deserts, into the Tropics. Most canids are opportunistic, eating whatever is available. Some, however, are primarily hunters; some rely on carrion; others are mainly omnivorous. Food habits, on the whole, vary with season and locality. A population of canids, numbering about one-tenth that of its principal prey, fluctuates with the increases and decreases of its principal prey.

In members of most genera, the gestation period ranges from 49 to 70 days, with an average of 63 days; but canids of at least two genera are reported to have gestation periods as long as 80 days. There usually is one litter, sometimes two, per year. Litters generally consist of 2 to 13 young. Babies, usually born in a burrow, are blind and helpless at birth but well covered with hair. They are weaned in 6 to 10 weeks and are cared for solicitously until they can fend for themselves. In members of some genera, more than one female may raise their young in one den. Young mature in 1, 2, or 3 years and in the wild live 10 to 18 years.

World distribution: The family Canidae is worldwide in distribution, except for New Zealand, New Guinea, Melanesia, Polynesia, the Moluccas, Celebes, Formosa, Madagascar, the West Indies, and some other oceanic islands. Domesticated dogs, however, have been introduced by humans in some areas where they did not occur naturally.

Fossil record: The known geological history of this family in North America dates to the late Eocene.

Number of species along the Oregon coast: Three.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus *Canis*: Dogs, coyotes, wolves

Derivation: The generic name *Canis* is the Latin word for dog.

General description: The genus *Canis* consists of eight species. The length of the head and body ranges from 56 to 137.5 centimeters, and the length of the tail from 23 to 56 centimeters. These animals weigh from about 6.8 to 79 kilograms.

These animals are intelligent and, to some degree, social creatures. They live and hunt in family groups, packs, or pairs. Members of this genus occur from the Arctic throughout the temperate region, to the open savannah country of eastern and southern Africa. Their diets are as varied as their habitats and habits.

Gestation periods range from 57 to 70 days. There normally is a single litter per year consisting of 2 to 13 pups, which are born either in a burrow dug by the female or in one that was appropriated from some other animal.

There is a relatively close relationship between the various species within this genus as evidenced by the successful interbreeding between all the wild species and the domestic dog. Walker et al. (1968, p. 1152) wrote:

> Domestic dogs have generally been referred to as *Canis familiaris*, as though they were a distinct species. It is much more likely that they are descended from many of the species of *Canis* with which humans have come in contact for many thousands of years. The aborigines undoubtedly raised young which they found entertaining and useful as hunting companions. As the humans shifted about, they undoubtedly took their dogs with them. These dogs were bred with dogs of different species that had been domesticated by other tribes of humans. Also some were bred with the wild stock as is still done. Thus the domestic dog is almost certainly composed of several strains which probably explains the readiness with which they have developed into the numerous breeds through selective breeding or by accident.

World distribution: The genus *Canis* occurs throughout North America and Mexico to Central America; throughout much of Europe, Asia, the Middle East to Russian Turkestan; and throughout northeastern, eastern, and southern Africa; as well as Australia. Humans have introduced the genus into places that it had not occupied before.

General reference: Walker et al. (1968).

Species *Canis latrans*: Coyote

Derivation: The specific name *latrans* is derived from the Latin word *latro* (to bark); *latrans* means "a barker." The subspecies *umpquensis*, the only subspecies of coyote in western Oregon, was named in 1949 from a specimen taken 8 kilometers southeast of Drew, Douglas County, Oregon.

Specific description: Total length, 1052 to 1320 mm; tail, 300 to 394 mm; hind foot, 177 to 220 mm; ear, 85 to 131 mm; weight, 6.4 to 20.9 kg.

Coyotes have erect, pointed ears, bristling manes on the back of the neck, and a triangular "cape" of long hair behind the shoulders. There is an elongated gland on the top of the tail near the base; it is covered with long, black, bristly hair. The winter pelage is long and relatively soft. The upper parts are light brownish gray over tannish underfur; the long, coarse, outer hairs are heavily tipped with black on the mane, cape, and back, as well as the top and tip of the tail. The backs of the ears are light reddish brown, but the muzzle, crown, outsides of the legs, and the lower surface of the tail are bright yellowish brown. The underparts, except the grayish throat band, are tannish to tannish white. The summer pelage, on the other hand, is thinner, coarser, and darker and more brown than the winter pelage.
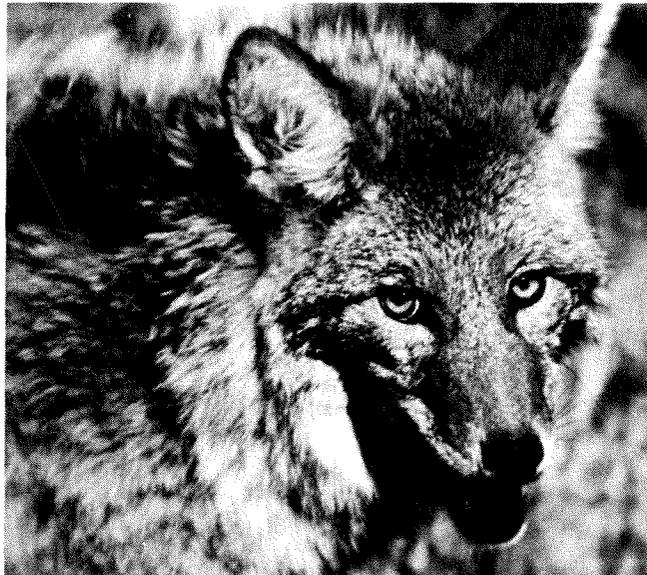
Photo courtesy Oregon Department of Fish and Wildlife.

Distribution along the Oregon coast: Coyotes appear to be generally distributed along the coast from Waldport, Lincoln County, north to the Columbia River. South of Waldport, the coyote's distribution along the coast is spotty and fairly localized; coyotes are increasing in numbers, however, and are showing up where before they had been unknown. They occur in appropriate habitat throughout the State.

Habitat: Along the Oregon coast, coyotes primarily occupy the wet pastureland, headland prairie, and headland shrub habitats. They occasionally hunt in or travel through the alder/salmonberry, foredunes, moving dunes, deflation plain, stabilized dunes, and mountain river habitats. They also move into clearcut areas in the mature conifer habitat. Logging roads aid penetration and dispersal of coyotes through a variety of otherwise unsuitable habitats.

Habits: Coyotes, sometimes called "brush wolves," although primarily active at night, are seen occasionally during the day. More often heard than seen, these graceful, easy travelers leave their sign throughout most of Oregon. Their characteristic howl, truly as much a symbol of the American West as the cowboy, is given most often at twilight and at dawn; it may be heard at any time during the night but seldom during the day. Coyotes also utter short, high-pitched barks or, in distress, a shrill "screaming" howl.

Compared with various other predators, coyotes are not physically strong, but their wits, craftiness, and courage more than make up for a lack of strength. Furthermore, their capacity to withstand and overcome injury, pain, physical handicaps, as well as other hardships, is almost incredible. Their senses of sight and hearing are exceptionally well developed, but without a doubt, their sense of smell is the most remarkable.

Coyotes are sociable; they may change mates yearly, but for the most part, pairs remain together for several years or for life. Even as adults, they have a capacity for playfulness with one another.

The adaptability, wariness, intelligence, and independence with which the coyote faces its life of ever-increasing human-made obstacles are legend. (The coyote was believed by many tribes of American Indians to be the creator of the Indians themselves, of fire, and of many other things, as well as the mentor of their world-see Gill (1970) for example.) Whereas the geographical distributions of numerous other North American animals are steadily shrinking, the coyote has increased not only its numbers but also its geographical distribution. According to Seton (1928), originally-at least until 1890 or 1900—the coyote inhabited about 3 million square miles of open spaces in the American West from the western shore of Lake Michigan southwest to the northwestern corner of Arkansas and the vicinity of Houston, Texas, into Mexico. Its range extended northwest from Lake Michigan, past the western tip of Lake Superior, to about the Great Slave Lake, District of Mackenzie, Canada, and south through Alberta, Canada, into Washington, Oregon, and California. Hall and Kelson (1959), on the other hand, illustrated the present day coyote's range as extending from the northern arctic coast of Alaska southeast past the Great Slave Lake to Lake Winnipeg, Manitoba, Canada, east to the southern tip of James Bay, and south to Ottawa, Ontario, Canada. From Ottawa, its range extends southwest to the Louisiana-Texas border and into Mexico. Furthermore, it inhabits about the eastern one-half of Alaska, south throughout the Canadian Yukon and all but extreme western British Columbia, Canada, southwest into Washington, Oregon, and California, west of the Cascade Range. Bailey (1936) depicted the coyote's distribution in Oregon as all of the State east of the Cascade Range, as well as southwestern Oregon and the entire Willamette Valley. Today, however, the coyote is found throughout the State, primarily because extensive clearcutting of the forests created suitable open habitat.
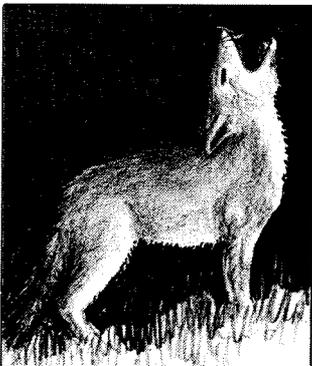
COYOTE

Coyotes usually rest during the day. In central and eastern Oregon they frequent the rimrock, canyons, and brushy areas where they can lie either in the sun or in the shade. Sometimes they sit with their backs close to a juniper tree and simply "watch the world" as they sun themselves. Along the coast they spend the day in thickets along the forest's edge or around piles of logging debris or fallen logs in clearcut areas. Underground dens are also used; such dens may be appropriated from some other animal and remodeled or dug entirely by a coyote.

In western Oregon, coyotes normally travel along the tops of ridges, as well as logging roads, visiting the saddles between hilltops and old "landings" where logs had been loaded onto trucks. Coyotes may travel great distances following the migrations of their prey, such as deer, into the high mountains in spring and summer and back to lower elevations in the fall and early winter. Nevertheless, they

do have home ranges. Their home ranges are not well understood, however (Hawthorne 1971, Knowlton 1972). Most articles on the coyote are related either to fragments of its life history or to its control or destruction as an economic detriment; Murie (1940), Seton (1928), and Young and Jackson (1951) discussed the coyote's life history.

Food: There are numerous studies about the food habits of the coyote from various parts of North America; most have been conducted with an emphasis on determining the coyote's role as a predator of livestock and game animals, such as deer and antelope (Clark 1972, Ellis 1959, Ferrel et al. 1953, Fichter et al. 1955, Gier 1968, Hawthorne 1972, Korschgen 1957, Mathwig 1973, Ogle 1971, Sperry 1941, White 1973). Although the coyote's menu gets it into trouble with some people, it also helps to control rabbits, hares, and rodents, which too are considered detrimental.

Coyotes are opportunists, both as hunters and as scavengers. They eat any small mammal they can capture as well as porcupines, deer, antelope, domestic livestock, native birds, and domestic poultry. They also eat great amounts of carrion, as well as occasional lizards and snakes. Insects, such as grasshoppers and crickets, are included in their diet. Coyotes are fond of fruits in season and partake of a wide variety, such as blackberries, cascara berries, strawberries, and salal berries. They occasionally raid gardens to get melons, earning them the name of "melon wolf."

When hunting small animals, a coyote may stalk and secure them by pouncing on them. The coyote chases rabbits and hares, taking short cuts until it is close enough to seize its prey. A pair of coyotes or a family group may pursue their prey, such as deer and antelope, in relays; one or two chase the prey toward a point where another individual takes up the chase while the others rest. Because of its method of hunting, the coyote is basically an animal of fairly open country; it normally runs down large prey instead of ambushing it as do most cats.

I do not condone or condemn the coyote; however, as with any animal, there are good and bad aspects about its effect on human interests. Furthermore, much damage to livestock attributed to coyotes is caused by domestic dogs-not coyotes.

Reproduction: Sperm production begins in males over 1 year old in November; coyotes are capable of breeding by mid-January and remain sexually potent for about 2 months.

They normally go house hunting during or shortly after the breeding season. Their dens, situated wherever the coyotes have a sense of security-usually on south-facing slopes-are prepared and ready by the time the pups are born. They usually have several dens cleaned out and other suitable areas located.

When a den or its surroundings are disturbed, particularly by humans, the coyotes move to another den. Even if they are undisturbed, coyotes tend to move periodically. Such movements probably have survival advantages by minimizing an

enemy's potential detection of the young, as well as avoiding excessively high populations of parasites (such as fleas) and accumulations of urine, feces, and food refuse. If coyotes are unmolested and their den undisturbed, they may use the den the next year.

Pups are born in a clean den from late March through early May, after a gestation period of 60 to 63 days. Litters range from 4 to 19 young, but the usual litter consists of 5 to 7 pups. Usually only one family is raised per year.

Pups weigh about 230 grams at birth, but their weight doubles in about 8 days. Although their eyes are closed at birth and do not open until they are 10 to 12 days old, the fuzzy, grayish or dark brown pups can crawl around in 2 to 3 days and can walk in 8 to 10. By the time they are a month old, they can run fairly well. Pups are fed only milk during their first 2 weeks; nursing continues for at least 3 months, sometimes considerably longer. At about 2 weeks of age, their deciduous teeth become visible, and the mother may begin to regurgitate small amounts of meat for them. Their permanent teeth replace their milk teeth when they are 4 to 6 months old, but feeding by regurgitation continues until the pups can tear food apart by themselves. Young usually attain sexual maturity by the next breeding season. Wild coyotes have lived 14 years, but these undoubtedly were very old individuals. The foregoing discussion is based on Gier (1968), Hamlett (1938), Jackson (1961), Knowlton (1972), Young and Jackson (1951); see also footnote 7, page 145.

Predation: Humans, with traps, guns, and poisons, appear to be the only creatures that are, to any extent, predators of the coyote. Parasites and disease, as well as periodic shortages of food and occasional prolonged periods of severely inclement weather, probably are the main nonhuman factors that control coyote populations.

Economic status: Because the coyote preys on livestock and poultry, whatever benefit is derived from its food habits unfortunately appears to be negated-the coyote has been judged and found guilty. A reasonable approach to the problem was presented by Gier (1968, p. 85):

> If part of the money and effort being expended at present for mass reduction of coyotes were to be properly directed, coyotes could become a real asset in rodent-rabbit control rather than a controversial "he is good-he is bad" creature. To effect such results, first a reasonably workable system must be established for determining coyote numbers-not just damage done. Second, a similar survey of natural food for coyotes (rodent-rabbit population studies) must be conducted continuously. Lastly, a control system must be maintained for removal of coyotes that become "killers" of domestic livestock and for general population reduction at critical times. With such information available, decisions could be properly derived whether to protect or reduce the coyote population that year.

Over a 22-year period from the 1952-53 through the 1973-74 trapping season, licensed fur trappers in Oregon caught 12,935 coyotes; of these, 6,145 were taken from the 1967-68 through the 1973-74 trapping seasons. The average price of a coyote pelt per year rose from $2.86 in 196768 to $19.45 in 1973-74. The 2,419 coyote pelts sold during the 1973-74 trapping season, computed from the average

price per pelt, brought Oregon trappers $47,049.55 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a). The coyote, therefore, also has an economically beneficial aspect.

Disease: Coyotes are potential carriers of rabies.

Selected references: Bennitt (1948), Broughton et al. (1970), Dieterich and Van Pelt (1972), Dobie (1949), Linhart et al. (1968), Ogle and Farris (1973), Trainer et al. (1968), Trainer and Hale (1969), Wobeser and Rock (1973).

Genus *Vulpes:* Red foxes

Derivation: The generic name Vulpes is from the Latin word *vulpis* (a fox) but it also means "cunning" or "craftiness."

General description: Foxes of the genus *Vulpes* are medium to small size for the family Canidae. They have large pointed ears, elongated sharp muzzles, and rounded bushy tails that are usually as long as the head and body. The pupils of their eyes are generally elliptical in strong light. Most, if not all, foxes have a definite "foxy" odor arising from glands situated under the tail near the anus (Albone and Fox 1971). They usually have six teats.

In members of the genus *Vulpes* the length of the head and body ranges from 37.5 to 86.5 centimeters, and the length of the tail from 22.5 to 55.5 centimeters. Adults weigh from 3 to 9 kilograms. They vary from grayish, tannish yellow, pale yellowish red, deep reddish brown, to black.

Foxes are intelligent. Although not naturally wary, as a result of contact with humans, they have developed a cunning that now connotes the name "fox" with the acme of cleverness or craftiness. They have keen senses of sight, smell, and hearing, as well as considerable endurance. At times they exhibit what almost seems to be "a sense of humor."

Red foxes live in many different habitats, from the northern arctic coast of Alaska and Canada, through the temperate brushy woodlands, to the Sahara Desert of Africa. They generally rest during the day in some sheltered spot. Members of some species are nocturnal, whereas others are active at any time. Red foxes tend to be omnivorous, eating such items as small mammals, birds, eggs, fruits, and insects.

Over most of their geographical distribution, they breed during the late winter. The gestation period ranges from 49 to 56 days. Litters range from 4 to 10 young, but the usual size is about 5. The cubs are born in a den and are cared for by both parents. Red foxes apparently mate for life; their lifespan is about 12 years.

World distribution: Red foxes occur throughout most of North America; Europe, including the British Isles; most of Africa, north and south of the Sahara; and most of Asia. They have also been introduced into Australia.

General reference: Walker et al. (1968).

Species *Vulpes **vulpes:*** Red fox

Derivation: The specific name ***vulpes*** has the same meaning as the generic name.

Specific description: Total length, 900 to 1120 mm; tail, 330 to 461 mm; hind foot, 145 to 180 mm; ear, 80 to 105 mm; weight, 3.1 to 6.8 kg-Alaskan red fox may weigh as much as 13.2 kg.
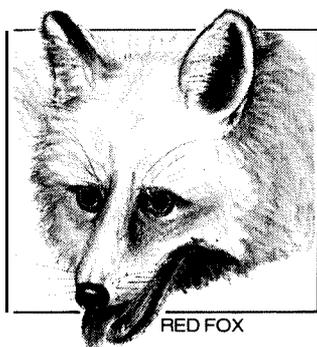
RED FOX

Red foxes are slender and light in build. They have large, erect ears and long, bushy, white-tipped tails. Their feet are small and furry. Their pelages are very long and soft. The "normal" red fox varies from pale yellowish red to deep reddish brown above, with white or light to medium grayish underparts. The lower portion of the legs is black. There are, however, other color phases. The "cross fox" is reddish brown above, and gets its name from the "cross" formed by a line of blackish hairs down the middle of its back which is intersected by another line of blackish hairs across the shoulders. The cross is most readily visible after an animal has been skinned and its pelt has been stretched out flat. The "silver fox," most prized of all foxes for its pelt, varies from "silvery" to nearly black, the general effect depending on the proportion of white or white-tipped hairs to black hairs. The "black fox" in reality is a "silver fox" that has only a meager number of white or white-tipped hairs. In all color phases the tip of the tail is normally white. For a good discussion of the color phases of the red fox in the Pacific Northwest, see Cowan (1938).

Distribution along the Oregon coast: Red foxes occur from the Columbia River, Clatsop County, south to the vicinity of Newport, Lincoln County, but with continued denudation of much of the Oregon Coast Ranges through clearcut logging, the red fox may slowly expand its distribution along the more level coastal areas.

Habitat: The red fox occurs primarily in the wet pastureland, headland prairie, and headland shrub habitats. It may also be found in the foredunes, moving dunes, deflation plain, and tideland river habitats.

Habits: According to Seton (1928), the red fox was all but absent from the Eastern United States during the early period of our history. European "fox-hunters" introduced the European red fox into the Eastern United States in colonial times; thus the eastern red fox in times past may have interbred with the European red fox. The red fox is a native mammal, however, in northern and northwestern North America.

Red foxes are creatures of open areas, such as meadows, that are interspersed with patches of brush and timber. They are resident wherever they are found and seldom emigrate to other areas unless forced to by shortages of food or other severe circumstances. These animals are alert, cautious, cunning, and swift. Intelligent and quick to take alarm, they can hold their own among humans.

A red fox crossing a meadow on a foggy morning is indeed a beautiful sight. The fox's graceful, fluid motions make it appear to float through the fog not touching the ground. Bailey (1936, p. 283) wrote of the red fox:
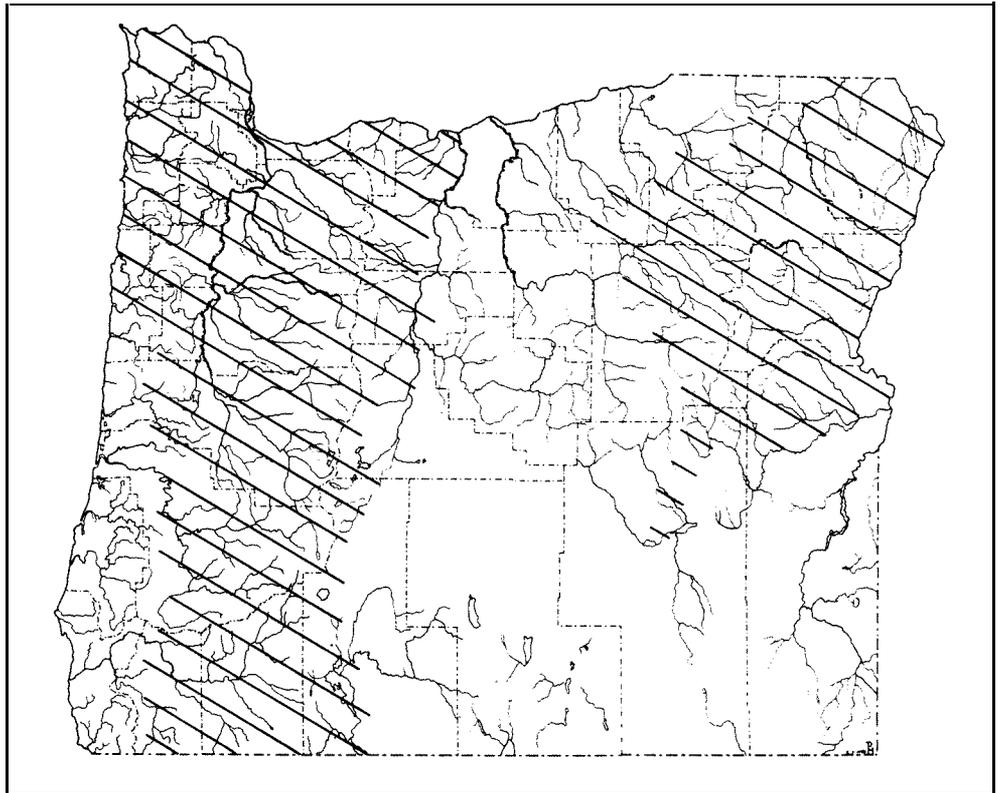
KNOWN DISTRIBUTION OF RED FOX

> Few animals are so quick and agile or so light and graceful in motion. . . .
> Usually the long lines of delicate tracks in the snow, the prints of the nar-
> row, furry feet in dusty trails, or the pungent almost musky odor greeting
> one's nostrils in the dewy morning, furnish the only evidence that a fox has
> passed along in the night.

Red foxes generally are not noisy. Jackson (1961, p. 303) stated that "its principal
sound is a rather high-pitched howl that consists of a few short yaps or barks
followed by a long gurgling ya-a-a-a-a-r, and sometimes ending in a near scream or
screech." Bailey (1936, p. 283) wrote that "their short, sharp little bark, like that of
some small dog but more rapid and prolonged" was heard in the evening or morn-
ing; see also Seton (1928).

The red fox is a mild-tempered carnivore, often frolicking at twilight or on
moonlight nights, but in no sense is it a gregarious or sociable animal, except in
the family group (Jackson 1961).

In addition to helping a red fox maintain its balance when forced to turn or dodge
swiftly, the bushy tail serves other purposes. Seton (1928, p. 487) stated, "Its nose
and pads are the only exposed parts, and these might easily be frost-bitten when
it sleeps during severe weather. But it is always careful on lying down to draw
these together, they curl the brush [tail] around them; this acts both as wrap and
respirator." He observed that the size of the tail depends on the coldness of the

climate. The tail, according to Seton (p. 487) is also important during a fight.

> After the first jump, they turn their brushes toward each other, open their mouths, showing their teeth, and advance snarling, watching carefully over their shoulders, as their rear is turned to the enemy. They make the funniest bounds imaginable; first one way then the other, as if made of rubber, frisking their brushes in each other's faces, or using them for a guard. . . [toward] off any sudden blow his adversary may deliver.

Although a red fox may occasionally lick itself clean, it usually rolls in sand or dust to cleanse its pelage (Jackson 1961).

Data suggest that the size of the home range of an individual red fox is similar to the size of the territory of the family. Red fox families occupy territories of about 1.6 to 4.8 square kilometers. Furthermore, data suggest that red foxes have innate minimum and maximum spatial requirements which are manifested in their territoriality. The size of a red fox's territory is a reflection not only of population density but also of overall environmental conditions. In other words, as a red fox population declines, the remaining individuals increase their territories to the maximum size; if, however, the population continues to decrease and all the remaining individuals have established maximum-size territories with adequate supplies of food, then areas of suitable habitat remain unoccupied (Sargeant 1972).

Food: Although including domestic poultry in their diet gives red foxes a bad reputation with farmers, on the whole what they eat is beneficial to farmers. The red fox is an opportunistic hunter and is omnivorous, eating mammals, birds and their eggs, reptiles, fish, insects and other invertebrates, carrion, as well as many fruits and other plant parts. In many areas the main prey of red fox consists of voles, rabbits, and hares but also includes shrews, moles, mice, pocket gophers, ground squirrels, chipmunks, tree squirrels, a variety of birds, and whatever else may be available. A few of the many studies on food habits of red fox are: Coman (1973), Englund (1965a, 1965b, 1969), Johnson (1970b), Knable (1970).

Jackson (1961, p. 304) described the hunting behavior of the red fox:

> The red fox hunts by stealthy approach, creeping low, stopping to stretch its head high to peek and sight its prey, then pouncing with forefeet on the mouse, rabbit, or other prey, and biting it back of the head if it be large or merely nipping or nosing it if it be small, before consumption. It never runs its prey any distance, and rarely waits by a trail for its prey unless it senses its presence nearby. It seems to prefer as food the forequarters and body of its larger victims, and has small liking for the hindquarters, which it often buries lightly in the soil as it does other surplus food.

Reproduction: The breeding season for the red fox begins in January and lasts through February. Occasional individuals may breed as early as the last of December. There usually is only one litter per year which is born in a clean den after a gestation period of about 53 days. Litters consist of 2 to 10 cubs, but 5 to 6 cubs is the normal size (Jackson 1961). Yearling females produce smaller litters than do older females. (Females are commonly called "vixens.") Sizes of litters vary from year to year, depending on the available supply of food for the vixens, as well as social stresses on them (Englund 1970).

At birth, the young are lightly covered with fine, fuzzy, dull gray, dark brown, or blackish fur, but with a distinctive white tip on the tail. Their eyes open in about 9 days; they grow rapidly, beginning to play around the burrow entrance in about 3 weeks. Morning and evening are the principal playtimes. Either parent, usually the vixen, watches or both parents watch the youngsters as they play. At about 2 months, cubs are weaned and food is then brought to them by their parents (Jackson 1961). Livezey and Evenden (1943) found that a pair of red foxes 3.2 kilometers west of Corvallis, Benton County, Oregon, had bought the following food to their seven pups: eight Beechey ground squirrels, several black-tailed jack-rabbits, one brush rabbit, one domestic turkey, one domestic chicken, and one "Oregon" towhee; the remains were scattered in and around the den. (For additional information on the diets of fox cubs, see Englund (1969).)

The cubs usually abandon the family den shortly after they attain 4 months of age, at which time they are nearly three-fourths grown and their permanent teeth are replacing their deciduous teeth. The young are essentially mature when they are about 6 months old, and they may breed the following winter (Jackson 1961). They begin to disperse from their natal range (the home range or territory of their parents and siblings) during October when they are about 7 months old. The straight-line distances traveled by 171 juvenile males ranged up to 162 kilometers with an average of 29, whereas the distances traveled by 124 juvenile females ranged up to 83 kilometers with an average of 9.9 (Phillips et al. 1972). According to Jackson (1961), the normal longevity (lifespan) of a red fox in the wild is probably less than 8 years, depending on the hunting and trapping pressures, but the potential longevity may be nearly 15 years; also see Andrews et al. (1973), Layne and McKeon (1956a, 1956b), Pearson and Enders (1943), Phillips (1970), Schofield (1958).

Although red foxes seldom use dens except to house and rear their families, there is usually more than one den in a family's territory. The foxes probably excavate most dens themselves, but they may renovate the burrow of some other animal. When possible, red foxes construct dens on or near the tops of south-facing slopes and take advantage of the warming spring sun. Dens ordinarily are 4 to 6 meters long but sometimes are 12 meters or more. Living quarters are at least 1 meter below the surface of the ground. The entrances are 30 to 37 centimeters high, 20 to 28 wide; there are usually at least two entrances to each den. Since they most often open in different directions, they afford the family a measure of safety. Even though the entrance to a den is usually littered with food refuse and other waste materials, the inner living quarters are often bare but always clean and tidy (Jackson 1961, Livezey and Evenden 1943, Seton 1928).

Predation: Although humans are undoubtedly the red foxes' worst enemy, they may be preyed on by wolves, lynx, fishers, wolverines, and occasionally a coyote. Some also die from the effects of porcupine quills after either an accidental or a purposeful encounter with the owners (Jackson 1961, Seton 1928). Dixon (1933) reported an experience about potential predation:

> I was fortunate enough to witness an attack by a golden eagle upon a cross fox. . . in Alaska on July 8, 1932. . . I saw an adult fox in worn pelage crouching in the open beside the road near a galvanized iron culvert. This

fox was very loath to run even when closely approached. At first I could not understand its unusual tameness, but I was soon enlightened by a golden eagle's swooping down at the fox, which speedily sought shelter. Looking into the culvert I found another large male cross fox hiding there. Seeing me he started off down the road at full speed, but before he had covered 100 yards there was a "hiss of wings," and the eagle flew at him like a thunderbolt. Just as the eagle struck, the fox jumped nimbly to one side and thus evaded the eagle's talons. As the eagle descended the second time, the fox fluffed out his tail and stuck it straight up in the air over his back, so that is served as a protecting foil at which the eagle struck, and again missed the fox. The third attack of the eagle was frustrated by a dive into a narrow crack in the solid rock, where I found the fox with his nose just sticking out. He allowed me to approach within three feet of him and even then he would not risk the open again. Instead, he crouched as far back in the shallow crevice as possible, where I left him trembling with his eyes glowing like twin coals of fire.

Economic status: Although red foxes are usually associated with "fox hunts" and raids on flocks of domestic fowl-such as chickens, ducks, and geese-they also eat many hares, rabbits, and rodents that are considered "pests" in their own right (Findley 1956, Johnson 1970b, Knable 1970, Korschgen 1959, Pils and Martin 1978, Sargeant 1972, Stanley 1963).

Red fox pelts have been fashionable for many years. Over the 22 years from the 1952-53 through the 1973-74 trapping season, 2,216 red foxes were captured by licensed Oregon fur trappers. The average price per pelt rose from $3.34 in 196364 to $27.12 in 197374; thus the 707 pelts sold during the 1973-74 trapping season brought licensed Oregon trappers $19,173.84 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a).

Disease: Red foxes suffer outbreaks of rabies; therefore, a sick fox should be left strictly alone. In addition, red foxes are one of the hosts of adult tapeworms, *Echinococcus multilocularis*, that, although small, are highly infectious to humans. Not known to occur in Oregon, this parasite may spread into the State. In red foxes, the tapeworms' eggs that pass through the anus are the infective stage; thus, fur trappers should use caution while skinning these animals. The larval tapeworms form cysts in humans and cause the serious "alveolar hydatid disease" (Carney and Leiby 1968, Hnatiuk 1969, Rausch and Richards 1971, Wilson et al. 1968).

Selected references: Amyx and Huxsoll (1973), Houseknecht and Huempfner (1970), Monson et al. (1973), Murie (1936), Richards and Hine (1953), Stuht and Youatt (1972), Trainer and Hale (1969).

Genus *Urocyon:* Gray foxes

Derivation: The generic name *Urocyon* is derived from the Greek words *oura* (the tail) and *kyōn* (a dog).

General description: There are two species of gray foxes. The length of the head and body ranges from 48 to 68.5 centimeters, and the tail from 11 to 44.5 centimeters. Adults usually weigh from 2.5 to 7 kilograms. Gray foxes have coarse pelages that, although commonly sold for furs, are not classed as fine furs. The face, upper part of the head, back, sides, and most of the tail are gray, whereas the throat, sides of the neck, lower flanks, and underparts of the tail are bright reddish brown. The hairs along the middle of the back and the top of the tail are heavily tipped with black, creating the illusion of a black mane. Black lines also occur on the legs and face of most individuals. The throat, insides of the legs, and underparts of the body are white.

Gray foxes are often called "tree foxes" because they frequently climb trees. These foxes use caves, cavities and crevices in rocks, and hollow logs and trees for dens; they may also dig their own dens or appropriate those of other animals. They are mainly nocturnal, resting in a secluded place during the day. Gray foxes have a varied diet, including small mammals and birds, as well as many fruits and other portions of plants.

A single litter, consisting of two to seven— usually three to four-young, is born each year in the spring after an average gestation period of 63 days. The cubs, born in a den, weigh about 115 grams and are blackish at birth. They begin eating solid food in about 6 weeks and begin to disperse in the late summer or early fall. The parents, on the other hand, may remain together throughout the year.

World distribution: Gray foxes occur only in the Americas, the Eastern, Southwestern, and extreme Western United States, south of the Columbia River, including certain islands off the coast of southern California, through Central America into northern South America.

General reference: Walker et al. (1968).

Species Urocyon cinereoargenteus: Gray fox

Derivation: The specific name cinereoargenteus is derived from the Latin words *cinereus* (ash colored) and *argenteus* (silvery); the name refers to the overall coloration of the backs and sides of these foxes.

Specific description: Total length, 800 to 1125 mm; tail, 275 to 443 mm; hind foot, 100 to 150 mm; ear, 80 mm; weight, 3.2 to 7.04 kg.
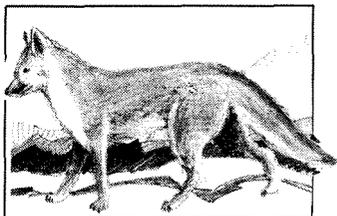
GRAY FOX

Gray foxes are relatively small; they have rather short legs, and fairly sharp, well-curved claws. Their pelages are short and coarse, and their tails appear somewhat flat vertically. The face, upper part of the head, back, sides, and most of the tail are gray because of the numerous white- and black-tipped outer guard hairs that obscure the brownish underfur. The throat, sides of the neck, lower flanks, and underparts of the tail are reddish brown. The hairs along the middle of the back and along the top of the tail are heavily tipped with black, creating the illusion of a black mane. The tip of the tail is black. Black lines also occur on the legs and face of most individuals. The throat, insides of the legs, and underparts of the

body are white. The summer pelage is brighter than the winter pelage, with lighter gray and more orangish sides and legs. A nursing female has pinkish hairs on her belly.

Distribution along the Oregon coast: Gray foxes occur from the vicinity of Florence, Lane County, south into California. They have not been recorded along the northern Oregon coast.
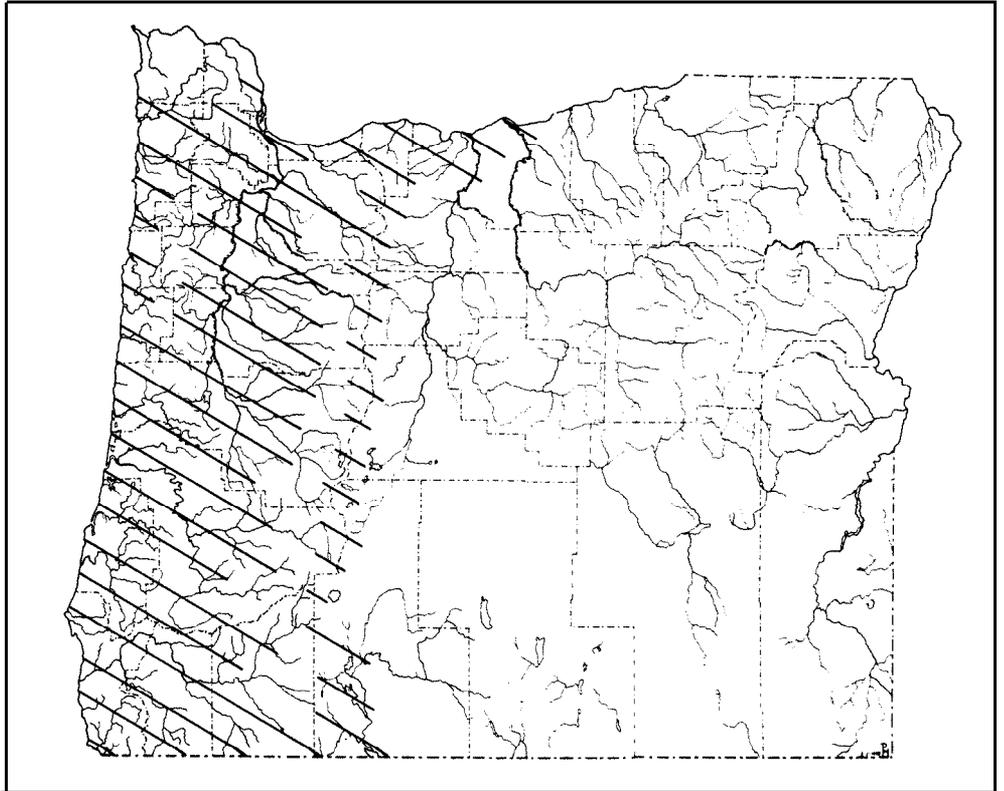
KNOWN DISTRIBUTION OF GRAY FOX

Habitat: These small foxes may be found in the riparian hardwood, headland prairie, headland shrub, and tanoak habitats. Undoubtedly, they occur in other habitats as well, at least occasionally.

Habits: Gray foxes are essentially inhabitants of wooded areas, particularly mixed hardwood or mixed hardwood-conifer forests. Although primarily nocturnal, they are not strictly so and have been seen during the day, apparently foraging for food. Gray foxes are thought to be "cowardly" by many people, but they are better regarded as cautious (Davis 1966, Seton 1928).

Gray foxes are either not as curious as or are more secretive than red foxes and are not so easily observed. They ordinarily sleep throughout the day in a hollow log or tree or some other sheltered place (Jackson 1961).

These small foxes lack the speed and fluid grace of the red fox; nevertheless, they are exceedingly quick at dodging and turning. Because they lack speed, these gray foxes, of necessity, take advantage of rocky or brushy cover. If adequate cover is lacking but trees are at hand, a gray fox will take refuge up the first tree that offers escape. It is the only member of the dog family in North America that regularly climbs trees. When a tree has limbs close to the ground, a fox simply hops from branch to branch as it ascends the tree. When necessary, gray foxes also "shinny up" or climb cat-fashion up the limbless trunk of a tree and, once among the branches, hop from limb to limb (Bailey 1938, Jackson 1981). Bailey (1905, p. 181) wrote of the gray fox:

> Strange as it may seem, these foxes go up the trunk of a tree with almost cat-like ease. I have found them looking down at the dogs from 20 to 40 feet up in the branches of nut pines and live oaks, and have known their climbing a yellow pine (*Pinus ponderosa*) where 20 feet of straight trunk over a foot in diameter intervened between the ground and the first branch. More often they take to a live oak or juniper, where the lower branches can be reached at a bound, and then, squirrel-like, hide in the swaying topmost branches. On the approach of the hunter they become anxious and seem to doubt the security of their position, sometimes making a flying leap to the ground. Stones and clubs will usually dislodge them from the tree top, but as they still have a good chance to escape the dogs and take to the rocks, it is a common and heartless practice to shoot them so as to break a leg and make escape impossible.

Gray fox climb trees not only to escape from enemies but also to rest and to hunt for food. They have even been found curled up in abandoned hawks' nests in the tops of trees (Seton 1928).

Bailey (1938) described the voice of the gray fox as a sharp little bark. Apparently it does less yapping and barking than the red fox. Its voice is less sonorous, lower in pitch, and not as loud as that of the red fox, but it is similar in some respects. When contented, the gray fox may utter a "purring grunt," but it is usually a quiet animal (Jackson 1981).

Jackson (1981, p. 310) wrote:

> The home of the gray fox is a den concealed in brushland or woodland, and may be in or under a hollow log or stump, in the base of a hollow tree, in a natural crevice among rocks, rarely in a burrow under a stump or rock pile, and very rarely if ever in a burrow in an exposed field or meadow. A den containing four young in a discarded milk can has been described in Pennsylvania in the year 1943. A scant nest is composed of leaves, grass, fur, and any available soft material scratched together by the fox. There is little evidence of sanitation around the den, though usually the entrance is not so messed with bones and waste food as in the case of the red fox, and the entrance is more direct and without the play platform. Winter protection or shelter from an enemy may be sought in any convenient hollow log, stump, or tree, or in a hole among rocks.

I have seen only one den of a gray fox, 3.2 kilometers south of Corvallis, Oregon. It was in a small grove of white oak trees. The den, dug by the foxes, had three well-worn trails leading to it, but the single entrance was well concealed under a clump of poison oak. It was occupied by two adults and four juveniles.

Seton (1928, p. 577) described the disposition of the gray fox:

> If we mix equal parts of Red-fox, Coon, and Bobcat, and season the combination with a strong dash of Cottontail Rabbit, we shall have the Gray-fox's disposition synthetically produced. He is shy, he is cunning, he is a desperate fighter when at bay, he loves the trees and yet rejoices in the briar brush, he can run for hours and is adept at trick-trailing, but will hide in a burrow or up a tree; and the places he frequents are the places where any one of these animals also may be found.

Food: Gray foxes are hunters of small animals but depend on fruits and other portions of plants for food more than other foxes do. In Oregon they feed on such small mammals as mice, gophers, kangaroo rats, woodrats, ground squirrels, chipmunks, and brush rabbits, as well as whatever small birds and unprotected domestic poultry they can catch. They also eat grasshoppers; beetles; berries of manzanita, juniper, and cascara; blueberries, grapes, figs, plums, cherries, apples, or any accessible cultivated fruits (Bailey 1936). Unwanted food may be left with little attempt at concealment; food, so far as is known, is neither hidden nor covered for storage (Jackson 1961). For additional information on the food habits of gray foxes, see Bailey (1905), Davis (1966), Errington (1935), Latham (1952), Nelson and Handley (1938), Richards and Hine (1953), Seton (1928).

Reproduction: Mating occurs from the middle of February through March. After a gestation period averaging 63 days, a litter of two to seven-usually three or four-cubs are born in a den. (Davis (1966) and Walker et al. (1968) cited the average gestation period as 63 days, whereas Jackson (1961) cited 51 days.) At birth cubs weigh about 115 grams; they are blind and nearly naked. Their eyes open in about 9 days, and they soon are covered with grayish or blackish fuzzy fur. Apparently the female cares for the young by herself until they are about 2 or 3 weeks old, at which time the male may begin to bring food to the family. At about 3 months of age, the cubs begin to fend for themselves, but they do not leave the family until late summer or early autumn, when they are nearly full grown. The parents, on the other hand, may remain together throughout the year. In the wild, gray foxes probably live less than 6 years; in captivity, they usually live less than 8 years (Jackson 1961, Walker et al. 1968). See also Wood (1958).

Predation: Jackson (1961) indicated that few predators molest adult gray foxes but that the bobcat, coyote, great horned owl, and possibly some of the large hawks may prey on the pups. Almost none are killed by automobiles. Davis (1966) stated that in Texas as the coyote population increases, the gray fox population decreases, and vice versa. People are the principal enemy of gray foxes, killing many of them with guns, traps, and poisons-some for pelts, some for elimination, and some for sport.

Economic status: True, gray foxes prey on domestic poultry and game birds to some extent, but it is doubtful that the species as a whole deserves the bad

reputation it has with farmers and hunters. Their basic diet helps to control rabbits, hares, and rodents, many of which are also economically detrimental.

Although the pelts of gray foxes are not as valuable as those of red foxes, they are, nevertheless, of demonstrable economic value. Over the 22 years from the 1952-53 through the 1973-74 trapping season, 2,591 gray foxes were captured by licensed Oregon fur trappers. The average price per pelt rose from $1.50 in 1967-68 to $16.98 in 1973-74; thus, the 259 pelts sold during the 1973-74 season brought Oregon trappers $4,397.82 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a).

Diseases: Gray foxes are susceptible to tularemia (Jackson 1961), a bacterial disease that is highly infectious to people. They also carry rabies (Jennings et al. 1960). During 1960 and 1961 gray foxes in the Willamette Valley of Oregon all but disappeared and did not come back until 1965 or 1966—an outbreak of rabies was thought to be responsible for the sudden and prolonged decline. Sick fox should be left strictly alone.

Selected references: Amyx and Huxsoll (1973), Jakowski and Wyand (1971), Kavanau et al. (1972), Stone et al. (1971), Wood (1958).

Family Ursidae: Bears

Derivation: The familial name Ursidae is derived from the Latin word *ursus* (bear) combined with the Latin suffix *idae* (family).

General description: Bears have large compact bodies, big heads, short powerful limbs, and short tails. They have small eyes and small, round, erect ears. Their feet terminate in five digits, each with a strong claw for tearing, digging, and in some cases, for climbing. Bears walk flat-footedly. Those that are mainly terrestrial have hairy soles, but those that climb a lot have naked soles. Males average about a fifth larger than the females. The length of the head and body ranges from about 1 to 3 meters and the tail from 7 to 12.5 centimeters. Adult bears weigh from 27 to 780 kilograms. They have long, shaggy coats; the pelage generally is unicolored, usually some shade of black, brown, or white.

Some bears are active primarily during the evening and night, others tend to be active during the day. Bears that inhabit steppes and barren areas often dig dens in hillsides; the usual den, however, is a cave, hollow log, hollow base of a tree, or the hollowed-out base of a stump.

Bears are related to the dogs and wolves (family Canidae), but the exact line of descent of the bears is uncertain. Bears have poorly developed senses of sight and hearing, but their sense of smell, although not on a par with some of their canine cousins, is excellent.

Bears are usually peaceful, inoffensive animals who try to avoid conflict; it is not surprising, therefore, that they are usually most numerous in areas remote from civilization. But if they must defend themselves, their young, or their supply of food, they are formidable and dangerous.

In temperate and colder regions, bears, except the polar bear, accumulate fat before winter, and with the onset of cold weather, they enter a den prepared earlier in the year. Once in the den, they sleep throughout the most inclement weather. Bears are not true hibernators since their body temperature is not reduced and their body functions are not completely slowed down; furthermore, they can be awakened easily and sometimes arouse during mild weather, which is not usually the case for creatures that really hibernate.

Bears inhabit the arctic, temperate, and tropical regions. Their diets are as varied as their habitats and habits. Chiefly omnivorous, they consume grasses, leaves, roots, and fruits, as well as insects, fish, mammals, and carrion.

Except when breeding or when accompanied by their young, bears are solitary. A female has a single litter of one to four young. The gestation period ranges from 6 to 9 months in members of most genera as a result of delayed fertilization and implantation of the ova or eggs. Most babies are born while the mother is asleep during the winter; birth dates vary from October to March. Young are very small at birth, from 228 to 453 grams. They become sexually mature at 2% to 6 years of age and usually live 15 to 30 years in the wild. One brown bear (*Ursus* arctos) lived 47 years in captivity.

World distribution: Bears inhabit the Northern Hemisphere and northern South America; they do not occur in Africa, Madagascar, Australia, various oceanic islands, or the Antarctic.

Fossil record: The bear family in North America dates to the late Pliocene.

Number of species along the Oregon coast: One.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus *Euarctos:* **North American black bear**

Derivation: The generic name *Euarctos* is derived from the Greek words eu (original or true) and *arktos* (a bear).

General description: Since there is only one species of black bear, refer to the species account.

World distribution: Black bear originally inhabited practically all the wooded areas of North America north of central Mexico. Today, however, they have been displaced from much of their former range.

General reference: Walker et al. (1968).

Species *Euarctos americanus:* North American black bear

Derivation: The specific name *americanus* is a proper name; this bear was named after America.

Specific description: Because measurements are generally lacking for black bear in the Pacific Northwest, the following measurements are from Jackson (1961): total length, 1270 to 1780 mm; tail, 80 to 125 mm; hind foot, 190 to 280 mm; ear, about 102 mm; weight, 22.7 to 90.9 kg.

The black bear is one of the largest mammals and is the largest carnivore in Oregon. It is exceeded in size only by some of the hoofed animals. Black bears are massive, with strong, heavy bodies and moderate-size heads; their facial profile is rather straight. They have small eyes and small, round, erect ears. The tapering nose has a broad pad (rhinarium) and large nostrils. The broad feet terminate in five digits, each with a strong claw. Compared with other species of bear, the claws are relatively short and those on the forefeet sharply curved. Their short tails are hairy and inconspicuous.

The black bear has a number of color phases-black, blue, brown, reddish brown (often referred to as "cinnamon"), and white. Different phases may occur in the same litter. Black bears occasionally have some white on the throat and chest. Only the black, brown, and reddish brown phases occur in Oregon (Cowan 1938).

Distribution along the Oregon coast: Black bear occur along the entire coast.

Habitat: They generally occur, at least occasionally, in all habitat types except the foredunes, moving dunes, deflation plain, coastal lake, and tideland river.

Habits: Bailey (1936, p. 321) wrote of the black bear in western Oregon:

> In the densely forested range of these west-coast black bears there was and still is a wealth of food and cover to support large numbers, and probably nowhere in North America were bears originally more numerous. In 1909, on a trip down the coast of Oregon the writer found them still abundant all along the way, although that part of the State had been well settled for many years. On one sheep ranch on the Chetco River in southern Curry County more than a hundred bears had been killed within the year without much apparent impression being made on the general supply. In 1929 the Forest Service credits the Siskiyou National Forest in that same general section as harboring 910 black bears, a fairly generous supply for even this extensive area of wild rough land. The dense cover of forest and undergrowth of the Coast Ranges has not only furnished protection but abundance of choice food for bears, so for actual numbers they have been less destructive to livestock, sheep, and pigs than in the more arid parts of the State where at times food becomes scarce.
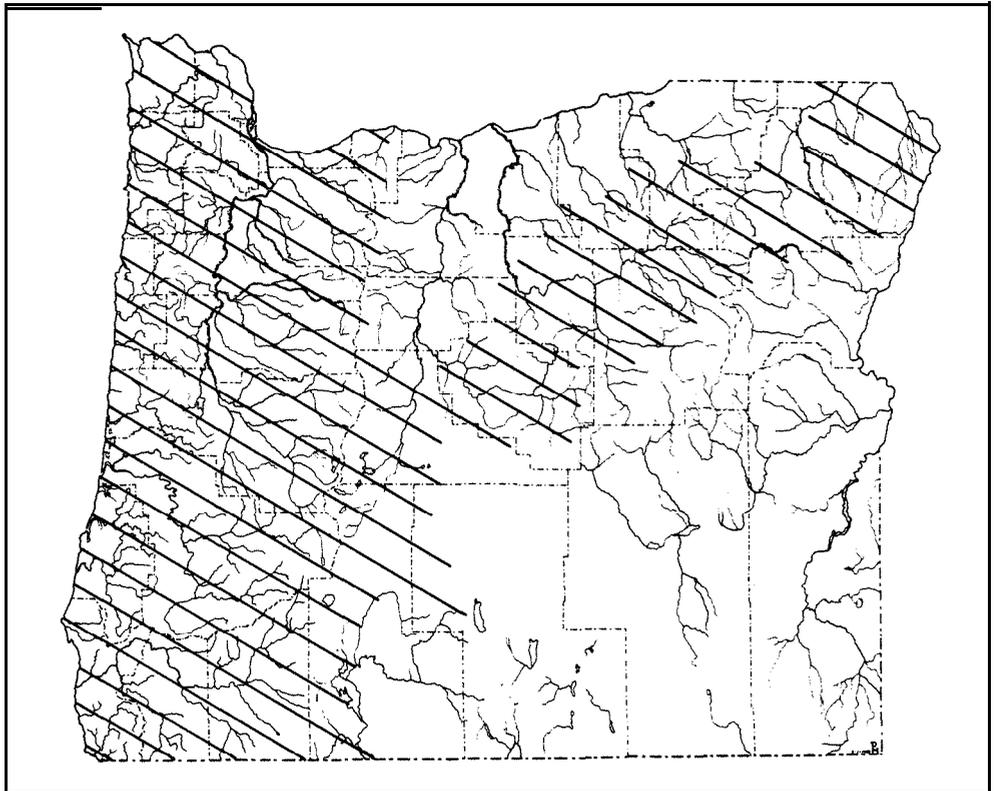
KNOWN DISTRIBUTION OF BLACK BEAR

Black bears are probably still more numerous in the Oregon Coast Ranges and along the coast than elsewhere in the State, probably because of improved habitat resulting from forest fires and extensive clearcut areas. Fires and logging have removed most of the virgin timber that once covered the land and have created relatively open, brushy country with a general abundance of food for the bears.

The setting sun in late afternoon and early evening usually brings the bears out to forage. They normally remain active throughout the night and into the early morning but occasionally may be seen during the day.

These mammals appear awkward and comical; people, therefore, often "humanize" their actions. As indicated by Dalquest (1948), a bear lumbering along a trail in full flight, its head swinging from side to side and its hind feet stretching past its forelegs, is indeed amusing. A bear's speed is deceptive; it may appear slow but can easily outrun a human.

Nussbaum related a story that illustrates why people often interpret a bear's actions in terms of human behavior.[17] Some years ago he and a coworker had left their lunches on the ground in a forest while they were working. Returning to eat,

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[17] R. A. Nussbaum, University of Michigan, Museum of Zoology,
Ann Arbor, personal communication, 1972.

they found an adult black bear pilfering their food. They yelled at the bear, and the startled animal ran to the nearest tree and started to climb. It got part way up the tree, then, losing its grip, slowly slid back to the ground. It climbed up again and slid down again. The performance was repeated a third time, after which the bear merely sat on the ground, its claws hooked into the bark of the tree and gazed at the two men. Its facial expression looked as though it were about to say, "Okay fellows you've caught me, now what are you going to do?"

Black bears are sometimes encountered unexpectedly when both a person and a bear unknowingly share the same huckleberry patch. After the initial shock of meeting face to face, both parties generally depart hastily in opposite directions. It is amazing how noisy a bear in full retreat can be.

Black bear have home ranges. In Montana the average length of a female's home range was 2.6 kilometers, whereas the average length of a male's home range was 6.2 kilometers. Home ranges of adult males ("boars") may overlap with home ranges of adult females ("sows"). But there is minimal overlap between the home ranges of two adult females or between the home ranges of two adult males. Home ranges of subadults may overlap considerably with those of adults. As an individual matures, its home range may increase in size (Jonkel and Cowan 1971).

From 1959 through 1966, Jonkel and Cowan (1971) examined 29 dens of black bears. Of these, 16 were in the bases of hollow trees; 3 under fallen logs; 5 in rock caves; 1 under a cabin; and 4 underground. The latter had been either dug by or enlarged by the bears. All the bears made hollows in which to lie, but only 10 of 31 bears moved bedding materials into the den. One female made a large bed out of bark she had stripped from cedar trees in the immediate vicinity of her den. Two bears locked the entrances to their dens with bedding material in a manner similar to that of true hibernators. A few individuals rearranged their beds during the winter.

In the coastal forest of western Washington, Poelker and Hartwell (1973) examined four den sites of black bears. Two dens were in hollow logs; one was in an ex-cavated cavity at the base of a large, rotten stump; and one was in a natural cav-ity at the base of a bigleaf maple tree. No bedding material was used.

Jonkel and Cowan (1971) found that late autumn and early winter weather greatly influenced the onset of winter dormancy. The bears usually entered their dens by late October, but during prolonged periods of Indian summer, the onset of dor-mancy was delayed until the beginning of November. The first heavy snowstorm generally sent the bears into their winter quarters. Poelker and Hartwell (1973) pro-vided evidence that at least some black bears along the Pacific coast do have definite periods of winter dormancy-nearly 3 months-even during relatively mild winters. Dormancy, beginning in early November, lasted until late February. From late February until the end of March, there was a period of mixed activity and in-activity, with complete arousal during the 1st week of April. Jonkel and Cowan (1971) found that the black bears they studied usually emerged from dormancy about mid-May; also see Erickson (1964, 1965), Gilbert (1952), Hatler (1967), and Spencer (19%).

Indians of several tribes thought that bears ate the skin off their feet during the winter and thus had sore feet in spring when they emerged from dormancy. Rogers (1974), aware of such beliefs, examined the feet of dormant black bears. He found that black bear do shed the hairless pads (soles) of their feet during winter dormancy. The newly forming pads are tender until they harden; thus, some bears indeed have tender feet on emergence. Furthermore, the droppings near the entrances of the winter dens of black bears had portions of their foot pads in them-the Indians had been correct.

Summer beds or shelters are merely concealed places scratched in the ground among dense vegetation, by a log or a rock, or under branches of a fallen tree. Resting places may be lined with bedding material. The den or resting site is fairly neat even though its owner does not habitually clean it, primarily because the bear goes some distance from its resting place to defecate or urinate (Jackson 1961).

As with most animals of solitary habits, black bears do not have any known regular call notes; they simply growl, bawl, and bellow when things are not to their liking. A mother, on the other hand, frequently vocalizes to her cubs. She calls them with a whimpering sound and warns them with a loud "woof-woof." When unsure of a disturbance, a bear will rise onto its haunches, sniff loudly, and look. Although a black bear's sight is poor and its hearing only moderately acute, its sense of smell is highly developed (Jackson 1961).

BLACK BEAR

Black bears are good, surprisingly fast, climbers. When starting to climb, a bear stands full length at the base of a tree, reaches up with its forefeet and grasps the tree with its claws and legs in a series of bounds. They cannot, however, climb small trees (Jackson 1961).

The black bear is also a good swimmer and seems to enjoy water. In hot country, a bear often bathes and wallows in shallow pools. Through regular use, such pools become known as "bear wallows." I have seen bears wallowing in muddy pools in the high Cascade Range. One large female wallowed for 3 hours on an extremely hot summer afternoon, but she did not share the wallow with her three cubs. Every time a cub tried to enter the wallow, the mother would throw it out of the water with a swipe of her forepaw. Although no such wallows were seen along the Oregon coast, they may exist.

Food: Black bears are opportunistic in their feeding. They eat a great variety of green vegetation, fruits, and fungi. In addition to plant material, they eat insects, as well as other invertebrates, mammals, birds, and carrion. Taylor and Shaw (1927, p. 37) wrote of a black bear in Mount Rainier National Park, Washington:

> He is an expert at pulling over garbage cans so as to get at their contents. One bear thus engaged was surprised by a man who quietly slipped up behind him and gave a war whoop. The bear did not take time to back out, but, uttering a surprised *w-o-o-ch!* plunged forward with the can on his head and shoulders, barely missing a tentfull of tourists, and. . . running full tilt into a large tree. The can. . . was pronounced a total wreck.

Since the food habits of black bears may differ greatly from one area to another, the reader is referred to the following references: Bennett et al. (1943), Brent and Bowhay (1956), Hatler (1967), Poelker and Hartwell (1973), Spencer (1955).

Reproduction: The testes begin to enlarge before the males arouse from dormancy and contain mature sperm before and after the period in which females are receptive, but by the time a male enters dormancy, the testes have again shrunk drastically and are nonfunctional. Females normally breed and produce litters only every other year. They come into estrus at least by the last week in May and remain in estrus until about the 2d week in August. The peak of the breeding season, however, normally is from mid-June through mid-July. A female remains in estrus either until she is bred or until her ovaries become reproductively nonfunctional. Ovulation is induced through copulation. After fertilization, the development of an embryo either ceases or is considerably slowed, and it does not become implanted in the wall of the uterus until about the first of December. After an embryo is implanted, it develops rapidly during the 6 to 8 weeks before birth in late January or early February. The gestation period is about 220 days. Litters range from one to four young, rarely five; two to three constitutes the usual litter (Erickson and Nellor 1964, Jonkel and Cowan 1971, Poelker and Hartwell 1973, Wimsatt 1963).

The cubs, born while the female is dormant, are about 15 to 20 centimeters long and weigh 200 to 340 grams at birth. The cubs are born with closed eyes and are sparsely covered with fine, stiff hairs. Development is slow the first few days after birth, but sufficiently nourished by the mother, the young grow rapidly thereafter. They open their eyes in about 25 days, at which time they are covered with short, fuzzy brownish hairs, even those that will be black adults. A mother is very attentive and protective of her young. If unduly disturbed, she may move to a new home and will carry each baby to the new den by the nape of its neck. Before they are 3 months old, the cubs commence playing by themselves, but they are carefully watched and guarded by their mother. At 6 months, they are able to fend for themselves. The young remain with the mother for a year or more, usually sleeping either with her or near her during their first winter. By the time they are 12 months old, they weigh 18.2 to 34.1 kilograms. A family normally breaks up during the breeding season (Jackson 1961). The youngest that a female black bear, in Montana, is known to have come into estrus was 4½ years. The age at which a female is known to have had her first litter ranged from 6½ to 8½ years (Jonkel and Cowan 1971). No information was found about the age at which males become sexually mature. According to Jackson (1961), the potential longevity of black bears is about 30 years, but they normally live about 25 years. In zoological parks, black bears frequently live more than 20 years.

Predation: According to Rausch (1961), in Alaska there is a widespread belief that grizzly bears prey on black bears and that the black bear may have evolved as a forest animal because of predation by the grizzly bear. Humans have been and are the main "predator" of black bears, killing many of them annually either for sport or for elimination. Black bears appear to have few enemies other than humans.

Economic status: Black bears may be detrimental to the commercially important timber of the Pacific Northwest because certain individuals girdle and kill trees by stripping off the bark to obtain the sapwood or cambium which they eat. Such

damage is normally localized and varies in severity from place to place. Furthermore, not every individual in an area damages trees (Maser 1967, Poelker and Hartwell 1973). On occasion, black bear kill sheep, pigs, and calves, but again, this is not a general behavioral pattern of the species as a whole; it is perhaps more common for black bear to raid orchards and beehives, the latter usually being badly smashed as the bears seek the honey. Black bear are classified as "game animals" in many States, including Oregon, where the annual limit is one black bear per hunter. Bear meat is often considered delicious if properly cooked. It can be used in mincemeat, and the fat, when rendered, is excellent for baking.

Disease: Bear meat, like pork, should be thoroughly cooked before it is eaten since bears harbor the parasitic round worm that causes trichinosis (Emson et al. 1972).

Selected references: Bray and Barnes (1967), Erickson et al. (1964), Erickson and Youatt (1961), Farrell et al. (1973), Folk et al. (1967), Harger (1967), Hedge et al. (1965), Jonkel and Miller (1970), King et al. (1960), Rausch (1961), Seton (1928).

Family Procyonidae: Ringtails, Raccoons, and Allies

Derivation: The familial name Procyonidae is derived from the Greek prefix *pro* (meaning before) and the Greek word *kyōn* (a dog) combined with the Latin suffix *idae* (family).

General description: The family Procyonidae, although containing only nine genera, is a diverse family and one that is hard to describe in general terms; members of this family are close to the primitive dog-bear (canid-ursid) stock.

Length of the head and body of members of the family Procyonidae range from 0.31 meter to 1.5 meters and the tail from 120 to 690 millimeters. Adults weigh from 0.8 kilogram to 135 kilograms, males averaging about one-fifth larger and heavier than females.

Procyonids have short, broad faces and short ears that are hairy and erect. The tail is prehensile or semiprehensile in some members of the family. Each foot terminates in five digits; the third digit is the longest. The claws are short, compressed, well curved, and, in members of some genera, semiretractile-they can be partly withdrawn into a sheath. In members of several genera, the soles of the feet are haired. The pelage varies from gray to rich reddish brown. Facial markings are often present, and the tail is usually ringed with light and dark bands.

Most procyonids become active in the evening, but some are active any time. Members of this family take shelter in a variety of places, such as hollow trees, rock crevices, and occasionally cabins.

Some procyonids walk on the soles of the feet with the heels touching the ground. Others walk partly on the soles and partly on the digits; their movement is usually bearlike. The members of this family are good climbers; in fact, one species spends nearly all of its life in trees.

Most procyonids travel in pairs or family groups. Members of one species travel in bands of as many as 200 individuals but usually in groups of 5 to 40. Procyonids are mainly omnivorous.

Litters range from one to six offspring. Young are born in the spring and generally weigh about 28 grams or more at birth. There may be one or two litters per year. Females of most genera begin to breed during their 1st year of life or shortly thereafter, but the males do not begin to breed until they are about 2 years old.

World distribution: The procyonids inhabit the temperate and tropical regions of the Americas and the mountainous portions of south-central Asia.

Fossil record: In North America, the record of the family dates to the early Miocene.

Number of species along the Oregon coast: Two.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus *Bassariscus:* **Ringtail**

Derivation: The generic name *Bassariscus* is derived from the Greek word *bassara* (a fox) and the Greek suffix iskos (diminutive form). The name probably alludes to this small mammal's foxlike features.

General description: Since there is only one species within the genus *Bassariscus,* refer to the specific description.

World distribution: The ringtail occurs from southwestern Oregon east as far as central Colorado, and south through Texas to southern Mexico.

General reference: Walker et al. (1968).

Species *Bassariscus astutus*: Ringtail

Derivation: The specific name *astutus* is derived from the Latin word *astus* (craft, dexterity). The name alludes to this alert, little mammal's quickness and agility.

Specific description: Total length, 616 to 811 mm; tail, 310 to 438 mm; hind foot, 57 to 78 mm; ear, 44 to 55 mm; weight, 870 to 1100 g.

RINGTAIL

A ringtail is about the size of a small house cat but more slender, with larger ears and a long, bushy tail. The tail is marked with eight blackish rings, including the tip, and seven whitish rings. The blackish rings are not completed on the whitish underside of the tail. The face is brownish gray with whitish spots both above and below the eyes and in front of the ears. The color of the pelage is about the same throughout the year; the back is dark yellowish gray and the underside tannish white or light yellowish white.

The ringtail is also called "ring-tailed cat," "miner's cat," and "cacomistle." "Ring-tailed cat" is not a good name because this mammal is not closely related to the cats. "Cacomistle" is a name more generally, and perhaps better, applied to the genus *Jentinkia* -also in the family Procyonldae-the Central American cacomistle. The name "miner's cat" came about in earlier years when much prospecting
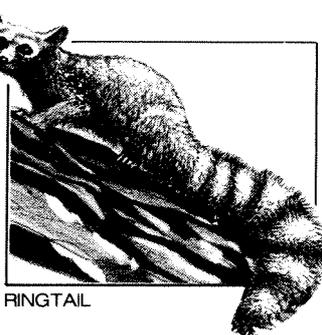
was going on in the Western United States. Miners tamed these mammals and kept them, instead of house cats, around their cabins because ringtails are excellent mousers.

Distribution along the Oregon coast: Along the Oregon coast, ringtails occur from Prosper, just northwest of Bandon, Coos County, south into California. Southwestern Oregon is the northern limit of their geographical distribution.
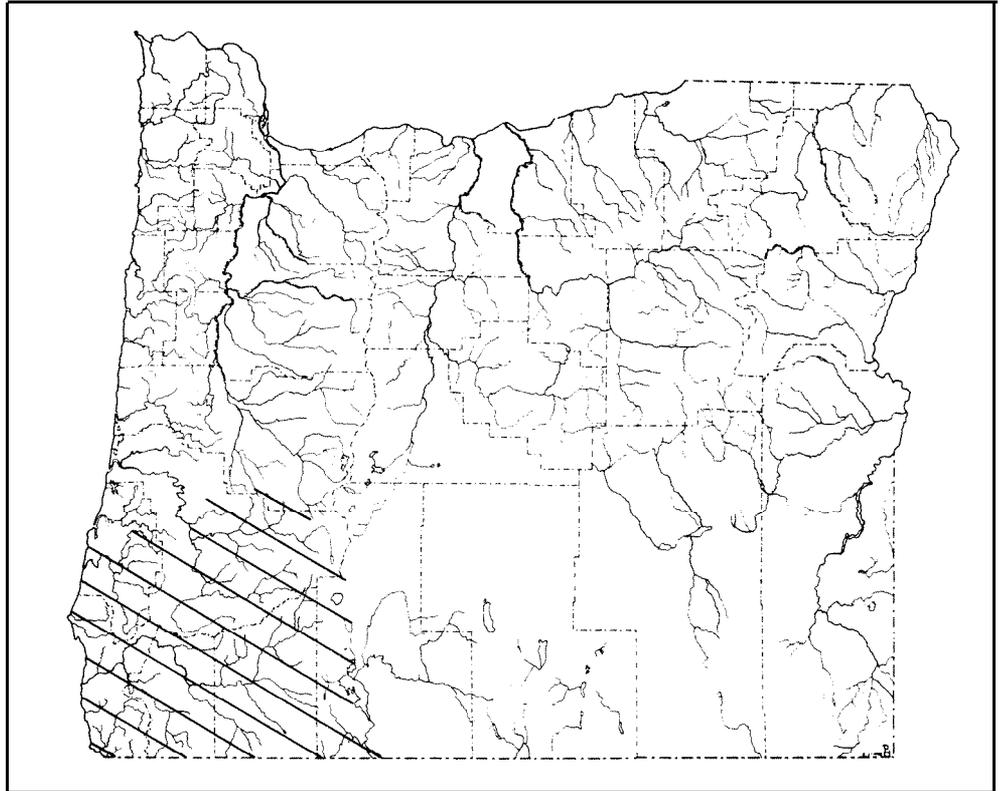
KNOWN DISTRIBUTION OF RINGTAIL

Habitat: Ringtails primarily occur in the tanoak habitat; however, they are also occasionally found in the mature conifer (redwood variant), riparian hardwood, lodgepole pine, headland shrub, and mountain river habitats. They are most common along rock cliffs near rivers, such as the Rogue River, Curry County.

Habits: Ringtails are primarily nocturnal and seldom seen during the day. Throughout much of their geographical range, they show a preference for rough, rocky, broken terrain, with or without trees. That they are eminently adapted to such habitat was illustrated by Trapp (1972). Unless otherwise stated, the following discussion is from his study.

A ringtail can rotate its hind feet 180°, pointing them straight back when it climbs downward, allowing the naked soles of its feet to directly contact the surface on which it is climbing. A ringtail descends a vertical surface headfirst. With the aid of fully extended claws, it can quickly ascend or descend vertical, rough surfaces. In fact, a ringtail can ascend the vertical edge of a smooth, narrow slab, such as a board or metal door, a narrow rod, or a smooth branch. It can also descend such objects rapidly, with or without use of its claws. An individual's strength and the friction of its naked soles, as well as its ability to rotate the hind feet either 90" or 180" and then clasp them tightly together, make such feats possible. One female even moved upside down along a cord (5 millimeters in diameter) strung between two supports, by grasping the cord with the flexed digits of all four feet. Rotation of the hind feet for grasping also occurs during play-fighting when an opponent is embraced and drawn close by all four feet. Grasping is further aided by a limited amount of opposability of the first digits of the forefeet.

Ringtails use a mountaineering technique called chimney stemming to negotiate, in any direction, a crevice between two closely spaced nearly vertical or vertical surfaces devoid of footholds. When climbing in such crevices, a ringtail exhibits surprising versatility. It may press all four feet against one wall and the back against the other; it may press both right feet against one wall and both left feet against the other, or it may use any combination of the four feet distributed be tween the two walls (except crossing the limbs). When using the "chimney" tech- nique to descend a crevice headfirst, a ringtail does not necessrily rotate its hind feet 180"; it can maintain sufficient control by applying adequate pressure to both walls.

Another amazing trait of ringtails is their ability to rebound or "ricochet" from one surface to another when rapidly ascending, descending, or running. The ricochet technique may be used to negotiate crevices that are too wide to allow use of the chimney technique and too smooth to climb directly. During an ascent, a ringtail appears to push, gaining momentum at the point of the ricochet. When descend- ing, on the other hand, the point of ricochet seems to slow the individual's momentum. The ricochet technique enables a ringtail to exert some control over the direction and speed of its travel, even permitting changes of direction from 90" to 180".

When leaping, a ringtail propels itself at a specific landing spot with considerable force; this is a deliberate, accurate launch at a particular location regardless of whether the direction is up, down, or horizontal. The "power leap" is frequently used even to jump only 0.3 to 0.6 meter, occasionally resulting in a resounding thump. One male could even launch himself accurately through an opening, 8.5 centimeters in diameter, into his nest box from a distance of 1 meter and an elevation of 76 centimeters.

A ringtail moving along a narrow ledge less than 5 centimeters in width can reverse direction at least two ways. It may raise the forequarters upward, climbing in a semicircle with the abdomen against the wall, dropping down facing in the opposite direction; or it may keep the head and torso aimed toward some object away from the ledge and walk the hind quarters up the wall in a semicircle over and down the other side while its tail hangs down over its back.

A frightened ringtail may seek a narrow crevicelike retreat where it wedges itself into the most inaccessible portion. Even while playing or exploring new places and objects, it crawls into any space that will accommodate its body.

Seton (1928, p. 277) wrote of the ringtail:

> Snug in his high aerial castle dwells the Ringtail, and sleeps placidly through the hours of brightness. Not even at sundown will he venture forth, as do so many of the gray-light creatures. Night, the very blackest, must be on woods and hill, before he unwinds his famous tail from his elegant body, peers with big, bright eyes from his high doorway, and commits himself to the adventures of his daily night.

> Long before dawning, he is fed, back, and upcurled again in his home hole; and the only proof that one commonly finds of his life and presence, is the endless chains of catlike tracks in the dust. . . .

Bailey (1905, p. 183) also was impressed with the ringtail: ". . . most of all, the big, soft, expressive eyes give a facial expression of unusual beauty and intelligence."

As indicated by Seton (1928), ringtails begin to forage well after dark. In California, one pair was observed nightly as they left their nest in an attic about 10:00 or 11:00 p.m. and proceeded slowly toward a brush-covered hillside. The ringtails moved swiftly and quietly while hunting in the thick brush and shadows, but when necessity forced them to cross moonlit places, their long tails were arched over their backs toward their heads. As the ringtails, readily conspicuous in the moonlight, bounced from rock to rock they appeared much larger than they did while hunting in the brush (Ingles 1965).

When frightened, ringtails secrete an amber fluid from their anal glands which has an unmistakable odor-sweet and musky. As it is secreted, the fluid spreads over the anal region but apparently is neither forceably expelled nor wiped or rubbed on objects (Richardson 1942). In April 1972, 16 kilometers east of Brookings, Curry County, Oregon, I heard a slight noise outside the cabin used as field head-quarters. It was a rainy night, and as I quietly opened the door, flashlight in hand, there was a blur of motion and the lingering odor of a ringtail. Although I did not clearly see the animal, the odor was positive identification of this late-night visitor.

On April 8, 1971, a man at Prosper, Coos County, shot an "unidentified critter" as it "attacked" him from a tree at night (Western World 1971). The "critter" was a ringtail, but it probably did not attack the man. The ringtail was in a fruit tree near which the man was passing. Apparently thinking that it was cornered in the tree, the ringtail had probably run toward the man, not to attack, but rather to get close enough to another tree to attempt an escape by leaping from one tree to the other. The man just happened to be between the two trees as the ringtail started its escape attempt.

The most commonly described vocalization emitted by ringtails is an explosive bark. Other vocalizations include a piercing scream and a plaintive, long, high-pitched call.

Food: Davis (1966) reported that 100 ringtails in Texas had consumed the follow-
-foods (in percent): small passerine (perching) birds, 9.9; small mammals
(woodrats, mice, squirrels, cottontail rabbits), including carrion, 24.4; snakes and
lizards, 3.9; toads and frogs, 0.2; insects, primarily grasshoppers and crickets, 31.2;
spiders, scorpions, and centipedes, 11.1; and fruits of native plants, principally per-
simmon, hackberry, and mistletoe, 19.3. The diet varied by season: mammals, in-
sects, and juniper berries in the spring; insects, spiders, scorpions, centipedes,
and persimmon fruit in the summer; birds, mammals, and fruits of hackberry and
mistletoe in the winter. There were insufficient data available to determine the diet
during the autumn. Apparently nothing is known about the food habits of ringtails
in Oregon.

Reproduction: According to Davis (1966), in Texas the breeding season is rela-
tively short. Ringtails apparently produce a single litter annually. Litters of one to
five (usually three or four) young are normally born during May and June (Walker
et al. 1968). Davis (1966) described two nursery dens. One, in a crevice near the
bottom of a rocky bluff, was about 13 centimeters in diameter at the entrance and
tapered to a narrow crack about 76 centimeters beyond. A female and four young
occupied it, but no nest was constructed for the young. The other den was in an
old, hollow stump on the side of a rocky bluff. A nest, consisting of a few dry
leaves, was in the bottom of the cavity.

Three or four days before giving birth, a female becomes antagonistic toward the
male, driving him off. At birth, ringtails weigh 28 grams. They are pink, fuzzy, and
helpless; and their eyes and ears are closed. They have blunt muzzles, no teeth,
and pigmented bands on their tails. Newly born ringtails vocalize by squeaks and
move in an awkward crawling, wriggling motion. At 26 to 29 days, their ears are
open; and by the time they are 31 to 34 days old, their eyes are also open. The
young become fully haired in a fuzzy pelage that is lighter than that of the adults
but similarly marked. At this age, the ears droop; the muzzle is long; and the
canine teeth and the outer incisors are through the gums. The young move in an
awkward crawl.

By the time the young reach 134 days of age, they are subadults, capable of adult
movements, and have the explosive bark of an adult; the testes of males, although
immature, have descended (Richardson 1942). One ringtail lived in captivity for 8
years (Walker et al. 1968).

Predation: Large owls and bobcats are probably the main enemies of ringtails. In
some States ringtails are hunted and trapped for their pelts. They are occasionally
killed by automobiles,

Economic status: Although ringtails may occasionally prey on unprotected
poultry, their natural food preferences make them beneficial.

Fur trappers reported taking 66 ringtails in Oregon from the 1940-41 through the
1972-73 trapping season. The average price of a ringtail's pelt brought only $1.50 in
1967-68 and $1.25 in 196869; thus, few trappers bothered with them. Most trappers
simply released or discarded the ringtails and did not report their capture (Oregon
State Game Commission 1972, Oregon Wildlife Commission 1974a).

Selected references: Fisher (1933), Sealander and Gipson (1972).

Genus *Procyon:* Raccoons

Derivation: The generic name Procyon is derived from the Greek prefix pro (before) and the Greek word *kyōn* (a dog).

General description: Probably most Americans are familiar with raccoons because of the "coonskin caps" worn by hunters, trappers, and frontiersmen during the early history of the United States.

The length of the head and body ranges from 41.5 to 60 centimeters and the tail from 20 to 40.5 centimeters. Raccoons weigh from 1.5 to 22 kilograms. Behind the pointed muzzle, the head is broad. There is a black "bandit mask" across the face and eyes, and there are 5 to 10 complete, black rings on the hairy tail, including the tip. The pelage is predominantly grayish to almost black. The toes are not webbed, and the claws cannot be retracted. The front toes are long and can be widely spread allowing the forefeet to be used skillfully.

Raccoons, although primarily active during the late evening and throughout the night, occasionally are active during daylight hours. They are excellent climbers and swimmers. These mammals inhabit timbered and brushy areas, frequently near fresh or salt water. They are omnivorous and eat such things as frogs, fish, crayfish, marine invertebrates, small mammals, and birds, as well as various seeds, nuts, and fruits.

Breeding takes place from January through June. The gestation period ranges from 60 to 73 days but averages 63. There may be two litters per year of one to seven young, but three or four offspring is the usual size. In the wild, the young travel with their mother when they are 10 weeks old and become independent at about 1 year. Females may breed when 1 year old, but males generally do not breed until their 2d year. Raccoons may live more than 10 years.

World distribution: There are currently seven recognized species of raccoons. They occur from southern Canada south throughout most of the United States, Mexico, and northern South America. Raccoons also occupy various islands off the coasts of North America, Mexico, and Central America.

General reference: Walker et al. (1968).

Species *Procyon lotor*: Raccoon

Derivation: The specific name *lotor* (a washer) is a New Latin word derived from the Latin word lotus (a washing). The name refers to the raccoon's habit of manipulating its food in water before eating it; in fact, the German name for the raccoon means a "washing bear" or a "bear that washes."

Specific description: Total length, 603 to 1050 mm; tail, 192 to 473 mm; hind foot, 83 to 138 mm; ear, 40 to 68 mm; weight, 1.8 to 22.2 kg.

Raccoons are heavy-bodied, compact mammals with pointed noses and short faces. They have erect ears and a black "mask" across the face, through the eyes.

They walk completely flatfootedly on naked soles. Their well-curved claws aid them in climbing. The soft underfur is largely obscured by the long, coarse, outer guard hairs. Dorsally, the pelage is a dark, coarse gray, appearing grizzled. Raccoons have a narrow whitish band across the forehead and cheeks and three whitish spots covering the chin and the sides of the nose. The tips of the ears are whitish. The round, bushy tail is completely encircled with six or seven black rings, including the tip, and six or seven gray rings. The tops of the feet are grayish. Ventrally, the pelage is light brown, more or less "silvered" by the scattered, long whitish hairs. The throat is brownish to brownish black and the chin whitish. The nosepad and the soles of the feet are black.

Distribution along the Oregon coast: Raccoons occur along the entire coast and in appropriate habitat throughout the State.

Habitat: Generally speaking, raccoons use all habitat types along the Oregon coast and occasionally wander into towns.

Habits: Although raccoons are primarily active during the late evening, throughout the night, and into the early dawn, they may be abroad during the day. While working on the Oregon coast, I heard a group of Steller jays scolding vociferously on a hot mid-July afternoon in 1970. As I quietly approached, I observed a pair of raccoons foraging along a trickle of water in the greenish light filtering down through the forest. Normally, however, the only evidence of raccoons is their babylike tracks dotting a sandbar or mudbar, a dusty road, or an ocean beach.

Urban (1970) found that, during the spring, adult raccoons became active when the sun set, but during the fall they did not commence their nightly activities until 2 hours after sunset. Juveniles likewise became active at sunset during the spring but started to forage 1 hour after sunset during the fall. Based on the recorded heart rates of three yearling raccoons, their times of sleep and activity are regular

and predictable (Folk et al. 1968). The period of deepest sleep was between 12:30 and 1:00 p.m. The time of emergence from the nest, however, varied with the time of sunset.

Contrary to popular belief, most raccoons, except females about to give birth, sleep on or near the ground during the day. A few rest in trees. Although some resting sites may be used more than once, most individuals shift to new resting places daily and do not follow a predictable pattern (Mech et al. 1966, Schnell 1969-70).

In his study in Minnesota, Schnell (1969-70) found that resting sites on or near the ground were in swampy areas, whereas most resting places in trees were in the upland, wooded areas. Urban (1970), studying raccoons in an Ohio marsh, found that during the spring they most frequently used muskrat houses. During the fall and early winter 66 percent of the raccoons used dens in trees compared with only 22 percent during the spring. It seems likely that the habitat exerts some influence on an individual's selection of a resting place. Furthermore, Schnell (1969-70, p. 86) found that raccoons sleeping on the ground were difficult to approach-perhaps sleeping less soundly than those in trees. Individuals sleeping in trees exhibited less reaction to human intrusion; although they may have been sleeping more soundly, they seemed "merely not motivated to respond." Even the noises made by climbing the trees to observe them, such as snapping branches and shaking leaves, 4.5 to 6 meters away did not cause the raccoons to alter their positions. Folk et al. (1968) concluded that raccoons are generally restless sleepers, whether alone or with company.

Schnell (1969-70, p. 84) described the resting sites of raccoons on or near the ground:

> Swamp resting sites varied from depressions or matted areas on the swamp or bog substrata to elevated root tangles of over-turned stumps. Sites on the ground surface were usually dry or slightly moist, although pools of water were often located 12 to 18 inches away. Some of these sites were completely unprotected, with no shielding vegetation immediately above; others were located under the cavity of a partially uprooted stump or the branches of a wind-felled tree. One sleeping raccoon was observed as high as three to four feet above the ground in a natural crotch formed by the projecting roots of an overturned stump. Another site was located in the open swamp on elevated grass tussocks above five feet in diameter and surrounded by water. This site was well hidden by the vegetation and could not be seen from more than five feet away. Two other sites in the open swamp could be seen easily from 10 feet away. One was a bed of crushed vegetation on a raised hummock beside a fallen log, and the other was in a mat of sphagnum moss.

When disturbed, a raccoon would leave its resting place and seek another in a similar situation. Schnell (1969-70, p. 86) said:

> Raccoon 623 was watched from nearby for about five minutes before turning her head slowly towards the observer and taking a crouched position. If there was no movement, her head would droop slightly and the eyelids

would partially close. If the observer moved even slightly, her head would orient in the direction of the movement. After five minutes the researcher rustled adjacent vegetation slowly and the animal then attempted to hide herself by drawing back into the vegetation. Ten minutes later she showed escape intention movements, orienting her head towards an eventual escape route and moving slowly in a partially crouched position. Each step was extremely slow and deliberate. A hind foot was raised slowly and held perhaps %-inch above the water; then it was dragged slowly forward until it again received the weight of the body. The front feet were not visible but probably they also performed similar movements, and the entire body seemed stationary except for slow forward motion. There were no sounds or moving vegetation to indicate the position of the animal as it moved away. This "escape" walk, while especially effective in water, was observed for raccoon 621 when it was walking on a dry substrate.

Raccoons sleeping in trees were in compact positions-lying on their sides, tightly curled-during the early morning; but by midday or later, they tended to sprawl with one or more legs, as well as the tail or head, hanging over the supporting structure. Hollow trees ("den trees") were used for sleeping also, but much less frequently. Entrances to dens varied from 1.5 to 12 meters above the ground, and sleeping quarters in most dens were well below the entrance. One feature common to all den trees was the absence of a ground-level entrance (Schnell 1969-70).

Over a period of years in western Oregon, I found several raccoons sleeping in trees. I discovered one male about 18 to 21 meters up in an ash tree; he was curled up in a natural bed where three branches separated from the main limb. The individual, discovered shortly after dawn, was plainly visible from the ground. On a sunny October afternoon, I found another male draped over the broken top of a young Douglas-fir tree about 15 meters up. Such resting sites, as evidenced by raccoon hair stuck to the bark, seem to be fairly common in areas of young Douglas-fir trees from 25 to 60 years of age. The tops are frequently broken and either permanently bent over or completely removed by wind and snow. With the leader gone, the smaller, secondary branches take over, forming a well-concealed area in which to sleep. On one occasion, a female raccoon and her four offspring were sleeping about 9 to 12 meters off the ground in the crotch of a large ash tree. The female was wedged into the crotch, and the young were all piled on top of her. Other resting sites in trees included the nests of squirrels, dusky-footed woodrats, red tree voles, Cooper hawks, and nest boxes made by humans for wood ducks. Schnell (1969-70, p. 87) stated:

> It is believed that the raccoon's attraction to tree nests is the source of food to be found there, and the use of nests for sleeping is secondary. Support for this idea is shown by the raccoon's early use of tree nests during the reproductive peak periods of birds and squirrels.

Urban (1970) indicated that the size of home ranges, as well as the distances traveled nightly, varied greatly depending on the habitat they encompassed. In his study of marsh-dwelling raccoons, he found that they spend the majority of their

time each night (75 percent) in the vicinity of shallow water. Schnell (1969-70) determined that the size of home ranges varied from 153 to 477 hectares for raccoons whose habitats embraced both lowland swampy areas and upland wooded areas. The average home range of females (251 ha) was smaller than that of males (449 ha), but the average home range of pregnant females (326 ha) was larger than that of nonpregnant yearlings (202 ha). The average distance traveled per night was also greater for males (6 km) compared with that traveled by females (3.2 km). Urban (1970) found that raccoons moved an average distance of 480 meters per hour. Movements of considerable distances occurred during a brief period, followed by a long period spent in areas of shallow water. During the fall, the greatest movement per hour occurred between 3 and 4 hours after sunset and was followed by 3 to 4 hours of limited movement. Movement then gradually increased until 1 or 2 hours before sunrise when it suddenly decreased. During the spring, this pattern of movement was essentially the same, but the total distance covered was more evenly distributed throughout the night. Generally speaking, individuals with large home ranges traveled farther per night than did those with small home ranges.

Mech et al. (1966) found that hollow trees were most frequently used during the winter, but on two occasions resting sites were localized in protected areas on the ground. They also found that more than one raccoon (usually siblings or a mother and her young) may occupy a den during severe weather. Hollow trees were most often occupied during the late fall and early winter; although on warmer days, the raccoons used muskrat houses as resting places. One raccoon, taken from a muskrat's house in January, had all four feet frozen (Urban 1970). Depending on the area, raccoons may use dens in banks (Dorney 1954, Urban 1970).

During the summer and fall, raccoons accumulate a layer of fat under the skin. Throughout the winter and early spring, sometimes as late as May, the fat is used. Average daily loss of weight by adults may be 0.19 percent during the critical months (Johnson 1970a). By spring, they may have lost over 50 percent of their weight of the previous fall (Mech et al. 1968, Stuewer 1943a).

Mech et al. (1966) found that in Minnesota it was difficult to separate the possible influence of temperature and snowfall on the beginning of winter denning of raccoons. The combination of the onset of cold weather and the first snowstorms may stimulate raccoons to seek their dens. Along the Oregon coast, raccoons were active throughout the year, except during the most inclement winter weather which seldom lasted more than 2 or 3 days at a time. They were active during clear, cold weather despite as much as 15 centimeters of snow on the ground and subsequent freezing. Regardless of whether they spend 1 day or several weeks "holed up" in their dens, raccoons do not hibernate but may become semidormant (Folk et al. 1967, 1968).

Food: Raccoons are omnivorous. Stomachs of 29 raccoons from the Willapa Harbor National Wildlife Refuge, Pacific County, Washington, were examined by Tyson (1950). Adults had been feeding entirely on tidewater and mudflat animals, such as mussels, shrimp, fish, and marine organisms. None of the 29 raccoons had consumed any plant material, and Tyson (p. 449) commented: "The conclusion seems reasonable that the raccoons took the food items which they preferred." I

have found that raccoons along the Oregon coast regularly patrol the beaches and eat any seafood that strikes their fancy. Inland from the beach they eat such things as crawfish, freshwater mussels and clams, frogs, earthworms, and young brush rabbits; they also rob the nests of birds, squirrels, and other tree-dwelling animals. Raccoons also eat such fruits as evergreen huckleberries, salal berries, elderberries, cascara berries, salmonberries, and apples. One young raccoon, killed by an automobile just east of Bandon, Coos County, even had a large, chewed piece of blue chewing gum in its stomach. Raccoons apparently shift toward a diet of available fruits during the fall and winter; this would be reasonable because some plants, such as evergreen huckleberry, retain many un-spoiled fruits throughout the winter, despite almost constant rain. (Also see Giles 1939, 1940; Hamilton 1936a, 1940, 1951; Jackson 1961; Johnson 1970a; Stickel and Mitchell 1944; Tester 1953; Yeager and Elder 1945.)
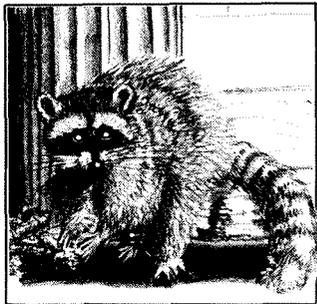
RACCOON

When hunting for food in a stream, a raccoon does not watch what it is doing but feels around under the water with its very sensitive forefeet, appearing to gaze off into space while doing so. When something of interest is encountered, a raccoon manipulates it briefly with the forefeet and then inspects it with the nose and mouth. The habit of manipulating food in water before eating it may have an adaptive value in that sand and grit are washed off before the food is consumed, preventing unnecessry wear on the teeth. Nevertheless, adult raccoons have badly worn and sometimes decayed teeth that may result from sand eaten with their food.

Reproduction: Male raccoons in Alabama had enlarged testes with mature sperm from December through June, and possibly until July or August (Johnson 1970a). On the other hand, Stuewer (1943b) concluded that males are capable of breeding throughout the year. Males with maximum-size testes were caught in western Oregon on February 11, May 6, June 5, and November 11. Females in the Northern United States breed from January through mid-March, with peak breeding activity during February (Hamilton 1936a, Jackson 1961, Stuewer 1943b). In the more Southern United States raccoons breed from February to June, with peak breeding activity occurring the last half of April. Testes of males reach a maximum average weight before the peak in conceptions (Johnson 1970a, Sanderson 1961a).

As the time of parturition approaches, pregnant females select den trees and may begin to sleep there 1 to 3 days before the young arrive (Schnell 1969-70, Schneider et al. 1971). Excluding periods of winter dormancy, females forage every night except after entering the den to give birth. They may remain in their tree-dens for 1 or 2 nights before giving birth. Two to three nights after the young ar-rive, they spend only short periods outside the dens-less than 6 hours, some-times less than 2 hours.

Pregnant females have been found from April through July and one in October, but the majority were caught from April through June. Nursing females have been found in August, but only about 4 percent of the juveniles were estimated to be born later than September 1. None of the females caught during October through December were lactating. Although very small raccoons are found in late winter, these animals may not have been as young as they appeared. Pregnancy in Oc-tober is regarded as "an extreme" (Johnson 1970a). In western Oregon, nursing females have been caught on June 21, July 22, September 17, and October 4.

Lengthening days partly influence the commencement of breeding (Bissonnette and Csech 1939). In addition, the temperature immediately before onset of the breeding season may also modify its commencement by so restricting the movements of the females as to cause them to miss being bred in the first estrous cycle; therefore, they may not be impregnated until they experience a second estrus 4 to 5 months later (Dorney 1953, Sanderson 1961a, Stains 1956).

The gestation period ranges from 63 to 65 days (Jackson 1961). Litters range from one to seven young, but the usual size in western Washington (Scheffer 1950) and in western Oregon appears to be two to three. Raccoons weigh about 85 grams at birth; their eyes are closed (Jackson 1961). The face mask is present as pigmented skin which is sparsely haired, but the tail-rings are present only as pigmented skin. The backs and sides are uniformly colored, and young of different colors-such as black, dark gray, dark brown, or light tan-may occur in a single litter. Hair on the backs and sides of newborn is relatively sparse, but at 1 week they are well covered; and by the time they are 7 weeks old, their pelage is similar to that of an adult (Montgomery 1968). The eyes of young raccoons open when they are about 20 days old (Jackson 1961). At 4 weeks they can walk shakily but can neither run nor climb; they can, however, walk, run, and climb at 7 weeks. They begin to eat solid food when they are 9 weeks old and are weaned at about 12 weeks (Montgomery 1969a).

The mother removes her young from the den and places them in a bed on the ground when they are between 7 and 9 weeks old. She may move them several times before they are old enough to begin accompanying her. When 16 weeks old, the young begin to follow their mother, and by 17 to 18 weeks they become semi-independent. Such semi-independence, beginning in September, continues until late November when raccoons begin their winter inactivity either as a family or at least close to one another. During this period of semi-independence, youngsters operate within their mother's home range (Schneider et al. 1971). Although females, and occasionally males, may become sexually mature during their 1st year of life, most do not breed until their 2d year (Johnson 1970a).

One raccoon lived in the wild for at least 12 years and 1 month (Haugen 1954).

Predation: Bobcats and great horned owls prey on raccoons to some extent (Jackson 1961, Johnson 1970a). Humans undoubtedly are the raccoon's main enemy—hunting them with dogs for sport, trapping them for their pelts, and trapping and poisoning them for elimination. They are also killed by automobiles. A sad commentary about this is that few people stop to see if they are alive or dead. I have stopped and put raccoons, usually youngsters, out of their misery. On one occasion, two babies were hit by one driver-one was dead, but the other lived in pain for several hours before I found it.

Economic status: Raccoons sometimes prey on domestic fowl, such as chickens, ducks, geese, and turkeys; in fact, a raccoon may become a real expert at raiding a henhouse. During the summer and fall, raccoons visit gardens and orchards, pilfering such delicacies as young corn, melons, and apples. On the other hand, raccoons are considered to be fine sport animals when hunted with "coon hounds," as well as being economically important for their pelts.

Over a 22-year period, from the 195253 through the 1973-74 trapping season, licensed Oregon trappers reported taking 40,327 raccoon pelts. The average price per pelt varied from $0.63 in 195253 to $2.95 from 1967-68 through 1971-72 to $10.15 in 1973-74. Thus the 3,897 pelts sold during the 1973-74 season brought $39,554.55 to Oregon trappers (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a).

I have cooked raccoons and found the flesh dark, rich, and delicious.

Diseases: Raccoon meat should be thoroughly cooked before it is eaten because raccoons may carry trichinosis. They also carry leptospirosis, tularemia, rabies, and Chagas' disease (Johnson 1970a). For information on rabies in raccoons see Bigler et al. (1973), Cappucci (1970), and Kappus et al. (1970).

Selected references: Bigler (1971), Boddicker and Progulske (1968), Clark et al. (1973), Eckroade et al. (1973), Grau et al. (1970), Herman and Price (1965), Inabnit et al. (1972), Karstad and Budd (1964), Llewellyn (1953), Montgomery (1969b), Nelson and Goldman (1930), Sanderson (1961 b), Seton (1928).

Family Mustelidae: Martens, Weasels, Skunks, Otters, and Allies

Derivation: The familial name Mustelidae is derived from the Latin word *mustela* (a weasel) combined with the Latin suffix *idae* (family).

General description: Mustelidae is a highly diverse group of mammals, consisting of 25 genera and nearly 70 species. The length of the head and body ranges from 0.14 meter to 1.5 meters. Adults weigh from 0.35 kilogram to 36 kilograms. Male mustelids average about one-fourth larger than the females. The pelage may be uniformly colored, spotted, or striped; some species of weasels turn white in winter in the northern regions of their geographical range. Members of most genera have long, slender bodies, but skunks, wolverines, and badgers are stocky. Ears are short and round or pointed. Short limbs terminate in five digits bearing compressed, curved, nonretractile claws. Badgers have large, heavy, relatively long, straight claws for digging. Otters have webbed feet which aid in swimming. All mustelids possess well-developed anal glands.

Members of this family are nocturnal, diurnal, or both. New World and Old World badgers sleep throughout most of the winter. The same is true of striped skunks in the northern regions of their range. Winter sleep may be interrupted by trips outside the shelter during warm weather.

Members of several genera are agile climbers; others are skillful swimmers. Mustelids travel singly, in pairs, in family groups, or in bands of up to 30 individuals representing several family groups. Some members have a home range of about 5 hectares; others may range over many square kilometers. Sea otters, which seldom leave the water, may range over an area of about 48 kilometers.

Members of many genera, particularly otters and Old World badgers, are extremely playful, especially when young. But they, as well as the wolverine and most other mustelids, can fight viciously if they must. Many mustelids emit pungent secretions from anal glands as a defensive mechanism. Members of some genera, such as skunks, are black and white; this color combination is thought to be a warning

coloration associated with the fetid anal gland secretion, indicating that the animal should not be molested. In some species, this contrasting coloration is exposed and emphasized by particular movements of an individual's body when it is alarmed.

Mustelids are primarily carnivorous. Although they hunt by scent, their senses of hearing and sight are well developed. Members of a few genera are more or less omnivorous; wolverines are scavengers, and otters feed mainly on aquatic life. Members of some genera store food.

The gestation period in members of many genera may range from 39 to 65 days; in others, with a prolonged delayed implantation, the gestation period may be as long as 12½ months. Most mustelids produce only one litter per year, but one species that does not have delayed implantation may bear up to three litters per year. Litters range from 1 to 13 young. With the exception of sea otters, which are born with their eyes open, mustelids are blind at birth. Most young are able to fend for themselves at about 2 months and are sexually mature in about a year. The lifespan of most wild mustelids ranges from 5 to 20 years.

World distribution: Mustelids occur throughout the world, except for Australia, Madagascar, the Antarctic, and most oceanic islands.

Fossil record: The fossil history of the family Mustelidae dates to the early Oligocene in North America.

Number of species along the Oregon coast: Eight.

General references: Anderson and Jones (1967), Walker et al. (1968).

Genus Mantes: Martens and fishers

Derivation: The generic name *Martes* is the Latin word for "a marten."

General description: Members of the genus *Martes* are inhabitants of forests, both coniferous and deciduous. The length of the head and body ranges from 340 to 615 millimeters; the length of the tail, from 150 to 425 millimeters. Adults weigh from 0.68 kilogram to 8.16 kilograms.

Martens vary dorsally from yellowish ("golden") brown to almost blackish, usually darkest on the feet and the tip of the tail; they vary from white to yellow to orange on the throat and chest. Fishers, on the other hand, have dark brown or grayish foreparts and blackish rumps, tails, and legs.

Members of this genus are generally solitary and may be abroad at any time. They are active throughout the year. During severely inclement weather they may remain in their dens. In mountainous regions, they may descend to lower elevations. These agile and graceful mammals are more or less arboreal. They eat a variety of foods, such as mice, voles, squirrels, porcupines, and fruits.

Most species have delayed implantation. Martens are born after a gestation period that ranges from 220 to 290 days. Fishers are born after a gestation period of 338 to 358 days. Litters, ranging from one to five young, are usually born in a den, such as a hollow tree, stump, or log. Individuals may live more than 17 years. Members of this genus have been highly prized for their pelts, and as a result of years of exploitation, they were nearly exterminated in many areas. Through rigid protection measures, these animals have regained a little of their former abundance in some areas.

World distribution: In the New World, martens inhabit Alaska, and martens and fishers inhabit Canada and the parts of the United States generally corresponding to the boreal coniferous forest. Only martens occur in the Old World, from the limits of tree growth south to the Mediterranean and across Europe and Asia into the Malay Archipelago.

General reference: Walker et al. (1968).

Species *Martes americana*: North American marten

Derivation: The specific name *americana* is a proper name; the species was named after North America.

Specific description: Total length, 513 to 735 mm; tail, 165 to 240 mm; hind foot, 70 to 95 mm; ear, 27 to 48 mm; weight, 0.68 to 1.45 kg.

MART EN

The marten has a long, slender body; the nose is short and pointed; the eyes are small; and the prominent ears are broad and round. The bushy, cylindrical tail accounts for about one-third of the animal's total length. The legs are short; each foot has a densely haired sole and five toes that terminate in semiretractable, slender, sharply curved claws. The pelage is thick, long, fine, and silky in winter but thinner and somewhat more coarse in summer. The coloration is about the same throughout the year. Dorsally, the pelage varies from light to dark yellowish brown or more reddish brown; the color may be slightly paler on the head and shoulders but darkens to blackish on the tail and the feet. The throat, chest, and sometimes the lower abdomen vary from yellowish to yellowish orange to rich orange.

Distribution along the Oregon coast: The marten originally occurred along the entire coast. Although it may still occupy the entire coast, it apparently is most abundant south of Waldport, Lincoln County (Yocom 1974).

Habitat: Along the Oregon coast, the marten principally occupies the mature conifer cedar swamp habitats; occasionally, however, it also occurs in the immature conifer, lodgepole pine/rhododendron, lodgepole pine/salal, and Sitka spruce/salal habitats. Now and then it may enter other habitats as well.
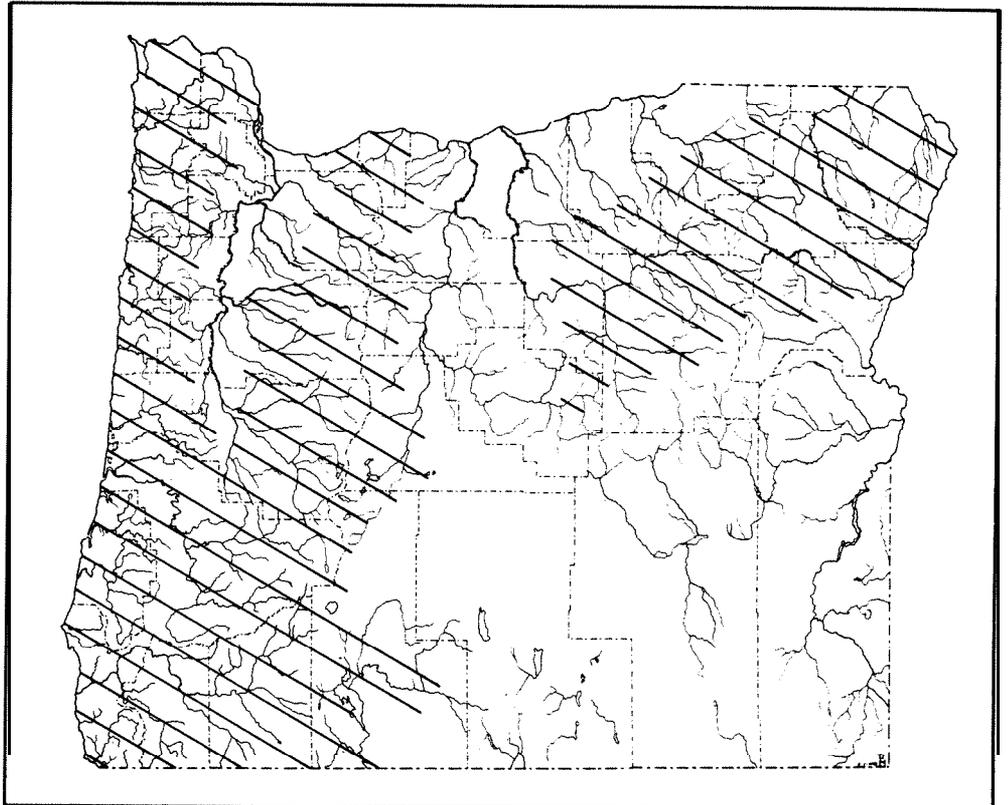
KNOWN DISTRIBUTION OF MARTEN

Habits: Martens are primarily inhabitants of dense coniferous forests, but they also travel extensively throughout the more open subalpine forests up to and beyond timberline. In general, martens are most closely associated with heavily timbered east- and north-facing slopes on which there are numerous windfalls. ("Windfalls" are areas of crisscrossed logs resulting from trees being blown down by strong winds.) They avoid areas that do not have overhead protection of living trees (deVos 1952, Quick 1953a, Weckwerth and Hawley 1962); therefore, the marten is frequently characterized as an inhabitant of the "deep forest." According to local fur trappers, martens have a particular affinity for the cedar swamp habitat along the Oregon coast. The dominant trees in these "cedar swamps" are western redcedar or Port-Orford-cedar; the latter are referred to as "white cedar swamps" by local trappers. Marten also tend to be ridgetop travelers. Since they do not tolerate the destruction of their habitat, they either have mostly disappeared or are extremely scarce along the Oregon coast. Furthermore, they show little inclination to remain in areas of either concentrated human use or residence. Their last real stronghold in the Oregon Coast Ranges appears to be in the vicinity of Loon Lake, Douglas County.

Miller et al. (1955, p. 7) wrote of the marten in British Columbia, Canada:

> The marten is a climax or near climax species. Its disappearance from large areas of its former range is at least partly the result of destructive forest practices which denuded the forest land and hence destroyed

marten habitat. Many lands so logged or burned are now supporting forests approaching maturity. At the same time, forest cropping is entering a new era. Former logging philosophies created vast areas of deforested lands. Modern methods work with land units in which forest areas of different ages remain constant. Provided that the older forests in such cutting units are old enough to be good marten habitat, this new era in forestry promises to provide and perpetuate constant areas of marten habitat.

The marten appears to be a less wide ranging species, at least in some areas, than was formerly generally believed. This has implications in management. Habitat destruction, as by fire or logging, can eliminate more individuals per unit area destroyed than was once apparent. In addition, the effects of trapping may be more local than early studies indicated.

Although martens are active during the night, chiefly at dusk and at dawn, it is not unusual to see an individual abroad during the day. These mammals appear to be as much at home in the trees as they are on the ground. When I have startled martens in the wild, they have almost invariably escaped by bounding up a nearby tree and then traveling from one tree to another, frequently leaping between trees with agility and grace. Martens are alert, wary animals that can disappear quickly when they choose. If an observer remains quiet and motionless, a marten may approach closely, apparently unaware of the person. Nevertheless, a marten's senses of sight, hearing, and smell are well developed, as is its curiosity.

The marten, on the whole, is a quiet animal making almost no noise as it roams its forested haunts. When it is with its young, however, it may utter a "soft purrlike grunt" or a "cooing sound." When captured or cornered, on the other hand, a marten may chatter, snarl, growl, hiss, or even "screech" or "scream" sharply (Jackson 1961). In 1958, I "treed" a marten in the high Cascade Range. The tree, a small fir near timberline, was so far from its neighbors that the marten could not jump from it to another tree. Being cornered, the marten "threw a temper tantrum." It ran up and down the trunk of the tree and out onto a branch toward my face, chattering, hissing, and snarling. Near the end of the limb, it would stop and bounce up and down on its front feet, all the while clearly communicating its "indignation." When I hissed or snarled in return, the marten would appear to swap ends in midair and disappear up the tree, returning almost immediately. After 15 or 20 minutes, I departed, leaving the marten hissing and bouncing on the limb.

Martens are basically solitary and do not seem to be particularly communicative vocally, but before and during the breeding season both sexes establish odor or scent posts by frequently rubbing the abdominal scent glands on such objects as tree branches (Jackson 1961).

A marten uses a den wherever it happens to be. Marshall (1951a, p. 900), tracking 16 martens to their dens, found that 13 had used logs and 3, holes in stumps. "There appeared to be little regularity in the use of dens-the important point was the proximity of the food."

Hawley and Newby (1957, p. 178) studied the home ranges of martens. They wrote:

> Home ranges of adult marten. . . of like sex were rather evenly distributed with little overlap. An exception was the almost complete overlap exhibited by home ranges of two adult males. Marten of opposite sex were apparently quite tolerant of each other since the home range of a male often included the ranges of one or more females. Tolerance toward juvenile marten of either sex was indicated since their home ranges were established without regard to ranges of other marten.

Some home range boundaries coincided with various features of the vegetation or topography; for example, with the edges of large, open meadows and burned areas. Since marten seem to avoid entering such areas, they apparently act as "psychological rather than physical barriers. . . ." On the other hand, a flowing stream may be a barrier to the expansion of a home range during the summer, but if the stream freezes solidly during the winter, it may be readily crossed by a marten (Hawley and Newby 1957, p. 178).

The area encompassed by a marten's home range has been variously given as 16 to 24 kilometers in diameter (Grinnell et al. 1937), 16 to 40 kilometers in diameter (Davis 1939), and 19 to 24 square kilometers (Marshall 1951a). Miller et al. (1955) indicated that marten's home ranges are smaller than was previously thought; and Hawley and Newby (1957) found that males had a home range of 1.5 square kilometers, whereas females had a home range of 0.43 square kilometer. Furthermore, Hawley and Newby (1957) captured an adult male at various times on successive days throughout a year. The 40 "minimum daily movements" ranged up to 2.6 kilometers; the average daily movement was 0.74 kilometer.

In studying the fluctuations of a marten population in Montana, Hawley and Newby (1957) found that the population was changing constantly because of immigration and emigration of individuals. They found that individual martens fit into one of three categories: (1) transients-martens captured over a period not longer than 1 week, (2) temporary residents-martens captured over a period longer than 1 week but shorter than 3 months, and (3) residents-martens captured over a period of 3 months or longer. Of the 85 martens caught during the study, 47 were transients, 8 were temporary residents, and 30 were residents. The large number of transients indicates that many individuals merely pass through an area. Even though 38 individuals were classed as temporary residents or residents, probably no more than 27 actually resided in the area at any one time, illustrating that residents, as well as transients, are involved in the fluctuations of a marten population.

Food: Martens prey on a wide variety of small mammals, such as shrews, mice, voles, woodrats, pikas, rabbits, hares, mountain beaver, chipmunks, squirrels, and even an occasional bat. Although small mammals are their most important food, they also eat insects, birds, and berries-such as Oregon grape, snowberries, strawberries, serviceberries, and currants-as well as carrion. Martens pursue their prey either on the ground or through the trees; they can go almost anywhere a squirrel can go. They also spend time on large rock slides, searching in and out among the boulders for available prey, such as pikas. Prey is initially bitten on the head and neck; once secured, it is taken to a sheltered spot to be eaten. Since martens consume the hair, bones, feathers, and entrails, as well as the flesh of

small animals, little evidence of their kill is left. When large prey-such as rabbits, hares, or squirrels-is eaten, the feet and large bones are discarded as refuse (Remington 1952). Weckwerth and Hawley (1962), studying the food habits of martens in Montana, determined that, besides eating available food, martens also definitely prefer certain foods. Following are a few of the other studies made of the marten's food habits: Cowan and Mackay (1950), Lensink et al. (1955), Marshall (1946), Murie (1961), Quick (1955).

Reproduction: Martens breed during June, July, and August, during which time males and females become playful with one another. As the breeding season terminates, however, they revert to a solitary life. Because of delayed implantation, the gestation period ranges from 7 to possibly 9½ months. Embryos, usually implanted in the uterus during February, have an "active" growing period of 27 days before birth. Litters, ranging from one to six (usually two to four) young, are born in April, May, or June (Bailey 1936, deVos 1957, Jonkel and Weckwerth 1963, Walker 1929).

The young are born in a nest in a hollow tree, stump, or log, which is lined with leaves, grasses, mosses, or other vegetation. A mother makes little attempt at sanitation, but the nest is kept clean because the feces are usually deposited in a pile away from it. Young, weighing about 30 to 40 grams, are naked, blind, and helpless at birth. They develop rapidly, and by the time they are 3 months old, they weigh almost as much as the parent. Young martens stay with the mother until about September, after which they begin solitary lives (Jackson 1961). Although males become sexually mature at 1 year, females do not mature sexually until they are 2 years old (Jonkel and Weckwerth 1963). According to Walker et al. (1968), martens have lived 17 years in captivity; their lifespan in the wild is undoubtedly less than 17 years.

Predation: Marten are preyed on by bobcat, lynx, fisher, great horned owl, and eagles (deVos 1952). Their greatest enemy, however, is humans who trap them for their beautiful pelts. Rarely is a marten killed by an automobile along the Oregon coast.

Economic status: Martens are one of the fur-bearing mammals in Oregon, but since the 194546 trapping season, both numbers caught and price per pelt have fluctuated widely. Even though the trapping seasons of 1947-48 through 194950 were closed to the taking of martens, 3,573 martens were reported caught by licensed Oregon trappers from the 194546 through the 1972-73 trapping seasons. During that time, the annual catch varied from 1,107 in the 1946-47 season to 8 in the 1968-69 season, and the average annual price per pelt varied from $33.88 in 1946-47 to $3.17 in 195960. From the 196768 through the 1971-72 trapping seasons, 144 marten pelts were sold at an average price of $6.35 per pelt. Fifty marten were reported caught during the 1973-74 trapping season; their pelts brought an average price of $5.10-a total of $255.00 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a). The value of marten pelts is thought to be about three times the price to the trapper (Ingram 1973). Fortunately, martens are not one of the more important fur-bearing mammals in Oregon. They are easily caught, and populations can be severely depleted by inadequate management. We need to know a great deal more about martens and their management in Oregon before they can safely tolerate the pressure of increased, sustained trapping.

Because martens tend to shy away from human habitations and because they annually destroy many "harmful" mammals, they must be considered beneficial. They are one of our most beautiful native mammals.

Selected references: Ashbrook and Hanson (1927, 1930), Brassard and Bernard (1939), deVos (1951a, 1951b), Enders and Leekley (1941), Hagmeier (1956), Hawley (1955), Jonkel (1959), Markley and Bassett (1942), Marshall (1951b), Marshall and Enders (1942), Newby (1951), Sekerak (1969), Seton (1928), Streeter and Braun (1968), Weckwerth (1957), Wright (1942a, 1953b), Yeager (1950).

Species *Martes pennanti:* Fisher

Derivation: The specific name *pennanti* is a proper name; this magnificent mammal was named after Thomas Pennant, a famous British naturalist. The species was first described in 1777.

Specific description: Total length, 716 to 1184 mm; tail, 300 to 422 mm; hind foot, 87 to 143 mm; ear, 41 to 47 mm; weight, 2.1 to 6.8 kg. Blanchard (1964) reported a 9.1-kilogram male fisher from Maine, but this was an unusually large individual.

The fisher is similar in structure and body proportions to the marten but is nearly twice as large, four times as heavy, and a different color. The head is broad and flat, narrowing to a pointed face and nose. The ears are round, low, and broad. The tail is moderately long, tapering, and bushy. Fisher have strong, moderately large feet with hairy soles. Each foot has five toes that terminate in sharply curved claws. The general tone of the pelage is very dark brown to blackish brown, but darkest on the lower back and rump. The tops of the head, neck, and shoulders are grizzled or "frosted" because of white- or pale gray-tipped guard hairs. The underparts are dark brown, occasionally with one whitish spot to a few whitish spots on the throat, and frequently with a white blotch or blaze on the belly. Females have finer and commercially more valuable pelages than do the males. The nose, feet, and tail are blackish. Coulter (1966, p. 36) wrote:

> The fur is dense and glossy on prime, early winter specimens. Color is variable between individuals and sexes. Seasonal changes in color are sometimes pronounced. Young animals less than a year old are usually darker than are adults, and almost all adult females examined were darker than adult males.

For an excellent discussion of the pelage of the fisher, see Coulter (1966).

The name "fisher" is really a misnomer-the fisher is not a fisherman. "Pekan," the Abenaki Indian name by which this animal is also known, is perhaps the best and most distinctive name.

Distribution along the Oregon coast: The fisher undoubtedly occurred at one time throughout the entire Oregon Coast Ranges. Bailey (1936) cited fishers as having been caught in the Oregon Coast Ranges of Lane, Douglas, and Curry Counties in 1913-14. To my knowledge, no fishers have been seen or caught along the northern Oregon coast in recent years. Sherrell (1970), on the other hand, stated that a

fisher had been trapped in Curry County (extreme southwestern Oregon) about 1957-59, and another individual was seen in 1966. Olterman and Verts (1972) reported that two fishers were accidentally trapped in Curry County in 1968. Furthermore, 11 fishers were released 40 kilometers west of Klamath Falls, Klamath County, Oregon, in 1961 (Kebbe 1961); if they survived, they may eventually repopulate the southwestern corner of Oregon. Nevertheless, wherever they occur in western Oregon they are extremely rare. Scheffer (1938b) discussed some early records of fishers in western Washington where they apparently are more abundant than in western Oregon.
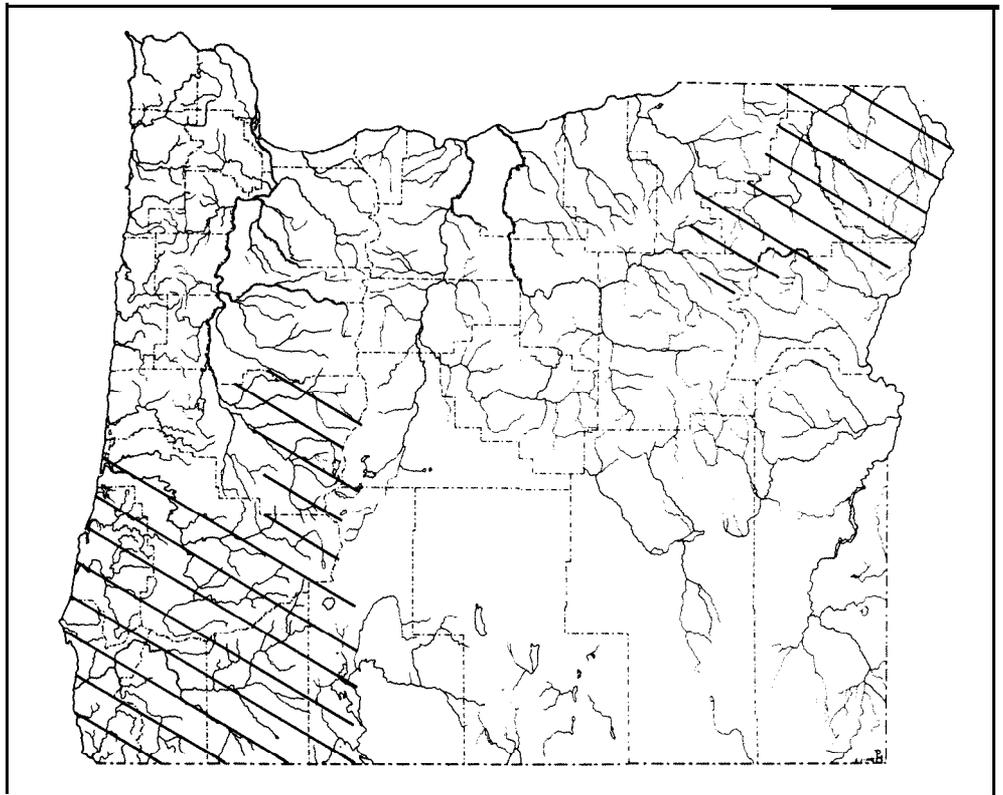
KNOWN DISTRIBUTION OF FISHER

Habitat: Along the Oregon coast, fishers probably inhabit the cedar swamp, mature conifer, and tanoak habitats, although the disappearance of these habitats may force existing fishers to occupy less suitable habitats; also see Yocom and McCollum (1973).

Habits: Unless otherwise stated, the following discussion is from Coulter (1966), who studied fishers in Maine. These mammals are primarily nocturnal but are also active in the daytime. If an individual has recently gorged itself, it is likely to go into a deep sleep and may not awaken for 48 hours. Although there is a tendency for these mammals to occupy the spruce-fir forest most often in eastern North America, they also live extensively in hardwood forests where conifers are not abundant. In the latter areas they seldom bypass even small stands of conifers.

Fishers, like their smaller cousins the martens, appear to be strongly reluctant to travel through areas lacking overhead cover; hence they are definitely forest dwellers by nature. Fishers avoid crossing open areas, such as meadows and frozen lakes; they will travel a kilometer or more around a frozen lake rather than across it. Furthermore, fishers seldom follow roads; but when they do, they most frequently intercept the roads near ridgetops covered by coniferous forest. Throughout most of the year, they tend to travel in more or less direct routes with little circling, but they commonly deviate from their general direction of travel to investigate dense thickets of coniferous trees or tangles of logs. During the peak of the breeding season, however, several fishers in an area apparently follow one another's tracks. When so engaged, they frequently separate, circle, rejoin, and backtrack so many times that it may be impossible to determine if the same individual is being followed. Such meandering usually occurs in late winter in areas of less than 5 square kilometers, but regardless of the breeding season, when proceeding from one definite location to another, fishers travel in the more usual, direct manner.
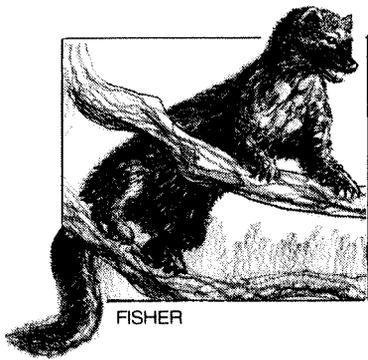
Although fishers are agile climbers, the tendency to climb seems to vary considerably between individuals and perhaps time of year. They are not so arboreally inclined as are their close relatives, the martens. Fishers can jump at least as far as 2.7 meters from one tree to another. In winter they may descend from a tree by leaping into the snow from heights of 4.5 to 6 meters, but trees are normally descended head first. In addition to being apt climbers, fishers are good, strong swimmers, entering water voluntarily.

FISHER

During the winter, fishers use temporary dens. Of 53 dens examined, 48 were in snow, in brush piles, under logs, or under the upturned roots of trees blown down by wind. One den was found in a hollow log and three were in deciduous trees. An animal had reached one of the latter, 7.6 meters above the ground, by leaping from an adjacent tree. Temporary dens in the snow are seldom used more than a few days. Such dens are not elaborate, usually consisting of a single tunnel dug into the snow for a length of 1 meter to 1.5 meters beneath the surface. An occasional ground burrow may be used, but whether fishers dig these burrows or merely appropriate a readily available one is not known. One such burrow was occupied by a fisher for at least 2 weeks.

Home ranges of fishers appear to encompass from 2.3 square kilometers to 7.2 square kilometers. In some areas at least, there undoubtedly are more than one fisher per 2.3 square kilometers. Even though their home ranges overlap, fishers are not very tolerant of one another. They are predominantly solitary animals except during the breeding season and the time that the young are dependent on their mothers.

Food: Unless otherwise stated, the following discussion is from Coulter (1966). Although female fishers are decidedly smaller than males, their basic hunting habits are similar, as are the kinds of prey taken. Size differences between the sexes apparently are unimportant for an individual's success in hunting.

A fisher's method of hunting is not, as yet, well understood. DeVos (1952) stated that a fisher apparently follows the fresh tracks of its prey until it is sighted. Coulter (1966, p. 136) observed, however:

> The fisher is largely an opportunist when hunting. It does not lie and wait nor does it often pursue prey for long distances. Most of its hunting consists of the chance investigation of sites where small mammals are likely to be found. Some effort is made to dig at small mammal dens or nests. The only species that fishers apparently seek out and hunt more deliberately is the porcupine. Trails were followed where fishers searched abandoned logging camps, hollow trees, and rock caves when porcupine sign was fresh.

(Also see Seton (1928).)

Fishers kill all prey, except porcupines, by biting it through the back of the head. The method by which fishers attack and kill porcupines has been variously described as follows: Either fishers flip porcupines onto their backs and dispatch them by attacking their undersides which lack quills, or fishers attack the vulnerable undersides of porcupines from the lower side of a tree limb (Anthony 1928; Cahalane 1944, 1947; Seton 1928; Walker et al. 1968). Coulter (1966) observed an adult female fisher kill three porcupines. The fisher circled a porcupine, making repeated, swift, rushing attacks at its face and head. Such attacks may last 30 minutes or longer, after which the porcupine dies from the accumulative effects of the wounds inflicted by the fisher's teeth and foreclaws. One of the porcupines that the female fisher killed weighed 7.7 kilograms, whereas the fisher weighed only about 2.7 kilograms; however, this fisher was unable to kill a porcupine weighing 10.9 kilograms, although she attempted to do so.

Once killed, porcupines are eaten in one of two ways, both of which minimize contact with the quills. One method is to begin eating on the unprotected underside. The other is to begin eating at the face, head, and neck, proceeding toward the tail in the same direction as the quills lie. Both methods normally leave a porcupine's skin, with quill attached, flattened and remarkably clean of flesh and most of the bones. One porcupine may afford a fisher a supply of food for several days.

As would be expected, fishers may sustain some injury from the quills of their victims, but even though quills sometimes penetrate a fisher's viscera, they seldom appear to cause serious damage to the animal. (See the species account of the porcupine for a discussion of the effects of its quills.) For example, Quick (1953b) examined 17 fishers and found porcupine quills embedded in four-one male and three females. The male had a quill stuck to the inside lining of the stomach. One female had a 1.25centimeter length of quill embedded in the flesh over her eye; another had part of a quill embedded in her liver. The third female had parts of five quills in the tissue around the small intestine and one extruding from it; a fragment of another quill had pierced the wall of the stomach. These quills, ranging from about 3 to about 19 millimeters in length, had not caused any visibly serious or permanent injury to the fishers. Furthermore, Coulter (1966, p. 157) wrote:

Quills were found embedded in the tissues of 127 of 365 (35 percent) fishers examined in Maine. Counts of more than 100 quills were made in some individuals. They were found in all regions of the body, although it was usual to find more of the barbed structures about the heads, necks and foreshoulders. In some specimens the quills had pierced the stomachs or intestines, or were found lodged in the mesenteries [tissues] supporting the above organs. Quills were common throughout the larger muscles. One animal had a single quill in a kidney.

None of the fishers had any inflammation or infection at the sites where the quills were embedded. (Also see Daniel (1960).)

In addition to porcupines, fishers eat a wide variety of small mammals-such as shrews, moles, rabbits, hares, squirrels, mice, and voles. They also eat a variety of birds, such as jays, nuthatches, woodpeckers, chickadees, thrushes, sparrows, grouse, and owls. A few amphibians and reptiles are consumed, as are some insects, nuts, and fruits. Snowshoe hares and porcupines appear to be the fisher's primary prey; additionally, large quantities of carrion, such as deer and moose, are eaten. Fishers normally eat the hair, feathers, and bones of small prey; however, the tufts on the ends of squirrels' tails, as well as the stomachs of squirrels and larger mammals, are discarded. Many of the bones of hares and porcupines are broken and eaten, but only the softer ends of the ribs of deer are gnawed. Fishers eat birds' eggs by opening them near one end and consuming their contents. (For an excellent discussion of the food habits of fishers from Maine, see Coulter (1966).)

Reproduction: Unless otherwise stated, the following discussion is from Coulter (1966). Fishers are probably polygamous in their breeding habits-a male mates with more than one female. Three to four months before the onset of the breeding season, fishers are decidedly solitary, but about the beginning of March they commence traveling together. Not all individuals, however, nor even the majority, associate at any one time. During the 2d and 3d weeks of March, fishers may stop as often as 16 times per 1.6 kilometers and establish scent stations marked solely by the fluid from their anal glands. Such behavior, occurring only in late winter, probably serves as a means of communication between individuals approaching breeding condition. The odor of the anal gland secretion of the fisher is not as strong as that of weasels and mink. Furthermore, although the latter often emit fluid from the anal glands when frightened or hurt, fishers apparently do not do so. Since fhese animals are predominantly solitary, males probably follow females in estrus by their scent. Once a pair has mated and the female is no longer in estrus, she most likely is no longer attractive to the male. Females come into estrus and breed within 6 to 8 days after giving birth (Hall 1942); the breeding season extends from late February until at least mid-April.

Litters, ranging from one to four (usually three) young, are born after a gestation period of about 51 weeks (Coulter 1966, Hall 1942). The gestation period is so long because of delayed implantation. Young are born from late February through the first of April, but the majority arrive during March. Babies are born in dens which, so far as is known, are situated in hollow trees. Coulter (1966) reported that one nursery den was located in a hollow tree, and Seton (1928, p. 460) wrote: "In May,

1899, a nest was discovered by some Indians in the woods north of Lake Winnipeg. It was, as usual, in the hollow of a standing tree, and about 40 feet up." Both of these nests contained three young.

Fisher are born blind, helpless, and only sparsely covered with fine, light gray hair on the middle of the back. They can utter short, high-pitched cries. Growth and development are rapid the first few days. In 3 to 4 days babies are almost entirely covered with fine brownish gray hair, and they weigh about 31 to 42.5 grams. They try to avoid direct light shortly before their eyes open, about 52 to 54 days of age, and for about 10 days thereafter. They can crawl awkwardly at about 2 months, at which time they weigh about 0.4 kilogram. At 10 weeks, young fishers become playful, and by 12 weeks they exhibit extreme curiosity with frequent physical contact in hunting activities. When about 2 months old, they eat meat brought to them by their mother. They begin drinking water at 10 to 11 weeks and are weaned by the time they reach 17 to 18 weeks of age, in late June or July. By this time they can leave the nest, and they begin to attack small prey in a manner similar to that of an adult. Although young fishers do not attain their full growth during their 1st year of life, some males and most females breed while still yearlings. Females, therefore, give birth to their first litters at 2 years of age. One fisher, according to Jackson (1961), lived in captivity more than 9 years. (For an excellent discussion of reproduction in fishers, see Coulter (1966) and Wright and Coulter (1967).)

Predation: No information was found on predators of the fisher. Humans are the only creatures known to regularly kill fishers; these animals are hunted and trapped for their beautiful and valuable pelts.

Economic status: Bailey (1936) cited nine fishers as having been caught in Oregon during 1913-14. Ingram (1973) cited the following data on fishers taken in Oregon before they were fully protected by a closed season in 1937—which is still in effect: 1924-25, 13; 192526, 9; 1926-27, 6; 1927-28, 9; 1928-29, 5; 1929-30, 6; 1930-31, 7; 1931-32, 2; 1935-36, 11. Bailey (1936) stated that prime fisher pelts brought $25 each in 1913-14 but that the price increased to $100 and $150 from 1920 to 1925. Jackson (1961, p. 337) wrote: "Single pelts often bring $75 to $100, and several have brought more than $300 each." Fisher pelts make durable, beautiful garments, and their rarity makes them highly desirable. Pelts of female fishers are finer haired and more valuable than those of males. Fishers have been transplanted into Oregon because of their predation on porcupines-as part of a "porcupine control program" (Hooven 1971 b).

Selected references: Chitwood (1932), Cook and Hamilton (1957), Coulter (1960), deVos (1951a, 1951b), Eadie and Hamilton (1958), Enders and Pearson (1943), Hagmeier (1956, 1959), Hamilton and Cook (1955), Hodgson (1937), Meyer and Chitwood (1951), Quick (1953a), Rand (1944).

Genus Mustela: Weasels, minks, and allies

Derivation: The generic name Mustela is the Latin word for "a weasel."

General description: Members of this genus are long-bodied, lithe carnivores. The length of the head and body ranges from 12.5 to 53 centimeters, and the length of the tail from 2.5 to 23.3 centimeters. Adults weigh from 0.09 kilogram to 1.64 kilograms. Dorsally, pelages vary from yellowish brown, light brown, reddish brown, dark brown, to black. Ventrally, they vary from white, yellowish, light reddish brown, to black. Several members of this genus have distinct black tips on their tails, and one species also has a black mask across the eyes and black feet. A few species turn white in winter and brown in summer.

For the most part these mammals are solitary. Some are good climbers; some are good swimmers; all are persistent in the chase. Their long, cylindrical, supple bodies allow them to pursue prey almost anywhere the prey can go; they can enter any burrow into which the head fits.

Members of this genus occur from the Arctic to the Tropics; their habitats, food habits, and reproductive habits are correspondingly varied.

Gestation periods vary tremendously, depending on whether or not a species has delayed implantation. Members of species without delayed implantation have a gestation period ranging from 39 to 43 days and produce more than one litter per year. Members of species with delayed implantation normally produce only one litter per year and have a gestation period ranging from 78 to 340 days. Litters range from 3 to 13 young. Born in a nest, babies become self-sufficient in about 5 to 6 weeks. Most members of this family probably live less than 2 years in the wild, but they may live considerably longer in captivity.

World distribution: There are about 15 species of Mustela. Members of this genus occur throughout North America, Mexico, and Central America, south to northern South America. They are also found throughout Europe and Asia, south to northern Africa, Java, Sumatra, and Borneo.

General reference: Walker et al. (1968).

Species *Mustela erminea*: Short-tailed weasel

Derivation: The specific name *erminea* is from the New Latin word *ermineus,* which in turn was derived from the Old French word *ermine,* the ermine.

Specific description: Total length, 186 to 341 mm; tail, 50 to 100 mm; hind foot, 18 to 44 mm; ear, 10 to 20 mm; weight, 30 to 84 g.

Short-tailed weasels are small, cylindrical carnivores with long, slender, lithe bodies. They have short legs and relatively short, hairy, slightly bushy tails. Their heads are small, horizontally flat, and taper to a blunt nose. The ears are prominent, round, and hairy. The feet terminate in five toes, each of which has a small, curved, sharp claw. The pelage is short, moderately fine, but not thick. In western

Oregon, the short-tailed weasel retains its dark coat throughout the year. The up per parts are uniform, ranging from brown to dark brown to reddish brown, being darkest on the face and nose. The white of the underparts extends from the lips or chin to the crotch and down the insides of the hind legs onto the tops of the feet; there often is some white on the tops of the front feet also. Although the under-sides are white, the amount of white varies. The tail is brown with a distinct black tip.

Distribution along the Oregon coast: Short-tailed weasels occur along the entire coast.
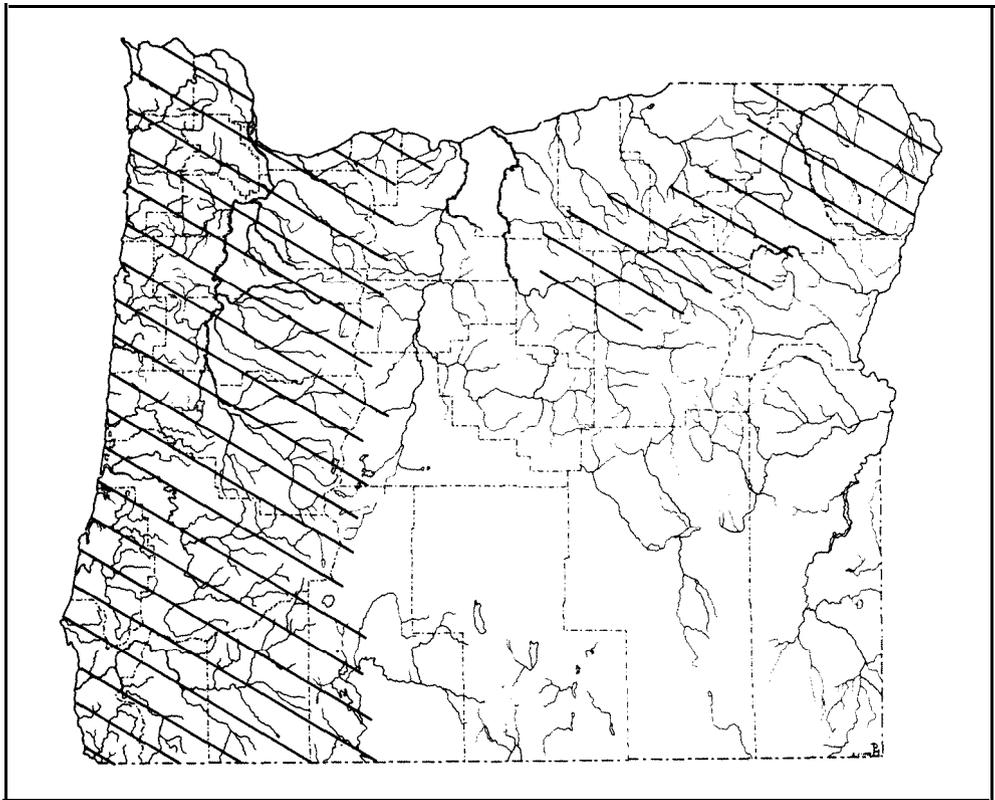
KNOWN DISTRIBUTION OF SHORT-TAILED WEASEL

Habitat: They occupy all habitats except the beach, foredunes, moving dunes, deflation plain, coastal lake, and tideland river. They rarely occur in the wet pastureland, headland prairie, and headland shrub. These small weasels appear to be most abundant in the alder/salmonberry and riparian alder habitats.

Habits: Short-tailed weasels (also called "ermines" or "stoats") are active primar-ily during the night, but daytime activity occurs as well. I have caught these weasels on bright sunny midsummer days in the middle of the afternoon. These carnivores are active throughout the year, and according to Jackson (1961), they do not migrate but may move their home base if confronted by a shortage of food or other defects in the habitat.
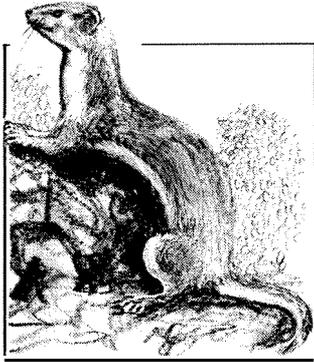
SHORT-TAILED WEASEL

Although they are not really abundant anywhere, these weasels occur from sea level up to and above timberline; in fact, Pruitt (1957) reported that the frozen and mummified body of a short-tailed weasel was found on June 20, 1956, at the 4572-meter level on Mount McKinley, Alaska. The weasel was discovered about 3658 meters above timberline and 3048 meters above the last alpine vegetation. Pruitt (p. 36) wrote of the weasel: "Since the North Ridge was unclimbed by man previous to this expedition the only conclusion one may reach is that this weasel traveled some two vertical miles above timberline under her own power before dying, presumably of starvation." Tracks in a blanket of snow often give the impression that these weasels are abundant. Seton (1928), discussing this phenomenon, stated:

> The winter woods of his haunt is usually a broad white sheet, with a million pattering tracks and winding trails that are the telltale record of a wee white demon. Judging by the number, we might suppose a thousand of these small fiends, and wonder why the tracks are everywhere, and the creature so seldom seen.

> , , , though there were myriads of tracks in the woods, there were none at all after two or three Weasels had been taken. So that really each Weasel is a never-tiring track-maker, grinding out tracks by the minute and the mile, and the score of miles twisting and circling, round and round, and punctuated every little while with a red spot in the snow.

Throughout much of its geographical distribution, the short-tailed weasel's winter coat of white matches the color of the snow, except for the black tip of the tail-hence, the "wee white demon." In western Oregon with its scant snow, this little weasel retains a brown coat-the same color as that of its summer pelage.

Short-tailed weasels in western Oregon seem to have a strong affinity for protective cover and seldom venture far from logs or thick vegetation. On the other hand, I have watched several of these carnivores climb as high as 9.1 meters into fir trees. Since the weasels were not aware that they were being observed, these daytime excursions into the trees appeared to have been made out of curiosity—an attribute with which weasels are generously endowed. Their small size undoubtedly makes them wary about exposing themselves unnecessarily; therefore, these secretive, little carnivores are seldom seen and are little known by the people along the Oregon coast. Even though they may reside in proximity to human habitations, they leave little sign and their presence usually goes undetected. Although individual weasels are captured, I have most often caught what appeared to be family groups, consisting of four to six individuals. Such groups, occurring in a small area within 2 or 3 days, appear suddenly and then just as suddenly disappear. Hamilton (1933b, p. 328), writing about the short-tailed weasel in New York, stated that adults "customarily pair, or at least run together, at times other than the breeding season."

Short-tailed weasels exhibit no lack of curiosity. Jackson (1961, p. 341) aptly wrote of this weasel:

> It has extreme curiosity, and will watch with deliberation and quietness objects or actions that may attract its interest. Then, with almost lightning

quickness, it may attack ferociously, even animals many times its own size, or it may discreetly continue its watchful curiosity, with muscular twitches and jerks indicating each urge to charge.

When in motion, a short-tailed weasel has a bounding gait. Because this long-bodied mammal brings its front and hind feet together, its back arches with each bound. The hind feet land almost, if not exactly, in the impressions left by the front feet; however, the right front and hind feet lag slightly behind the left feet, causing a diagonal track. The normal distance between bounds is about 475 centimeters, but when traversing open spaces, the short-tailed weasel may resort to long, graceful bounds up to 1.8 meters in length. One such bound was measured at 2.5 meters. The short-tailed weasel is quick in every movement of its lithe, muscular body and is a master at dodging (Jackson 1961, Soper 1919). Seton (1928, p. 600) wrote:

> Whatever a Weasel does, is done quickly-whether it be to seize the bounding Squirrel, clinch on the rash terrier's nose, elude the rifle ball at the flash, or save its young-it is sure to act like lightning, and with nearly uniform success. . . . I have often seen this energetic little creature seeking for Mice in the deep, soft snow. . . . Sometimes it gallops along a log, or over an icy part of the drift; then plunges out of sight in a soft place, to reappear many yards away, bounding here and there, over and under, restless and tireless as the waves of the sea-forever changing his place, pose, and direction; the embodiment of lithe grace and endless assiduity.

Short-tailed weasels normally appropriate the nest of one of their victims and then use the hair of their prey to line it. Once appropriated, the nest is kept clean of fecal material because its new owner defecates in a particular place outside the abode; such behavior is evident both in the wild and in captivity. Prey, on the other hand, is frequently eaten within the nest, resulting in an accumulation of food refuse. As victim after victim is secured and brought to the nest, the weasel plucks out the hair and places it here and there, pushing and nudging it against the sides of the nest cavity and forcing the structure to expand. The longer a weasel occupies a particular nest, the larger and better insulated it becomes. Although such behavior appears to be most typical in winter, captive short-tailed weasels lined their nests at all times of the year. A weasel undoubtedly derives a survival advantage from this type of nesting behavior. In addition to its high expenditure of energy, the general structure of its body is such that there is a disproportionate amount of surface area and, therefore, a greater loss of body heat.

Although most nests are discovered on the ground and prove to have been the renovated nests of victims, a few nests of short-tailed weasels have also been located underground. That these weasels have subterranean nests is not surprising; I have often trapped them in the burrows of mountain beaver, and they no doubt frequent the burrow systems of other animals as well. Seton (1928) stated that John Burroughs found such an underground nest, composed of two or three handfuls of leaves and the hair of mice and moles, in a cavity under a roof of fine tree roots. Ingles (1942) reported that short-tailed weasels had been using a burrow beneath a hollow tree, as well as a hollow root and the tree itself.

Short-tailed weasels emit a variety of vocalizations. Their repertoire includes a repetitive, low chatter; when excited or alarmed, they vent a shrill, sharp note-almost a "screech''-or a series of sharp, soft "barks." The sound most often heard is a "hiss." Jackson (1961) indicated that this weasel may "purr softly" when satisfied or contented.

With rare exception, the short-tailed weasel leaves no doubt that it has not the slightest intention of striking up a friendship. If the warning is not heeded, the tiny, needle-sharp teeth may be clenched suddenly on an unsuspecting finger. On the other hand, to call these small carnivores "blood-thirsty killers" or "demons" is to unjustly characterize them. In 1965 I caught a pregnant female short-tailed weasel near Hebo, Lincoln County, Oregon. She was one of the exceptions-gentle and friendly. Although no one but I could get close to this weasel, when I put my hand into the cage the weasel would come to me and allow me to gently scratch her ears. Occasionally, she even licked a finger but never tried to bite. When I opened the nest in which she was sleeping, she would open sleepy eyes and turn partly onto her back, facilitating a gentle rubbing of her chest and abdomen.

Food: The short-tailed weasel is a superbly adapted carnivore. Its long, muscular, supple body is well suited to the chase, and its small size allows it to go almost anywhere its prey can go. In addition to exceedingly quick reflexes, it has acute senses of sight, hearing, and smell. With its senses always keen, this weasel spends much of its time foraging about logs, banks of small streams, thickets of vegetation, and rockslides. When hunting, it is in almost constant motion; no nook or cranny escapes its careful scrutiny. It seems that the weasel uses all its senses during the hunt. Although the sense of smell appears to be its primary hunting tool, when an object or sound has attracted its attention but cannot be fully understood, the weasel often stands on its hind legs and looks the situation over. Dropping down, the weasel may advance toward the object and stand up again; this procedure is usually repeated until the weasel knows what is going on.

When prey is located, the weasel's excitement is often portrayed by its tail, which suddenly appears to be about twice the usual size as all the hairs stand straight out; the weasel may also lick its lips a time or two before, in a blur of motion, it attacks. The rapid dash usually terminates with the weasel's teeth sunk deeply into the back of its victim's skull. At times, however, a swift chase ensues before contact with the prey can be made. Occasionally during a chase, the weasel misses the head and grabs the victim's back, legs, or even tail. At such times, the weasel clutches the prey with its forefeet and at the same time quickly jerks the prey down between its forelegs with its mouth, then releases its grip and attempts to get another hold closer to the head. If the prey does not escape the weasel's grasp, the weasel continues these maneuvers until at last its teeth are securely fastened in the base of the victim's skull. Should the victim escape, the chase is on; a hunting weasel is the epitome of single mindedness. Once the teeth are sunk into the base of the skull, the weasel hangs on, periodically clenching its jaws together. If the victim is small, such as a deer mouse, it is drawn toward the weasel by the latter's forelegs and feet while the claws of the hind feet are used to tear at the prey. If, on the other hand, the victim is large and more difficult to handle, such as a Townsend chipmunk, the weasel flops onto its side, periodically clenching its jaws, driving its fangs deeper into the prey's skull. When an animal

is thus bitten, its legs and feet work wildly for a time; by lying on its side, the weasel tends to keep the victim's legs off the ground, allowing the kicking to take place in the air. Such behavior undoubtedly makes the prey easier to handle and also conserves the weasel's energy. If more than one victim is present, the first one is swiftly dispatched and the second victim attacked. When a lone victim is killed, however, the weasel may dawdle over its meal.

The short-tailed weasel normally chews through the victim's skull and eats the brains. Now and then, a biologist's specimens suffer severe damage when one of these weasels checks on the traps, set to capture small mammals, before the biologist does.

Once the prey is secured, it is usually, but not always, carried to the nest or at least under cover, to be eaten. When an excess of prey is available and more victims are killed than meet the weasel's immediate needs, the excess is often stored in a pile near the weasel's nest.

Short-tailed weasels prey mainly on small mammals; along the Oregon coast, they eat shrews, shrew-moles, baby brush rabbits, chipmunks, deer mice, voles, house mice, and jumping mice. They are also known to eat small birds, occasionally frogs and small fish, and sometimes earthworms (Aldous and Manweiler 1942, Hamilton 1933b, Osgood 1936). Willey (1970), after watching one of these weasels pursue grasshoppers, suggested that the short-tailed weasel may include some insects in its diet, at least now and then.

Reproduction: Jackson (1961) indicated that the breeding season, as far as is known, occurs during July and August; and Wright (1942a) stated that male short-tailed weasels are not sexually active after the first of September. In western Oregon, males with enlarged testes have been trapped in March, April, and May; and males with maximum-size testes have been trapped in July. On the other hand, van Soest and van Bree (1970) showed that the maximum development of testes occurred from February through April in The Netherlands.

Implantation is delayed in short-tailed weasels. According to Jackson (1961, p. 341), young are born from the middle of April to early May, "indicating a gestation period of about 255 days." Van Soest and van Bree (1970) stated that embryos are implanted and develop for about 8 weeks before birth. Litters range from 4 to 13 young, but 6 to 7 seems to be the usual size. Two pregnant females, with four embryos each, were trapped in western Oregon-one in March and the other in April. Apparently there is one litter per year.

Short-tailed weasels are born in underground nests, which are frequently located under tree roots, stumps, or logs. There may be many tunnels and runways leading to and from a nest which consists of leaves and grasses intermixed with the hair of the weasel's victims. Although food refuse may be scattered about and food may be stored in the runways, the adults use particular places as toilets, thus keeping the nest clean (Bishop 1923, Jackson 1961).

Young are born helpless, blind, and sparsely covered with fine, white hairs, about 2 millimeters long. They are pinkish with long necks. One-day-old short-tailed weasels average about 1.7 grams. At 14 days of age, a heavy brown mane stands out markedly along the top of the neck in contrast to the rest of the body which is sparsely covered with white hairs. The weasels' eyes open when they are 35 days old, and by the time they are 45 days of age the brown hair on the back obscures any trace of the mane. At this time the young are active and playful. They are cared for by both parents (Hamilton 1933b). According to van Soest and van Bree (1970), females become sexually mature during their first summer and usually mate, bearing their first litters the following spring. Males are probably not sexually mature until the year after their birth.

Predation: There seem to be no mammals (other than humans) that persistently prey on short-tailed weasels. Owls, such as the barn owl, great horned owl, northern spotted owl, barred owl, and snowy owl, capture these weasels. Some hawks, such as the rough-legged hawk and the goshawk, also obtain a few. Seton (1928) wrote of a bald eagle that had been shot that had the bleached skull of a weasel, thought to be a short-tailed weasel, clinging to its throat in a "death grip." Weckwerth and Hawley (1962) found that martens prey to some extent on weasels, but they did not state which species of weasel.

Along the Oregon coast, domestic dogs and cats undoubtedly are the short-tailed weasel's main enemies, although some also get run over by automobiles.

Economic status: Short-tailed weasels seldom cause damage to human property, such as poultry; but they do destroy countless small mammals, mostly rodents, that are considered by humans to be detrimental to their interests. Therefore, in addition to the economic value of their pelts, these weasels are beneficial.

Although the short-tailed weasel is a valuable fur-bearer in many States in which its winter coat is white, in Oregon weasel pelts have not been worth much. During the 29-year period from the 194546 through the 1973-74 trapping seasons, 5,204 weasels were reported caught by licensed Oregon trappers. The largest number of pelts (1,043) were sold in 1947-48, and the smallest number (17) in 1971-72. In the 11-year period from 1945-46 through 1955-56, 4,251 of the total 5,204 weasels were taken. During the 5-year period 1967-68 through 1971-72, 182 weasel pelts were sold at an average price of 31 cents per pelt, bringing the trappers $56.42. Only 54 weasel pelts were sold during the 1973-74 trapping season at an average price of 37 cents per pelt, bringing the trappers $19.98 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a). Both short-tailed weasels and long-tailed weasels are included in the above discussion since the Oregon State Game Commission reports did not differentiate between the two species.

Selected references: Fog (1969), Hall (1945, 1951), van Soest and van Bree (1969), van Soest et al. (1972).

Species *Mustela frenata:* Long-tailed weasel

Derivation: The specific name *frenata* is derived from the Latin word *frenum* (a bri-die), combined with the New Latin suffix *ata* (denoting the use of the word as an adjective). The name refers to the white markings on the heads of some individuals of this species of weasel which resemble a bridle-hence, the subspecies *frenata* is known by the common name of "bridled weasel." The subspecies *altifrontalis*, occurring along most of the Oregon coast, was described from a specimen obtained at Tillamook, Tillamook County, Oregon, on July 10, 1928.

Specific description: Total length, 285 to 550 mm; tail, 115 to 196 mm; hind foot, 36 to 54 mm; ear, 19 to 28 mm; weight, 110 to 326 g.

Long-tailed weasels are one of our smallest carnivores. They have long, cylindrical, slender, lithe bodies. Their legs are short, and their hairy, slightly bushy tails are relatively long. Their heads are small, horizontally flat, and taper to a blunt nose. The ears are prominent, round, and hairy. The feet terminate in five toes, each of which has a small, curved, sharp claw. The pelage is short, moderately fine, but not thick; summer and winter pelages may be almost indistinguishable. The back, sides, and the outsides of the legs, including the feet, vary from brown to yellowish brown but the face and tail are darkest; the tail terminates in a distinct black tip. There may be some white hairs on the face. The throat, chest, belly, and insides of the legs vary from yellowish white, light yellowish, dark yellowish to orange. Although the long-tailed weasel west of the Cascade Range retains essentially the same pelage throughout the year, in many areas of its geographical distribution the winter pelage is entirely white except for a black tip on the tail. Occasionally, as winter progresses, the underside and the tail may show some sign of a yellowish stain.
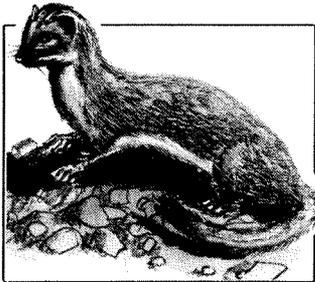
LONG-TAILED WEASEL

Distribution along the Oregon coast: Long-tailed weasels occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: These weasels inhabit or travel through all the habitats except the coastal lake.

Habits: The long-tailed weasel is not restricted to forested areas or protective cover as is the smaller short-tailed weasel. Moreover, the long-tailed weasel is frequently active during the day in areas that are almost devoid of protective cover. Regardless of where an individual lives, it is active throughout the year.

Most people tend to think of weasels as highly nervous, energetic, fearless, and blood-thirsty creatures. Such a portrayal of the weasel, however common, is an oversimplification that tends to instill an image of the weasel as an animal of uncontrollable anger, vengeance, killing, and malice toward the world. Although its reputation is not altogether without a basis, for the most part human interpretations of its behavior have created this rigid image of what a weasel should be like, but it is not necessarily accurate. For example, Edson (1933, p. 77) wrote of a long-tailed weasel that had just been given its freedom from captivity in an unfamiliar place:

Cautiously and deliberately the animal made its exit. It seemed in no haste but for a few moments sought the concealment of some near-by vines. . . . With deliberate circumspection it chose a course toward the rear of the place. . . disdaining the cover of near-by vegetation. Its calm and rather slow movements gave no suggestion of the electric potentialities embodied within the elongated anatomy of this testy little carnivore.

Moore (1945, p. 261) observed that, together with the weasel's seemingly limitless curiosity, it has a propensity toward playfulness:

Hand in hand with curiosity went playfulness. This was first noticed on the third day of the weasel's captivity when it was observed sprawled on its back in the doorway of its nest box toying with the door. For minutes at a time the weasel scratched at it, bit it, and tugged it up and down with its teeth. After it had become accustomed to its environment, the animal invariably played with its food, leaping upon it from every angle, biting it, rolling over and over, wrestling with it, tossing it about, and "killing" it again and again. Whenever fresh bedding. . . was provided in the cage, the weasel rolled and romped in it and wormed its way through and through it.

When its playground widened to include my table top, many more playthings became available. It pushed ink bottles about, rolled vials back and forth, wrestled with an electric extension cord, essayed to climb the goose-necked table lamp, jumped in and out of its cage, and wrestled with the large feet indecorously propped on the table. From one thing to another it dashed, pausing and posing charmingly at the end of each short rush, a superb picture of grace and alertness. Attracted by my hand on the table the weasel crept up to it and sniffed it. If the hand stayed there, the weasel nipped it gently and ran away, and then presently returned to sniff and nip and run again. This continued with the nip growing harder each time, eventually provoking a shout and a vigorous cuff which always missed the quick rascal. Lurking furtively behind objects at the far side of the table until the scolding tone went out of the voice which addressed it, the weasel then came forth once more to start another game of some kind.

(Also see Hansen (1952).)

Although long-tailed weasels do not appear to be abundant west of the Cascade Range, in western Oregon and Washington they seem to be most easily trapped in the proximity of the burrow systems of mountain beaver. It is not known whether this habit of frequenting the burrows of mountain beaver in any way influences the distribution or the routes and distances traveled by these carnivores. In "A Visitation of Weasels," Edson (1933, p. 76) prefaced his remarks by the statement: "Then came the weasels." He trapped nine of them in a system of mountain beaver burrows from June 6 to August 11, 1932, in an area no larger than 0.4 hectare. Clarence Mullins, a retired Government trapper whose property adjoins the Cascade Head Experimental Forest near Otis in Lincoln County, Oregon, observed nine of these weasels in and around the burrow system of a mountain beaver (Maser and Franklin 1974). Mullins (see footnote 6, page 145) stated that in the summer of 1969 he had been trapping mountain beaver because they had been damaging his seedling trees. Within 1 week he caught nine long-tailed weasels in

traps, all of which had been set within an area of about 90 meters. The sudden appearance of a group of wandering long-tailed weasels during the summer indicates that it is a family. I examined the skulls of five of the weasels trapped by Mullins. One was from an adult female, the others were from young animals. Moreover, Mullins said he was positive the weasels had been a family because of their size and appearance.

Polderboer et al. (1941) found that four weasels traveled an average distance of 95 meters from their dens during a single winter's night; the maximum distance traveled was 196 meters. Glover (1943) wrote that 11 males had traveled an average distance of 215 (18-773) meters and 10 females 106 (6-433) meters in 1 night. Quick (1944) stated that one male traveled an average of 3.2 kilometers per day but covered a maximum distance of 5.5 kilometers in 1 day. On several occasions, I have tracked long-tailed weasels in snow for more than a kilometer in open country without finding them. They seem to travel farther in open country than in brushy country. These weasels, at times at least, travel routes repeatedly; thus, when tracks are located and a trap is set, the weasel is usually caught on its next trip through the area.

Pearce (1937, p. 483) wrote of a long-tailed weasel pursuing a chipmunk up a cherry tree about 25 centimeters in diameter:

> The first rush carried it straight up the trunk for approximately 10 feet, where it hesitated momentarily before continuing. Then, instead of climbing vertically, it made progress by travelling in short ascending spirals around the trunk, scarcely making 3 feet in height for each circuit of the tree. Upon reaching the limb by which the chipmunk escaped, the weasel followed out along this in the same spiral manner. This limb had a diameter of about 4 inches at its base and extended upward at an angle of perhaps 20 degrees above the horizontal. It was much smoother than the scaly-barked trunk. The weasel, finally confronted with the space leaped by

its intended prey, stopped, and after looking across several times, aban-doned the pursuit. Turning around, it made its way head first almost down to the ground, using the same spiral mode of progress, but at a leisurely pace. . . . While travelling down the side limb it appeared practically to wrap its sinuous body around the limb.

Jackson (1961) stated that this weasel climbs "with some difficulty" and never appears to be "free and at home" when so doing. Davis (1966), on the other hand, said that weasels are adept at climbing trees. In the summer of 1969, I observed a domestic cat chase a male long-tailed weasel up a large cottonwood tree. The weasel bounded straight up the trunk for 6 meters before reaching the first branch, at which point it turned around and faced the cat which left the weasel alone. There had been no hesitancy on the part of the weasel at any point during its climb. Seton (1926, p. 625) stated that one of these weasels swiftly chased a red squirrel almost to the topmost branch of a large hemlock tree.

Long-tailed weasels often take over and renovate the aboveground nests of their victims. I examined two or three such nests in central Oregon in October 1971. The nests had been those of montane voles (*Microtus montanus*); the weasel had enlarged the nests and lined them with the hair of its victims, making the nests snug and warm. All nests were in an exposed area about 15 meters from a small stand of ponderosa pine. The nests had not been used very long.

Shaw (1921, p. 167) found the nest of a family of long-tailed weasels in western Washington; it was made out of mosses and was "about as big as a dinner plate." The weasels' nest was situated in a large, subterranean chamber that had been constructed by a mountain beaver. The chamber appeared to have been simultaneously occupied by the weasels and the mountain beaver.

Quick (1944, p. 77) examined four winter dens and found that in the "entries of used dens" the weasels had "latrines" from which feces were collected "by the handful." Polderboer et al. (1941, p. 116) collected weasel feces from "latrines found at the entrances of burrows and from latrine chambers found within bur-rows." Such "toilets" help to keep the nests clean.

Long-tailed weasels do not seem to know the meaning of "fear" and are savage fighters if cornered. When a long-tailed weasel becomes irritated, its tail suddenly appears to be about twice the usual size as all the hairs stand straight out; it may also stamp its front feet and voice a kind of explosive hiss. If further irritated, it forcibly emits some "musk" from its anal glands and may attack. Some years ago I shot a rabbit and, going over to pick it up, found that a long-tailed weasel had claimed it, with not the slightest intention of sharing it with anyone or anything. Every attempt to retrieve the rabbit was repulsed by a stamping, sputtering weasel with a stiff, oversize tail. The weasel's attitude was a clear indication that it would take even more drastic action if necessary. The courage of this weasel earned it not only my respect but also my rabbit.

Weasels occasionally sleep so deeply that they are difficult to awaken. Seton (1928, p. 629) wrote:

> In my small menagerie, I have had half-a-dozen Weasels. . . Their sleeping dens are arranged so as to be easily and silently opened. Several times I have lifted the lid to find the Weasel in a deep sleep-a sleep so profound that I had to poke him vigorously with a stick before he awoke, looked up, and rushed forth with a little puff of wrath, and a little puff of smell.

Although long-tailed weasels have attacked people, as well as animals much larger than themselves, evidence indicates that such attacks were provoked. Seton (1928, p. 631) cited an example of such an incident:

> The following occurrence that I witnessed in 1897 is good evidence of the ferocity and courage of this animal: On Sept. 5th, I was out near Medora, N. Dak., on Roosevelt's old ranch, with several men on a Wolf hunt. At night, as we were about to roll up in our blankets, a member of the party called out: "Say Jack, there's a Pack-rat just ran under your saddle." As a Pack-rat (Neotoma) is a notorious mischief-maker among leathers, Jack went over and gave the saddle a kick. Then we heard him gasping, swearing, and finally shouting for help. In the dim light, we could see him dancing like a maniac, and clutching at his throat. The campers all sat up and answered his calls for help, with jeers and derision. "Look at Jack; he's got 'em again. Kill them, Jack; the air's full of them," etc.

> A white bull terrier with us, now rushed forth growling, and seemed also to leap at the man's throat, then to shake himself. Now the man grew calm, and we learned that he had kicked out, not a Pack-rat but a Long-tailed Weasel, which immediately had attacked him. It had run up his legs a number of times, aiming at his throat. He had clutched it and cast if off again and again, but it had persisted, and might have done him serious injury, but for the prompt assistance of the bull terrier.

Food: The long-tailed weasel is a predator well adapted for either an open chase or pursuit of its prey in the latter's burrow. Its long, bounding, tireless pursuit can wear down its prey to a point where the outcome is without question. The same weasel can "snake" its way through any burrow system through which its head can pass. Sometimes an individual pursues its prey up a tree. In addition to its ability to "weasel" its way into or out of almost anywhere it wishes to go, this sinuous-bodied carnivore is very quick in its reflexes. Edson (1933, p. 76), after being nipped on a finger, commented, "If lightning is any quicker than a weasel the margin is of microscopic breadth."

The weasel's quickness and dexterity of movement is both remarkable and effective in subduing its prey. Pearce (1937, p. 487) observed that his captive long-tailed weasel could spring upward from the floor of its cage, twist its body in midair, and land hanging upside down from the top of its cage. He marveled at the "smooth precision and nicety of judgment" with which the animal leaped from the floor of its cage, twisting its head and body slightly sideways, to enter its nest box:

. . . during the many times that I watched him carry mice through the open-ing, he never once bungled his entrance. In fact, the speed with which he left the floor, entered the box, deposited the mouse and thrust his head out of the opening after turning around within the small space, always seemed incredible. . . . A favorite exercise involved leaping to a small stick about three-eighths inch in diameter. This stick had been pushed through the mesh across the cage a few inches less than two feet from the floor, and was very smooth. Although he leaped for this stick from all manner of twisted positions, from top, sides and bottom of the cage, he neither under- nor over-estimated his distance at any time. Upon reaching the stick he seemed to attain his balance instantly, almost without effort.

Coupled with this speed and precision of movement and judgment, a weasel also uses its body and feet to advantage in securing a victim. Miller (1931a) noted that when a weasel was within striking distance of small prey, such as chipmunks, it would seize the handiest portion of the victim's body with its teeth and quickly "throw" its body in a loose, snakelike coil over the victim's body. Such a maneuver effectively subdued the prey's frantic struggles, allowing the weasel to shift its initial grip to the back of the head or neck for the killing bite. Allen (1938) stated that a weasel, biting a chipmunk initially at the back of the head, would arch its body around the victim while holding it with all four feet. Large prey, such as rabbits and pocket gophers, are rendered helpless by a bite at the base of the skull. A weasel can accomplish this without tearing the victim's skin. In the wild, in an open chase, a weasel can kill young rabbits; but under the same cir-cumstances, adult rabbits can kill a weasel by kicking it with their powerful hind legs and feet. The story is different, however, if an adult rabbit is confined to close quarters which hampers its maneuverability but not that of the weasel (Allen 1938, Glover 1943, Nichols and Nichols 1935, Polderboer et al. 1941, Svihla 1931).

Although long-tailed weasels do pursue their prey above ground, they are really masters of subterranean burrow systems where they hunt pocket gophers and ground squirrels. Scheffer (1932) is among those who have been fortunate enough to observe weasels hunting pocket gophers; I have watched these weasels hunt ground squirrels, popping up in one burrow entrance after another, often many meters apart. Although a long-tailed weasel can pursue a pika or "rock-rabbit" in and out among the boulders, often securing its intended meal, a weasel's success is not a foregone conclusion. I watched a long-tailed weasel hunting pikas in the talus at Multnomah Falls, along the Oregon side of the Columbia River in 1966. The weasel pursued one pika into the talus but came out following another in-dividual, only to disappear again into the talus.

There is frequent reference to the habit of "blood sucking" by the long-tailed weasel. Blood is not "sucked," but rather the blood that flows from the wound in-flicted by the weasel's teeth is lapped up by the weasel as long as it is freely flowing (Allen 1938).

In hunting, long-tailed weasels seem to use the senses of smell, sight, and hear-ing, which undoubtedly aids them in capturing a wide variety of prey under varied circumstances. Depending primarily on mammals for food (Criddle and Criddle 1925, Hamilton 1933b, Mumford 1969, Polderboer et al. 1941, Seton 1928), some in-sects, reptiles, and birds are taken as well (Dearborn 1932). Sturges (1955) watched one of these weasels catch and kill a larval salamander.

Reproduction: The testes of male long-tailed weasels begin to enlarge in late March and reach their maximum size in April. They shrink rapidly during August and the first of September, reaching their minimum size by mid-September. The increase and decrease in the size of the testes correlates with the onset of the spring and fall molts. Adult males have sperm in their testes and are fertile from April through August, but most females are probably bred during July. Weasels have delayed implantation. Although the gestation period ranges from 205 to 337 days, it averages 279 days. The embryo is not implanted until 27 days before birth, after which time development is rapid. A female comes into heat between 65 and 104 days after giving birth. She will remain in heat for several weeks if she is not bred (Wright 1942a, 1942b, 1947, 1948b, 1948c).

One litter is produced annually, ranging in size from four to nine young but usually six to eight. The babies, born between mid-April and mid-May, arrive in a clean, snug nest which is normally located in the underground burrows of such mammals as chipmunks, ground squirrels, pocket gophers, or mountain beaver. Sanderson (1949, p. 412) examined a nest occupied by eight baby weasels:

> The simple burrow was about three inches in diameter, with two chambers at a depth of twelve inches. One of these was empty, the other contained the young. The two surface-openings were but two feet apart and the entire burrow was no more than three feet long. . . the meager nest material consisted entirely of finely chopped grass. There was no mouse hair present, no accumulation of fecal material, and no storehouse containing food. If there had been stored food it would probably have been eaten by the young after the capture of their mother.

At birth, weasels are pink and wrinkled with a few sparse, rather long, white hairs on the head and back. They have very long necks, resembling the necks of their parents. Babies average about 3.1 grams when 1 day old. By 2 weeks, they are covered with silky, white hair which is longest on the back of the head, neck, and over the shoulders. Long-tailed weasels never develop a mane such as characterizes the young of short-tailed weasels. Young begin to eat meat when about 21 to 25 days of age, but their eyes do not open until they are 36 or 37 days old. They are weaned in about 5 weeks and have their permanent teeth by the time they are 75 days old. It is thought that both parents care for the offspring, at least until they are weaned (Hamilton 1933b). Young long-tailed weasels attain the peak of their growth by the 10th week, after which they grow more slowly (Sanderson 1949). Females are sexually mature by the time they are 3 months old, and during their first summer of life, they are bred by adult males. Young males, on the other hand, are not sexually mature until the following spring, when they are 10 to 11 months old; with the onset of their spring molt, their testes begin to grow actively and the production of sperm commences (Wright 1947). The lifespan of the long-tailed weasel is not known.

Predation: Errington et al. (1940) described the great horned owl as a predator of the long-tailed weasel, and Latham (1952) found that both red and gray foxes kill them. Some of these weasels undoubtedly fall prey to other larger owls, as well as to some of the large hawks. Occasional individuals also are killed by large or poisonous snakes. A few are killed each year by automobiles on Oregon roads,

and along the Oregon coast I obtained an adult female that had been killed by a domestic cat and an adult male that had been killed by a domestic dog. Humans take the greatest toll annually with traps and guns. Most long-tailed weasels are killed for their pelts.

Economic status: Other than for their occasional depredations on domestic poultry or rabbits, long-tailed weasels are beneficial. Their prey-for the most part, rodents, rabbits, and hares-is considered economically detrimental to human interest.

Although the long-tailed weasel is a valuable fur-bearer in many States in which its winter coat is white, in Oregon weasel pelts have not been worth much. See the previous species account of the short-tailed weasel.

Selected references: Hall (1951), Hamilton (1933b), Miller (1930, 1931b).

Species *Mustela* visor?: North American mink

Derivation: The specific name vison is either an Icelandic or a Swedish word meaning a kind of marten or weasel; however, vison is derived from the Danish and Swedish word vissen, meaning "withered" or "shriveled." The reference of the name is not clear.

Specific description: Total length, 418 to 720 mm; tail, 127 to 245 mm; hind foot, 52 to 80 mm; ear, 20 to 27 mm; weight, 0.68 to 1.64 kg.

The mink is essentially a long-bodied, muscular, cylindrical carnivore. It has short legs. The tail, comprising about one-third of the animal's total length, is hairy and moderately bushy. The head is horizontally flat, tapering to a blunt nose. The ears are low, wide, round, and hairy; the eyes are relatively small. A mink's pelage is composed of coarse, glossy guard hairs overlying a thick, soft, fine underfur. In summer, the pelage varies from dull, reddish brown to light reddish brown; in winter it varies from rich, dark brown to nearly black. The pelage is uniform in color except for variable streaks or spots of white on the chin, chest, or belly. The white markings are the same throughout the year, but the mink retains its dark coat which does not turn white in winter. The mink has well developed anal glands that secrete an unmistakable "minky" odor.

Distribution along the Oregon coast: Mink occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Minks primarily occupy the riparian alder, willow/sedge marsh, cedar swamp, coastal lake, tideland river, and mountain river habitats. At one time or another, however, minks at least pass through all the habitats.

Habits: Minks are primarily active during the night, but it is not uncommon to see them abroad during the day. Mainly aquatic in habits, they are most commonly associated with freshwater streams, rivers, and lakes; along the coast, they also frequent the brackish water of estuaries, river mouths, and salt marshes, as well as occasionally visiting rocky points jutting into the sea.

Minks tend to be nocturnal throughout the year; this tendency is in general synchrony with the annual day-night cycle. Although activity patterns change seasonally, the amount of daylight is not the decisive synchronizer. Activity normally begins after sunset and during the summer is most closely correlated with the onset of darkness. Cessation of activity is less affected by sunrise. The amount of nightly activity is higher (more concentrated) during short summer nights, whereas during long winter nights the amount of activity is lower at any one time but spread out over a longer period. In addition to the length of the night, there also is a direct correlation between activity and temperature. Minks increase their activity as the temperature drops; thus the colder the night, the longer the duration of activity, presumably because of the need for a greater amount of food (Gerell 1969).

Unless otherwise stated, the following discussion is from Gerell (1970) who studied minks in Sweden. The size and shape of home ranges of mink vary, depending on the immediate topography as well as the availability of food. A mink's home range tends to be long and narrow, approximating in shape the body of water along which it lives. Although an individual covers its entire home range over a period of time, such coverage is not evenly distributed. Two of the basic factors that influence an individual's use of its home range are the location of its active dens and the pattern of its daily movements. A mink tends to concentrate its activity in "core areas" or "restricted areas," the location of which seems to be dictated by the availability of usable dens, normally from two to five. Furthermore, during a period of activity a mink continually moves back and forth within a restricted area, usually about 300 meters in length. Sooner or later it moves to another restricted area, and the pattern of continuous back and forth movement is repeated. The mink eventually visits its entire home range, but this type of movement causes a great irregularity in the intensity of use of the home range. Such irregularity may be influenced in large measure by the availability of food, as well as by suitable hunting places. A mink that is familiar with its entire home range covers it more leisurely than does an individual that is not so familiar with its home range. When moving from one restricted area to another during the winter, minks normally follow the banks of their home bodies of water regardless of the direction of the current. Throughout the rest of the year, however, minks generally follow the bank only when moving upstream.

The size of home ranges of adult minks varies not only according to the sex of an individual but also according to the season. Home ranges of males average about 3.2 kilometers in length, whereas those of females average about 322 meters. Males cover the greatest distances during the spring, which coincides with the breeding season and their search for mates.

The home ranges of juveniles are considerably smaller than those of adults, but they also vary according to the sex of the individual and the season. Home ranges of males average about 1.6 kilometers in length, whereas those of females average about 0.8 kilometer. Males move around moderately during their first summer. As fall approaches, their movements increase, probably as a result of dispersal. They are most sedentary during the winter and most widely traveled during the spring-their first breeding season. Females appear to do much of their wandering during their first summer and are most stationary the following spring-their first breeding season also. (Also see Gerell (1971), Mitchell (1961).)

Although the rank coastal vegetation greatly reduces the chance of seeing minks during daylight hours, these mammals leave the mud and sand of the coastal watercourses dimpled with their tracks. As reflected by the tracks, these graceful carnivores travel in a bounding movement.

Lacking no measure of curiosity, they examine every nook and cranny in their path, as well as some to which they have to make special trips. Their usual mode of travel is to follow the water's edge until something of interest necessitates swimming to be investigated. Completing an investigation, they again follow the edge of the water. Though they seldom swim great distances, nonetheless, they are excellent swimmers. One mink occasionally floated down a stream while curled up asleep (Gianini 1927).

Minks do not make trails as such but follow the trails of other animals. Along the Oregon coast they regularly use the trails of beaver, particularly in the vicinity of the latter's dams.

Not particularly friendly with one another, minks are not as solitary as most other members of the genus *Mustela*. When minks do meet, however, there may be a fight which, according to Jackson (1961), consists of much shrieking, snarling, and tumbling, but probably few injuries. Lewis (1927), having observed minks fight, wrote:

> . . . I could see a mixup of lithe, brown forms, swiftly whirling about in the water. In a few seconds the cries ceased and there came a sound of rapid swimming as the combatants crossed the pool. Then followed a scurrying through the leaves as the animals raced down the opposite side of the creek, every few seconds giving vent to their rage in an outburst of mink profanity.. . .

During a fight, minks may discharge the fetid odor from their anal glands. A startled mink may also leave the pungent odor hanging in the air long after the animal has vanished.

There are some occasions, however, when minks fight to the death. Williams. burgh, quoted in Seton (1928, p. 534), witnessed such a deadly engagement:

> Standing within six or eight feet of me were two large male Minks, eyeing each other intently, their small eyes looking like coals of fire, and with mouth slightly open, their backs arched, necks stretched forwards, their hind legs close to the ground. . . .
>
> The first motion was a quivering of the bodies, followed by increasing rapidity in breathing. Then slowly each advanced toward the other, until 18 inches apart, when each seemed to be gathering all the strength possible to make a final leap. After standing motionless for a full minute, one of them turned his head a little to the right, and instantly the other did the same. Probably 10 seconds elapsed while in this attitude when, quicker than the eye could follow, they sprang towards each other, and, catching by their throats just back of the lower jaw, held to each other with a grip that meant death to the one that should let go his hold.

With a determination to conquer or die, they wound each other round and
round until exhausted from loss of blood, when, spreading their fore feet to
brace themselves, they stood perfectly still until one of them staggered,
then fell, pulling the other with him laying them both down in the sand,
growing weaker and weaker until they ceased to breath.
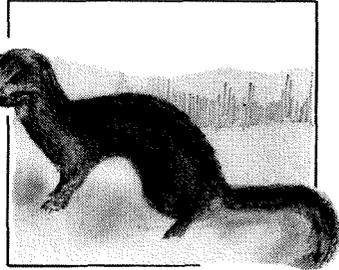
MINK

The reflexes of minks are very quick, yet the animals are relatively slow runners;
thus, they normally seek shelter rather than trying to outrun a pursuer. Bailey
(1938) stated that minks are often "treed" at night by dogs hunting raccoons.
Bailey also commented (p. 294) that a mink, cornered in a burrow or hollow log or
tree, is "bad medicine" for any dog that attempts to get a grip on it. The mink is
far quicker than any dog, and usually gets the first hold, on a dog's nose or lip—
taking full command of the situation.

As fighters they perhaps have no superiors of their own size, and even in
the open, a mink will often severely punish a dog of many times its size
and send the dog home with a bloody face and a sad heart. The mink has
a savage scream with which it threatens a dog. . . [and]. . . will scream and
fight to the last. . . .

Mink normally live in a burrow or den. Jackson (1981, p. 355) offered a good
summary:

The den is near water and may be in a hole under tree roots, a stump, or a
log, sometimes in a hollow log, a crevice in a rock or a cranny in a drain,
bridge, or pier, not infrequently in an abandoned or pilfered muskrat house,
and occasionally in a hole in the steep bank of a creek, river, or lake. A
great majority of the dens. . . are made in abandoned burrows of the
muskrat or some other mammal, although the mink may dig its own bur-
row. The burrow is 8 to 12 or more feet long, 4 or more inches in diameter,
and 2 to 3 feet under the surface, always with one or more entrances just
above the water level, and occasionally with a steep entrance to the soil
surface above. The male has his own den, and does not build such a com-
plete nest as the female, which has a nesting and brooding enlargement of
the burrow a few feet back from the water-side exit. The nesting den is 10
to 12 inches in diameter, and is lined with grass, plant fibers, feathers, and
fur to make a snug home for the kits. Feces and urine of the adult are
usually deposited outside the den or burrow.

In western Oregon, I have found minks occupying the abandoned lodges of
beaver.

Seton (1928) noted that, when in their dens, minks may sleep so soundly that at
times it looks like a "sleep of death." When so sleeping, they are difficult to
awaken, but once aroused they are instantly in full command of their senses.

Food: The sense of smell in minks is acute, as may be their hearing, but their
sights only moderate. Minks appear to do much of their hunting by scent, and
when a mink tracks a rabbit, an observer gains the impression that the hunter is

of single-minded purpose and that the outcome is inevitable. Minks have been observed on the Oregon coast on several occasions as they pursued brush rabbits along sandy roads through dense vegetation. They have passed under parked automobiles and within 1 foot of people without giving the slightest indication that anything but the rabbits were on their minds.

Dalquest (1948, p. 200) stated, "Fur trappers report that minks feed on mountain beavers, and that the flesh of the mountain beaver is the best bait for attracting minks." I know of no record of minks actually killing mountain beaver, although minks most certainly can overpower young ones. An adult mountain beaver, however, may well dictate a different ending since the quickness, maneuverability in small spaces, and viciousness of this rodent, as well as its compact, muscular structure and strong front teeth, undoubtedly operate as a potent defense system, particularly in its own burrows. Nevertheless, minks frequent the burrows of this large, pugnacious rodent even when such burrows are a kilometer distant from the nearest water. I have captured several minks in traps set in the burrows of mountain beaver in an effort to catch the owners at home. In addition, I have heard from others who have also taken minks in traps set for mountain beaver in the latter's own burrows. All minks so captured were large, adult males.

Minks are primarily carnivorous, eating fish, frogs, snakes, mammals (occasionally including bats), birds and their eggs, crayfish, clams and mussels, as well as some insects. Two young minks that I trapped along the Oregon coast had eaten northwestern gartersnakes (*Thamnophis ordinoides*); in fact, one of the minks had also consumed the shed skin of a snake. Svihla and Svihla (1931 b) found that minks living along the Olympic Peninsula of Washington hunted in the tide pools and also ate marine clams. On the whole, crayfish, fish, frogs, and small mammals-such as various mice, rats, and voles (including the muskrat)-are the staple foods of minks. These carnivores have been most frequently associated with a staple diet of muskrats. On this latter point, Errington (1954) and Stollberg and Hine (1952) concluded that predation by minks on muskrats is related to the density of the muskrat population as well as to the specific conditions of the habitat. Minks prey much more frequently on muskrats under conditions of drought or of overpopulation of this large vole. According to Jackson (1961), minks do not store excess food but rather eat portions of each victim and leave the remains. (For further information on the food habits of mink see: Dearborn (1932), Errington (1943), Gerell (1968), Goodpaster and Hoffmeister (1950), Guilday (1949), Hamilton (1936b, 1940), Korschgen (1958), Sargeant et al. (1973), Sealander (1943), Wilson (1952).)

Reproduction: The breeding season begins in late January or early February and lasts through March or early April. During the season of breeding, a male mink may visit two or more females and a female may receive two or more males; furthermore, she may share her den with a male (Marshall 1936). Because of delayed implantation, the gestation period varies from 40 to 75 days but averages 51 days. The embryo becomes implanted and grows actively for only 30 to 32 days before birth (Enders 1952). A single litter, ranging from 2 to 10 but usually 4 young, is born during April or May. The young, called "kits," are born in a clean nest. At birth kits are naked, pale pinkish, with closed eyes; they weigh about 6 grams. They are soon covered with fine, short, "silvery-white" hair that is replaced by a

dull, fluffy, reddish brown coat when the young are about 2 weeks old. The young grow rapidly, and by the time they are 25 days old, their eyes are open and they have a sleek coat of short hair. Weaning is begun in 5 or 6 weeks, and when about 8 weeks old, the young attempt to capture their own prey. A family normally remains together until autumn when each individual goes its own way (Davis 1966, Jackson 1961). Minks have lived 10 years in captivity (Walker et al. 1968).

Predation: Minks seem to have few persistent predators other than humans. Great horned owls occasionally capture minks (Errington et al. 1940), and domestic dogs now and then kill one. A few are killed along the Oregon coast each year by automobiles. Humans are the main predator of minks, killing them with guns and catching them with traps. Most minks are taken for their pelts.

Economic status: Minks are occasionally destructive to poultry and, under some circumstances, to game birds and fish. But the numbers of rodents, often con- sidered by humans to be undesirable pests, that are killed by minks, as well as the value of their pelts, outweigh all losses. In fact, in the past mink-ranching was big business.

In Oregon, minks are one of the more important fur-bearers. During the 22-year period from 1952-53 through the 1973-74 trapping season, licensed Oregon trap- pers reported having caught 44,618 minks. The average price per pelt varied from $14.72 in 1954-55 to $3.29 in 1970-71 to $9.37 in 1973-74. Trappers sold 1,117 mink pelts during the 1973-74 season for $10,466.29 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a).

Selected references: Aulerich and Swindler (1968a, 1968b), Barber and Lockard (1973), Birney and Fleharty (1966, 1968), Elder (1951), Gorham et al. (1965), Greer (1957), Hollister (1913), Lechleitner (1954), MacLennan and Bailey (1972), Northcott et al. (1974), Stockdale (1970).

Genus *Spilogale:* **Spotted skunks**

Derivation: The generic name *Spilogale* is derived from the Greek word *spilos* (a spot) and the Latin word gale (a helmet); the name probably alludes to the white spot on this skunk's black forehead.

General description: There are only two species of spotted skunks; the length of the head and body ranges from 11.5 to 34.5 centimeters and their tails from 7 to 22 centimeters. Adults usually weigh from 0.2 to 1 kilogram. Of the three genera of skunks, the spotted skunks have the finest pelages. The basic color pattern con- sists of six white stripes extending along the back and sides; these stripes break up into smaller stripes and spots on the rump. A triangular white spot is in the middle of the forehead, and the tail is usually tipped with white. There is infinite variation in this basic pattern, so no two individuals have exactly the same mark- ings. Spotted skunks can be distinguished from the other two genera of skunks by their small size, spot on the forehead, broken white pattern, and white-tipped, black tail.

World distribution: Spotted skunks occur from southern British Columbia, Canada, south throughout most of the United States and Mexico into Central America.

General reference: Walker et al. (1968).

Species *Spilogale putorius:* Spotted skunk

Derivation: The specific name *putorius* is the Latin word for "a foul odor" or "a stench."

Specific description: Total length, 351 to 448 mm; tail, 110 to 192 mm; hind foot, 40 to 53 mm; ear, 24 to 32 mm; weight, 400 to 965 g.

The spotted skunk is a slender, graceful, bright-eyed little animal with a small, tri-angular head and low, round ears. It has short legs, and its feet have long claws and naked soles; this skunk walks flat footedly. Its pelage is soft and full when prime, and its intricate black and white pattern is beautiful. The pelage is clear black or slightly grayish black, except for the four clear white shoulder stripes and two side stripes; there also is a white spot on the forehead, one on each cheek, and eight white spots on the rump. The basal one-half of the plumelike tail is black and the terminal one-half of the tail is white. An individual's color pattern re-mains the same throughout its life and throughout the seasons.

Distribution along the Oregon coast: The spotted skunk occurs along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Spotted skunks use all the habitats to some extent, except the coastal lake. They are common, however, in the alder/salmonberry, riparian alder, riparian hardwood. and tanoak habitats.

Habits: Spotted skunks are known by several names. In Oregon the most com-mon name is "civet cat," but they are not closely related to the civets, which are primarily Asian and African mammals and do not occur in the New World; skunks are confined to the New World. In the Southwestern United States they are called "polecats," "hydrophobian skunks," "phoby skunks," and "phoby cats." The last three names result from the fact that these skunks carry rabies or hydrophobia.

SPOTTED SKUNK

Generally speaking, the proximity of a skunk invokes uneasiness in people because they know only of the unpleasant weapons of these white and black animals. As a youth, I was fortunate enough to learn that skunks are basically unaggressive and seemingly self-assured. Nevertheless, such knowledge did not come without a few strained situations on my part, but the skunks took everything in their stride. It was a little spotted skunk that finally got across the point that they use their weapons only when under imminent duress. At the approach of a severe storm, I had taken refuge under a huge pile of driftwood high on a beach. In getting ready to spend the night in that shelter, I had laid out my sleeping bag (the mummy type) next to a small sandy rise with a neat, round hole in it. As twilight waned and my small fire burned, I got into the sleeping bag. Within 5 min-utes, a small head with bright eyes separated by a white spot appeared in the en-trance of the hole that was about 0.6 meter from my head. The skunk and I looked

at one another-i froze! For the next hour the skunk alternately walked over, sat on, and sniffed me; I was confined to the mummy bag. The skunk also rummaged in my food, helping itself to whatever struck its fancy. Since I made no offensive move, neither did the skunk. Having established an "understanding," I was "free" to unzip the sleeping bag and watch the skunk provided I did not interfere with its comings and goings from the burrow or with its meal. Toward the end of the hour, the skunk wandered off into the night, whereupon I moved the sleeping bag to allow the skunk unimpeded access to its burrow, which it entered shortly before dawn.

In September 1971, I was camped along the Chetco River in Curry County, Oregon. Since I was studying the mammals of the area, I had set a number of traps, including some to catch small animals alive. One pleasantly warm evening as twilight deepened, a rustling of leaves announced two spotted skunks as they strolled forth in single file out of the brush, each with the white tip of its elevated tail drooping casually. After a moment of silence, they suddenly appeared within 3 to 3.5 meters of my campfire where they stood, bright eyed, inspecting me. I in turn inspected them. After a minute or two, the skunks silently disappeared, but the night was almost instantly pierced by the high-pitched "scream" of a deer mouse. There followed the muffled sounds of live-traps being moved about, and from each location came the "death scream" of a deer mouse as the skunks systematically robbed each trap of its occupant.

It was amazing how much racket one of these small carnivores created. I wondered how they made a living with all the scrappings, scratchings, and rust-lings that heralded their whereabouts. They were noisy not only in the brush but also in the open. Two to three hours after darkness had settled over the forest, one of the skunks apparently heard a deer mouse in a trap on the other side of camp because it galloped, flat footedly in the manner of skunks, past the tent. For so small a denizen of the forest, its passing was incredibly loud. Almost im-mediately, the "scream" of a deer mouse was heard. Having by that time pilfered every trap, the skunks were forced to earn their food. They became as quiet as they had been noisy. Their success in hunting, however, was clearly communi-cated by the "death screams" of deer mice.

While hunting, a spotted skunk may walk so that the hind feet are placed exactly in the prints of the front feet. Depending on the individual, strides range from 12.7 to 14 centimeters. When a skunk is hunting in the open, a bounding gait is the most common mode of travel. The front and hind feet work in pairs when an in-dividual' bounds, and depending on the size of the individual as well as its speed, strides vary from 23 to 36 centimeters (Crabb 1948).

Unless otherwise stated, the following discussion of the habits of these skunks is from Crabb (1948) who studied them in Iowa. Spotted skunks are strictly nocturnal. The living space of an individual skunk depends on the existence of several dens, available food, and safe passage between the dens and the food. The skunks are sociable with one another to the point that even dens are not the property of one particular individual. Rather, they are the communal property of the entire popula-tion, and as such, a den may be occupied either by a single skunk or by as many as six or seven individuals. The only time a den is not shared is when a mother is using it as a nursery in which to raise her young.

Dens may be located in natural crevices in rocks, under piles of rocks, under or within buildings, or in hollow trees or logs. Crabb found one den that was at least 6 meters above the ground in a hollow maple tree. Under some conditions a skunk may dig its own den, but more often the deserted burrow of some other animal is appropriated and renovated. Along the southern Oregon coast, I found one spotted skunk using the hollow base of a large madrone tree as a den. Another individual was using a hollow in the base of a dusky-footed woodrat's lodge; this was a large lodge and was constructed on the ground. Along the northern Oregon coast, spotted skunks were frequently found using the large burrows of mountain beaver. As variable as den sites may be, Crabb discovered that all dens are situated in such a way that they are totally dark within, and they all afford protection against adverse weather conditions. To a lesser extent, they offer protection against enemies.

A den may be a simple or a complex burrow, depending on its former owner. Within a burrow there are one or two sleeping chambers lined with grasses or other vegetation. Dens are either permanent or semipermanent, the latter being used only at intervals. Since a skunk moves from den to den when it is so in-clined, the permanency of a den depends in part on its location.

A skunk's mobility in an area depends somewhat on its physical abilities as well as its rate of travel and endurance. Although a spotted skunk moves quickly, its speed is easily exaggerated. Even when "thoroughly motivated," these skunks can be followed at a brisk walk of about 7.2 kilometers an hour. When traveling nor-mally, such as while foraging, they scarcely move if food is abundant and easily obtained; otherwise they may travel all night. Crabb (p. 219), by way of illustration, wrote:

> , , ,an excursion one winter night by a spotted skunk. . . is described in the following account. The second week in January 1940, a male skunk came out of a barn, went. . . across a pasture and into a corn stalk field. There it hunted over about four acres and then went south into an uncut timothy hay field and thoroughly hunted over an area of about five acres. In the timothy-field it caught one meadow mouse. . . . From the timothy it re-crossed the pasture to a strawpile-butt den, a few rods south of the barn from which it started.

The skunk, hunting alone, had captured only one vole. It must have been out all night because it had traveled 4410 meters or 4.4 kilometers leaving the barn, wandering around hunting, and returning, yet the skunk had not moved more than 0.5 kilometer from its dens. That this skunk did not amble far from its dens is not surprising since an individual normally has two or more semipermanent or perma-nent stopping places or nests in the vicinity of its central den.

Crabb stated that a spotted skunk does not have a "territory" in the concept of the term-it does not defend an area against the trespass of another spotted skunk. He further suggested that the expression "area of familiarity" should be used to describe a spotted skunk's domain. He thought that the concept of a "home range" was too rigid for these skunks. Crabb wrote (p. 217):

> Any particular part of the area of familarity [sic] serves the little skunk only so long as it suits him. When it no longer provides the necessities of life to his satisfaction he moves on. He may move into another part of his previous area or he may extend his familiarity to new and unexplored ground. The fact that other skunks move in on him or that he moves in on others probably makes no great difference to him. A place to sleep, reasonably secure from dogs, men, and daylight; availability of any of a large number of foods, animal or plant; and chances of a reasonably safe passageway between the two seem to be the basic factors regulating the limit of usefulness of any part of the area of familiarity.

In reality, the "area of familiarity" is merely a variation of the concept of a home range.

The living space of individuals is similar for males and females during the winter; an area 0.4 kilometer square, containing two or three dens, is adequate for an average individual. Within this area a skunk may forage, with much wandering around, over a distance of a few meters to several kilometers per night, but it seldom goes more than 0.4 kilometer away from its central den. Although a female's living space is the same during the summer as it is during the winter, a male's living space increases during the summer to include from 3.2 to 6.4 square kilometers.

The spotted skunk is well equipped for self-defense; its liquid "musk" is a potent weapon. The liquid, which contains a sulphide called "butylmercaptan," looks much like "skim milk" with some "curds of cream" mixed with it. Even though the fluid varies from white through light yellow to greenish yellow, the "white curds" are nearly always present (Crabb 1948, Jackson 1961). The fluid is secreted by two glands located on either side of the anus; it is stored in vesicles, each with a capacity of about 1 teaspoon (Blackman 1911). The fluid is forcibly ejected through "nipples" that are hidden within the anus when the tail is down but may be everted when the tail is elevated over the back.

Since spotted skunks normally use their musk reluctantly, they give definite warning signals before they "fire." One common signal is the rapid stamping or patting of the front feet on the ground; this can be plainly heard for a meter or two. Such a warning may mean one of two things: (1) It may be an indication of anger, especially when directed toward another skunk. When such is the case, the threat is carried out by snarling and biting. (2) It may indicate fright, and then the stamping or patting is always accompanied by a raising of the tail; if the bluff is effective and the skunk begins to feel secure, all is well-if not, a stink ensues.

Another common warning of anger or fear is the "handstand," in which a skunk balances on its front feet, tail high in the air. In this position the animal's back is toward the disturbance and its head arched upward so that it can watch its adversary. Although they frequently do not discharge fluid in this position, they will if too closely pressed. I have seen these skunks perform the handstand on a number of occasions and have been amazed at the length of time they can retain the stance. Crabb (1948) has seen spotted skunks walk several meters while maintaining this position. Walker (1930) discovered that the handstand is also used as a playful gesture, and Crabb (1948) watched half-grown skunks perform this maneuver while playing with each other.

On a still day the fluid can be discharged with amazing accuracy for a distance of 1.8 meters; however, on a windy day a person standing downwind may receive the spray on the face from as far as 4.6 meters away.

Spotted skunks normally spray only in an emergency; whenever possible, they will climb a fencepost or a tree to avoid dogs and people rather than discharge their musk. Though not as adept in trees as are squirrels, nevertheless they are rapid climbers and can remain secure in a high crotch all day if danger below persists.

It is generally believed that a skunk is unable to squirt when its tail is down, but this is only partially true. If the tail cannot be raised, it may be swung to one side allowing a discharge. Although the tail is normally lifted clear of the "line of fire," as a warning as much as a method of preparation, a thoroughly frightened skunk will discharge its odor all over its own tail if lifting the latter out of the way is impossible.

Food: Spotted skunks are omnivorous and eat whatever is available. Crabb (1941) found that during winter, mammals comprised the bulk of a skunk's diet; in spring, mammals again were the most important component of the diet, but insects were also eaten. Insects were the predominant foods in summer, but fruits, mammals, and birds and their eggs were eaten also; in fall, insects again formed the major portion of the diet, along with fruits, mammals, and some birds. Of the mammals eaten, cottontail rabbits and mice appeared to be the most important items. Of the insects consumed, ground beetles (family Carabidae) and scarab beetles (family Scarabaeidae) were the most important; some insects must be dug out of the ground.

In addition to prey they have killed, spotted skunks also rely on available carrion, such as rabbits and pheasants. Carrion, usually large animals, is ordinarily dragged to the entrance of a den, or at least under cover, before it is eaten. The large bones are not consumed. Feathers are pulled out rather than bitten off and are generally,scattered about. More than one visit is normally made to a carcass on successive nights.

Dalquest (1948) found the remains of three red-backed voles in the stomach of a spotted skunk that had been trapped along the southern Washington coast. I found the following items in the stomachs of spotted skunks trapped along the Oregon. coast:

February, one stomach-a few feathers
April, one stomach-small amount of unidentified hair
June, one stomach-a young bird, one cricket, and blackberries
August, two stomachs-one contained a large portion of a snowshoe hare and
    part of a bird; the other contained fruit and beetles
October, one stomach-a deer mouse and part of a brush rabbit
November, one stomach-two or three deer mice
December, two stomachs-one was "full" of deer mice; the other held a single
    centipede.

The snowshoe hare eaten by the skunk in August had been consumed as carrion, as was indicated by a large number of maggots in the stomach. Furthermore, the

few droppings of spotted skunks that were found during the summer contained only the remains of ants. in addition to these foods, spotted skunks along the Oregon coast often systematically raided traps night after night. They ate not only the trapped animals but also the bait of unsprung traps, including such things as peanut butter, oatmeal, and rolled oats.

Reproduction: The males' testes begin to enlarge in March and by late September have attained maximum size. Females on the Olympic Peninsula of Washington begin to breed during late September and continue into the 1st week of October; in the more southern latitudes, however, breeding appears to occur earlier. Spotted skunks in the Eastern United States breed primarily in April. Although female spotted skunks in the Western United States have delayed implantation, those in the Eastern United States do not. The eastern skunks have a gestation period of approximately 55 to 65 days; the gestation period of western skunks ranges from 230 to 253 days, but the embryo becomes implanted and grows actively for only the last 28 to 31 days before birth. West of the Rocky Mountains, babies are born from late April throughout May, but east of the Continental Divide, they are born during June (Mead 1968a, 1968b; Foresman and Mead 1973); also see Greensides and Mead (1973). Litters range from one to five young.

Crabb (1944) described the growth and development of spotted skunks. Newly born young weigh about 10 grams; their eyes and ears are closed, and they are thinly covered with fine hairs. The black and white markings are distinct on their smooth skin. Their teeth are not visible, but their claws are well developed. Babies can crawl feebly about the nest and can voice a distinct squeal. Although the hair is longer at 7 days, it is still too thin to offer much protection. At 24 days, they elevate their tails in a warning fashion when frightened, but no musk is emitted. The eyes open between 30 and 32 days, and when they are 35 days old, their canine teeth begin to erupt. At 42 days, they begin to eat solid food, and by 46 days they have full command of their weapons. Young are weaned in about 54 days and appear to be nearly full grown by the time they are 3 months old. Both males and females become sexually mature during their first summer of life and take part in the autumn breeding season (Mead 1968a). Spotted skunks have lived in captivity for at least 4 years.

Predation: Spotted skunks probably have few enemies other than humans and domestic dogs. Great horned owls occasionally kill and eat a skunk. Spotted skunks probably seldom come into conflict with porcupines, but a male skunk trapped in 1972 in the western Cascade Range, Lane County, Oregon, had the tip of a quill embedded in its left lung near the top of the heart. The 17-millimeter quill did not seem to have caused permanent damage; the area surrounding the quill was not inflamed. Some skunks are killed each year by automobiles.

Economic status: Spotted skunks sometimes molest poultry, particularly young chickens and eggs, but this habit is probably acquired by individuals and is not a trait of the species as a whole. Many of the skunks that live around farms are wholly beneficial since they kill many rats and mice as well as other "pests."

Although the economic value of skunk pelts is not great, many are caught each year by fur trappers. During the 22-year period from the 1952-53 through the 1973-74 trapping season, licensed Oregon trappers reported capturing 4,052 spotted skunks (civets according to the Oregon State Game Commission). The average price per pelt for the 5-year period from 1967-68 through 1971-72 was $1.26 (Oregon State Game Commission 1972). During the 1973-74 trapping season, 516 pelts were sold at an average price of $2.01. They brought $1,037.16 (Oregon Wildlife Commission 1974a).

Disease: Since spotted skunks carry rabies, any skunk that appears to be sick should be left strictly alone (Hattwick et al. 1972, Hendricks and Seaton 1969, Johnson 1959).

Selected references: Gates (1937), Genoways and Jones (1968), Heidt and Hargraves (1974), Howell (1906), Layne and Winegarner (1971), Mead (1967), Mead and Eik-Nes (1969), Seton (1928), Van Gelder (1959).

Genus *Mephitis:* **Striped and hooded skunks**

Derivation: The generic name *Mephitis* is a Latin word meaning "bad odor."

General description: There are two species of skunks within the genus *Mephitis.* The length of the head and body ranges from 28 to 38 centimeters, and the length of the tail from 18.5 to 43.5 centimeters. Adults normally weigh from 0.75 kilogram to 2.50 kilograms. Their contrasting black and white patterns have considerable variation. The striped skunk usually has white on the top of the head and on the nape of the neck extending down the back as two narrowly separated stripes. In some individuals, the top and sides of the tail are white, whereas in others the white is limited to a spot on the forehead. The white areas are entirely of white hair. Hooded skunks may have a white-back or a black-back phase. In the former, some black hairs are intermixed with the white ones; in the latter, the two white stripes are widely separated and are situated along the sides of the body, rather than being narrowly separated and situated along the back as on the striped skunk.

Males are solitary during the summer, but in winter a male may share a den with several females. In the northern parts of its geographical distribution, a skunk sleeps throughout the winter, with occasional forays outside the den. Resting almost anywhere it can find a dry place during the day, a skunk is normally active from dusk throughout the night. The skunk is omnivorous.

Skunks of the genus *Mephitis* breed in late winter or early spring. After a gestation period of about 63 days, 4 to 10 (usually 4 or 5) young are born in a den lined with vegetation. At birth, skunks weigh about 28 grams. After 6 or 7 weeks, the young are weaned; they stay with their mother until August or September when the members of the family go their separate ways. Breeding may occur at 1 year. Individuals have lived 10 years in captivity.

World distribution: Skunks of the genus *Mephitis* occur from southern Canada south to Central America.

General reference: Walker et al. (1968).

Species *Mephitis mephitis:* Striped skunk

Derivation: The specific name *mephitis* has the same meaning as does the generic name.

Specific description: Total length, 564 to 800 mm; tail, 180 to 393 mm; hind foot, 59 to 90 mm; ear, 20 to 28 mm; weight, 1.1 to 4.1 kg.

Striped skunks are heavy-bodied animals with short legs and large, bushy tails. They have small eyes, pointed noses, and short, round ears. These skunks walk flat footedly; their feet have naked soles. The long claws on their front feet aid in digging. Although these skunks have a characteristic black and white pelage, there is considerable variation in the proportions of white. The pelage of the body is all black except for a narrow, white stripe on the forehead between the eyes and a broad, white stripe from the top of the head to the shoulders which then divides along the sides of the back, meeting again across the top of the tail near the middle. The tip of the tail is black. The long hairs of the tail may be white at the bases but usually have black tips. Many individuals have a light yellowish or light orangish wash to their white patterns.

Distribution along the Oregon coast: Striped skunks occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: These skunks are most commonly found in the foredunes, deflation plain, stabilized dunes, wet pastureland, headland prairie, and headland shrub habitats; along some parts of the coast, however, they may also occur in the alder/salmonberry, lodgepole pine/rhododendron, and lodgepole pine/salal habitats.

Habits: The presence of a skunk may be announced by a "skunky odor," but this is not always the case. Bailey (1971) found that skunks usually begin their activity within 1 hour after sunset; in fact, he observed one skunk leave its den within the same 10 minutes on 10 consecutive evenings. Remaining active throughout the night, they often do not retire before sunrise and occasionally are active during the day. These skunks are placid animals, plodding along in a slow, indifferent, ambling walk, stopping here and there to inspect the ground and to dig out insect larvae. Unlike spotted skunks, striped skunks cannot climb trees and in general are not as graceful and agile as their smaller cousins.

A skunk makes its home in a burrow which it may dig; more often it appropriates the burrow of some other animal which it then remodels. According to Verts (1967b), slopes appeared to be preferred den sites, presumably because of good drainage. Although a burrow may have a single entrance, it usually has two open ings and may have as many as five. A den may be located in a cave or opening among rocks, under a stump or log, in a hollow log, or under a building. Burrows

have an average range of 5.5 to 6.1 meters in length but may be longer than 15 meters. They reach an average maximum depth of 1.2 meters below the surface of the ground-seldom more than 1.5 meters. Burrows less than 51 centimeters below the surface do not usually contain a nest and may be used only temporarily. There normally is only one nest per burrow, now and then two, but seldom three. A nest is lined with grasses and dry leaves and is situated in a chamber that is merely a widening of the burrow to a diameter of 30.1 to 38 centimeters. A main burrow frequently has side burrows and blind pockets (Allen and Shapton 1942).

In western Oregon, I have found striped skunks sleeping all day in the bottoms of lodges that dusky-footed woodrats built on the ground. A striped skunk sleeping in one of these lodges taught two young hunters (one of them me) an important lesson. The boys were hunting for woodrats with bows and arrows: One youth would jump up and down on the lodge, and when the rat ran out the other shot it. Everything went as planned for perhaps a dozen lodges; then after several jumps on one particular lodge, no rat sallied forth. Yet there had to be a rat within the lodge; it looked "ratty." When several more jumps failed to produce the rat, the one boy tore the lodge apart while the other waited, poised to shoot at the slightest movement. Then it happened-movement! The arrow sped to its mark. The remainder of the lodge exploded from within, and in the same instant, as though fired from a shotgun, an accurate barrage of amber fluid struck both youngsters simultaneously. That the skunk died almost instantly was little consolation for two very chagrined boys who walked the 10 kilometers home with all their clothes, except undershorts, hung as far behind them as the length of their bows would allow. One boy lived in the woodshed for a week and the other in the basement. Never again have I shot at anything without knowing exactly what it was!

Bailey (1971) found that the home ranges of three adult male striped skunks varied from 17.4 to 38 hectares both during and after the breeding season. Two juveniles (of unspecified sex) had home ranges of 12.5 and 46.1 hectares. The 12.5-hectare home range was that of a youngster who was still with its mother, whereas the 46.1-hectare home range was that of a juvenile after the family had disbanded in the fall. Verts (1967b) indicated that the greatest movements of juveniles may occur during the autumn when they are dispersing from the areas in which they were born and raised. The average straight-line distance that adult males and females traveled between points of capture was 0.8 kilometer. Juvenile males traveled an average of 0.3 kilometer and juvenile females 0.6 kilometer. One juvenile male, however, traveled 2 kilometers in 27 days (Bailey 1971).

Adult male skunks may exhibit some territorial behavior by mutually avoiding one another since they appear to occupy distinct areas. Females, on the other hand, apparently move about freely within the home ranges of several males; furthermore, males-probably transients-may move through the home ranges of other males during the spring (Bailey 1971).

Striped skunks are comparatively silent, seemingly without any loud vocalization, but they do occasionally utter a variety of low grunts, growls, snarls, squeals, twitters, and chatters. A series of low grunts may be emitted while an individual is eating (Jackson 1961).

STRIPED SKUNK

Striped skunks have a contrasting black and white coloration that undoubtedly acts as a warning to most animals; nevertheless, the raising of an individual's tail is the ultimate warning. The fluid is secreted by two glands on either side of the anus; it is stored in vesicles each with a capacity of about 1 teaspoon (Blackman 1911). The fluid is forceably ejected through "nipples" hidden within the anus when the tail is down but protruding when the tail is elevated (Crabb 1948). Jackson (1961, p. 378) said:

> The chemical responsible for skunk scent is butylmercaptan, a sulphur-alcohol compound that like all volatile suphur [sic] compounds is malodorous. Pure butylmercaptan in considerable internal doses produces unconsciousness, lowering of body temperature, slowing of pulse, lowering of blood pressure, and a general paralyzing of the central nervous system. Skunk fluid has been said to have a lasting deleterious effect if sprayed into the eyes, but this is not true. One's eyes will smart and burn for a moment, sometimes possibly for nearly an hour, and one will become blinded with tears from the skunk spray, but the pain is soon gone and there is no lasting trouble.

Bailey (1936, p. 309) wrote of the striped skunk:

> . . . with tail erect and black and white plume strikingly spread, the skunks make little runs at the enemy, which generally keeps beyond the enchanted circle, but if not, jets of amber liquid are thrown with surprising accuracy to a distance of 10 or 15, or possibly 20 feet, filling the air with the most stifling odor. An experienced hunting dog will usually keep beyond the danger limit and merely bark at a skunk, but one without experience or with a reckless disposition often rushes in and grabs the skunk, usually by the wrong end, and shakes the life out of it, greatly to his own and his master's sorrow. Often the dog becomes violently sick and loses his supper and would like to die, but cannot. If water is near he will plunge in and wash his mouth and his fuming coat, but to little purpose. If there is no water he will chew up the ground and leaves and roll and wallow in the grass or sand, but with little relief or improvement of his condition. Many a dog, however, never gets nearer than the first barrage, and the skunk safely reaches home before the enemy recovers from its surprise and discomfort. Under similar circumstances men, bears, mountain lions, and railroad trains are treated like dogs, with a full discharge of the weapons of skunkly warfare, and with varying but rarely enjoyable results.
>
> The skunk's weapon is the simplest of squirt guns. . . .The strange part of it is that from the rear the skunk can aim and shoot with such precision. With a quick twist of the body it will fire over one shoulder or the other at an enemy directly in front or aim at an object to one side or the other, or in the rear, or even directly above, and generally with astonishing accuracy. The only really safe place is beyond the animal's range.

Food: Although classified as a carnivore, the striped skunk is really an omnivore. Their diet includes fruits, grasses, leaves, buds, grains, earthworms, crayfish and their allies, snails, insects, fish, amphibians, reptiles, birds and their eggs, mammals, carrion, and garbage.

Along Puget Sound, Washington, Dalquest (1948) found that the purple shore crab formed one of the staple foods of the striped skunks; however, the skunks also wandered over the beaches when the tide was out and ate stranded fish and other marine animals. I found that they patrol the beaches and foredunes regularly along the Oregon coast, but the droppings I examined contained only insects-primarily sand-dwelling beetles, such as ground beetles (family Carabidae), darkling beetles (family Tenebrionidae), and scarab beetles (family Scarabaeidae). A few droppings, examined a kilometer or two inland from the coast, consisted primarily of ground beetles, a large, flightless tiger beetle (family Cicinidelidae), and numerous crickets and grasshoppers. In addition, skunks dug out several underground nests of wasps and bumblebees and ate the adults and larvae. Much of their prey is procured by digging, which is not surprising since a skunk's sense of touch is acute. On the other hand, a skunk may hunt by lying in ambush or by slowly stalking its intended meal, then suddenly pouncing on it. A striped skunk is too slow to pursue and capture prey (Jackson 1961). Small prey, such as a hairy caterpillar or a toad, may be rolled on the ground with one or both forepaws in an effort to remove hair or other objectionable matter before it is eaten (Schmidt 1936). For additional information on the food habits of striped skunks see: Dearborn (1932), Hamilton (1929, 1931, 1935, 1936c), Kelker (1937), Lantz (1923), Pellett (1913), Storer and Vansell (1935), Verts (1967b).

Reproduction: Striped skunks apparently breed during February and March throughout most of their geographical distribution (Verts 1967b). The normally placid male skunk becomes quite different during the breeding season (also called rutting season).

A captive male became "nervous" and aggressive; he would alternately stamp his front feet (a sign of irritation or fright) and then charge; at times his charge was preceded by a violent shaking of his entire body. He would usually stop his charge within a meter of a person and stamp with both front feet while twisting his body as if to spray and then would approach sideways. His mouth was held open, and if he came into contact with a person, he bit viciously. When not in rut, this skunk spent most of the daylight hours sleeping, awakening only occasionally to eat and drink. He became more active as darkness approached, but then he only ambled about and did not appear concerned with anything. Furthermore, his activity was limited during the winter to warm periods followed by a thaw. When in rut, however, he was active during all nights except when snow was falling (Ernst 1965).

During rut he drank almost twice as much as he did at other times, and instead of urinating in only one corner of his enclosure, he urinated indiscriminately throughout his quarters. His urine became more pungent and at times he would either lap his own urine or roll in it.

The male's rutting activities began on January 27 and ended on March 2, but they were confined to the hours of darkness; his daytime activities were unchanged (Ernst 1965).

Females normally produce a single litter per year. The babies are born into an underground nest of clean vegetation during May and June, after a gestation period of 62 to 64 days. Although litters range from 2 to 10 skunklets, 6 or 7 constitute the usual litter. Young are born with their eyes and ears closed; they weigh about 28 grams. Their heads look much too large for their bodies, and their pinkish skin is thinly covered with very short, fine hairs. The color pattern is clearly discernible at birth. The white is much lighter than the rest of the animal; in fact, the extent of the white areas can be more precisely determined at this age than when the animals reach adulthood. In about 12 days, striped skunklets begin to fill out and appear to be more sturdy. The claws are much better developed and those on the front feet are nearly twice as long as those on the hind feet. Their eyes begin to open at 21 days of age, and they seem to be more sensitive to their surroundings. By the time they are 26 days old, their tails are well haired and when the hairs are erected they look quite "businesslike." The ears begin to open. Both eyes are open when the skunklets reach 30 days of age; at this time they can emit small quantities of musk. The characteristic odor becomes noticeable at about 50 days of age (Stegemen 1937). A mother leads her family out to hunt at dusk, her young following single file. According to Bailey (1971), the young become self-sufficient by the middle of August. Although a family group may break up during the autumn, more often a family remains together. Some males, however, may begin to shift for themselves (Jackson 1961). According to Verts (1967b), striped skunks become sexually mature in time to take part in the first breeding season after their birth.

Predation: Jackson (1961) stated that the great horned owl and the barred owl prey on these skunks. Domestic dogs are also among the striped skunk's enemies. People, their main enemy, kill many of them annually for their pelts or merely to eliminate them. In Oregon many skunks are killed by automobiles, particularly juveniles during the late summer and throughout the fall.

Economic status: Although individual striped skunks may raid poultry yards and beehives, they are far more beneficial than detrimental. The chief asset of the skunk is its diet, since it consumes tremendous quantities of "harmful" insects, as well as numerous mice and rats. Jackson (1961) stated that the oil from the fat of striped skunks is an excellent rubbing oil. He (p. 380) also wrote that, "Skunk meat for some might be difficult to relish, yet properly cooked it is clean, white, and delicious, in taste and texture between pork and chicken."

Licensed Oregon trappers reported taking 7,664 striped skunks during the 29-year period from the 1945-46 through the 1973-74 trapping season. The largest annual catch (1,846) was in 1945-46; the smallest annual catch (33) was in 1956-57. The average price per pelt increased from 56 cents in 1967-68 to $2.33 in 1973-74. During the 1973-74 trapping season, 472 pelts were sold for $1,099.76 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a).

Diseases: Striped skunks carry rabies, leptospirosis, and tularemia-all of which are highly infectious to humans. Any skunk that appears to be sick should be left strictly alone. For information on rabies, leptospirosis, and tularemia in striped skunks see: Burkel et al. (1970), Cappucci et al. (1972), Hattwick et al. (1972), McKeever et al. (1958), Schnurrenberger et al. (1970), Storm and Verts (1966), Tabel (1970), Verts (1967b).

Selected references: Allen (1939a), Bemrick and Schlotthauer (1971), Dyer (1969b, 1970), Hamilton (1937), Houseknecht and Huempfner (1970), Jacobson et al. (1970), Lincoln and Anderson (1973), Seton (1928), Shaw (1928), Stegemen (1939).

Genus *Lutra:* **River otters**

Derivation: The generic name *Lufra* is the Latin word for "otter."

General description: The length of the head and body of otters of the genus *Lutra* ranges from 55 to 80 centimeters and the length of the tail from 30 to 50 centimeters. Adults weigh from 4.5 to 14 kilograms. Otters have flat, round heads and short necks that are about as wide as the head. Their bodies are long and cylindrical and their thick, muscular, flexible tails taper to a point. They have short, powerful legs and webs between their toes. Otters have small ears and nostrils that can be closed when the animals are in water. Their short, thick pelages are dark brownish above and lighter below; the lower jaw and throat may be whitish.

Superb swimmers and divers, river otters inhabit all types of inland waterways as well as estuaries. Although most active at night, they are often abroad during the day. They hunt singly or occasionally in pairs. Their diets consist of crayfish, frogs, turtles, fish, and aquatic invertebrates, in addition to the birds and mammals they can catch.

These beautiful, graceful mammals are probably the most playful members of the family Mustelidae; in fact, they are some of the most playful mammals in the world. Members of some species slide down mudbanks and snowbanks, regardless of an individual's age. They may tunnel under snow to emerge some distance beyond, or when traveling overland on snow and ice, they may combine running and sliding.

Otters are normally gentle, sociable animals, but males may fight one another during the breeding season. The New World otter *(Lutra canadensis)* has delayed implantation; its gestation period ranges from 9½ to 12% months; the Old World otter *(Lufra lutra),* on the other hand, has a gestation period of about 2 months. Litters, ranging from one to five (usually two or three), are born in dens lined with dry vegetation. The young are weaned in about 4 months; the family remains together about 8 months. River otters have lived 19 years in captivity.

World distribution: River otters occur throughout most of North America and South America, most of Africa, Europe, Asia, and the large Malayan islands.

General references: Walker et al. (1968), Harris (1968), Van Zyll De Jong (1972).

Species *Lutra* canadensis: Canadian river otter

Derivation: The specific name canadensis is a proper name; this species of otter was named after Canada, combined with the Latin suffix, *ensis,* denoting possession-hence, Canadian river otter.

Specific description: Total length, 835 to 1300 mm; tail, 300 to 507 mm; hind foot, 100 to 146 mm; ear, 20 to 35 mm; weight, 3 to 11 kg-large males occasionally weigh as much as 13.6 kg (Jackson 1961).

Canadian river otters are long, cylindrical carnivores with low bodies. Their legs are short and their long, tapering tails are somewhat flat horizontally. Their heads are small, as are their eyes and ears. The feet are webbed between the toes. The soles of the feet are naked and may have what appear to be warts. The thick, silky, underfur is wholly concealed by short, glossy guard hairs. Dorsally, the pelage varies from dark brown to dark reddish brown and is slightly paler below. The throat and cheeks are grayish brown. In summer the pelage may fade to a lighter, more reddish brown.

Distribution along the Oregon coast: The river otter occurs along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: River otters occur in the riparian alder/large stream, coastal lake, tideland river, and mountain river habitats; occasionally they visit the riparian alder/small stream habitat.

Habits: Though otters are primarily active at dusk and throughout the night, they are often abroad during daylight hours. To be fortunate enough to observe otters as they frolic in a clear, placid lake or a bounding, rushing stream is to behold the epitome of aquatic grace and beauty among land mammals. Moreover, their frequent chirping gives the distinct impression that they are thoroughly enjoying a good time.

OTTER

Over most of their geographical distribution, otters are constrained to freshwater, but in coastal areas they readily navigate brackish and marine environments. Along the Oregon coast they frequent the bays, estuaries, and even some of the rocky points that project into the ocean along the mouths of the larger rivers.

River otters are excellent and versatile swimmers. They can swim either by paddling with the limbs in any combination or by holding the limbs outstretched toward the rear, close to the sides, while they undulate their powerful bodies. The strong undulating motion is used when swimming in earnest, and during such times they swim alternately on the surface of the water and beneath it (Liers 1951, Tarasoff et al. 1972).

River otters have three gaits when moving on land-walking, running, and bounding. When walking, the whole body is held rigidly with the head and neck outstretched, and since the hind limbs are a little longer than the front ones, the body is inclined slightly downward. The end one-third of the tail may drag on the ground. A running otter holds its tail above the ground by slightly arching the terminal one-fourth of it. Bounding is an otter's fastest gait; when bounding, the front
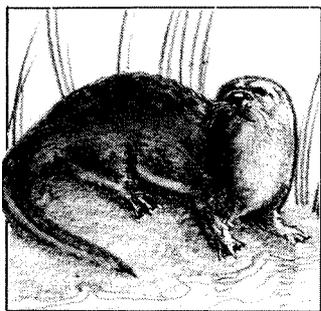
and hind feet are brought toward each other causing the back to arch and the tail to be lifted off the ground. Otters traveling overland on snow or ice combine running and sliding. They alternately run, then tuck their front feet under their bodies and slide, run again and slide again (Liers 1951, Tarasoff et al. 1972).

Otters are great travelers. Liers (1951) stated that individuals may travel 80 to 96 kilometers along stream courses in a year and that families may range from 4.8 to 16 kilometers in one season. Jackson (1961, p. 384) wrote that a family of otters may travel over 160 kilometers while seeking a more suitable home. "Even from an established den a lone otter, particularly a male, or a pair, may travel 20 to 30 miles and return after an absence of several days." The actual distances traveled by otters vary greatly and undoubtedly are related to the available supply of food, the general suitability of the habitat, and perhaps to an "innate wanderlust."

Tabor (1974) studied 254 otters that were taken in western Oregon, primarily along the coast, during the 1970-71 and 1971-72 trapping seasons. About 59 percent of the otters were taken from major rivers, 28 percent from small tributary streams and creeks, and 13 percent from lakes; 30 percent of the otters were trapped from waters influenced by tides.

Regardless of the body of water otters inhabit, they have particular areas where they emerge to roll and rub themselves. Along the coast they nearly always choose sandy areas, but they will use grass, leaves, and even snow. They are particular about their rolling areas in that they use the bank farthest from a nearby road. It seems that human activity along a road makes them "nervous," particularly when such activity is on a road some distance above the water and, therefore, out of their view. Spending so much time in water makes it imperative that they keep their pelages clean to maintain insulating properties. The frequent rolling and rubbing appears to serve this purpose. Otters invariably leave their "sign" at these rolling areas-both their urine and black, tarlike feces. In fact, Liers (1951, p. 2) stated that "When several otters travel together each one tries to be the last to leave its mark, [even] if that last mark amounts only to a dribble."

Otters have more than their share of curiosity. They may approach to within a meter of a boat in water and stop to watch. If on the bank, they may sit up full length, brace themselves on their tails and watch. Otters often accompany their observations with a commentary of chirps.

The antics of otters have all the appearances of play. Liers (1951, p. 9) wrote of the otter:

> They enjoy sliding to the full. Finding a hill that is clear of debris, they will coast to the bottom, do an immelmann turn there, and run immediately to the top to repeat the performance. Even though the ground may be slightly rough, so that they will get repeated bumps on their stomachs, they will coast again and again. On a particularly steep and slippery slide the rare otter that may not like the excessive speed will thrust his fore paws forward to slow the pace or even to break [sic] itself to a stop. But it is usually not long until that timid one has become accustomed to the speed and he joins with the others in the sliding game with reckless abandon. In the summer, otter will substitute mud or grassy banks for the snowy hills. But

snow is always tops for otter slide and it is on those slides that they let their good nature show by their playing, tussling, and wrestling for all that they are worth. It is a good picture of perfect relaxation.

Then in one sentence, Liers summed up the otter's outlook on life, "Otters love to play in the water and to romp and slide across the countryside."

Although otters are generally renowned for their "carefree" manner, they have another side to their personalities that is aptly described by Seton (1928, p. 691):

There are few wild animals in America that have not been described by someone as "skulking cowards," however brave they may be in a single fight-so described by men who knew nothing of risk or war-wound. Yet there is one [the Canadian river otter] that all men of the woods agree is clear grit, grit to the bone, without a yellow streak, staunch to a finish, a fighter that never shuns a fight, that never surrenders.

Liers (1951, p. 9) wrote:

Over most of the year otters are social, gentle, and playful. They also are quite loyal to each other. If another otter is in trouble, or their master or even a dog that they are attached to is in difficulty, all otter&] in the vicinity will pitch in to fight off the danger. On one occasion while I was walking with some of my otters through a field, a farmer's dog ran out to attack my Airedale that was also along with us. The otters immediately jumped into the fight and drove the stranger howling from the scene. On another occasion a strange dog attacked me. . . . The otters that were loose in my yard came charging to my assistance and drove the dog off of the premises.

Food: Otters eat a variety of foods, but there is some seasonal variation in their diets. During winter and spring they may subsist primarily on various fishes, whereas during summer and fall crayfish are apt to be their staple. They also eat such animals as turtles, frogs, salamanders, freshwater clams and mussels, large aquatic beetles, a few mammals and birds, some carrion, and occasionally blue-berries. Along the coast, otters include crabs and other seafood in their menu (Dalquest 1948, Knudsen and Hale 1968, Liers 1951, Morejohn 1969, Sheldon and Toll 1964, Toweill 1974; also see footnote 14, page 217).

Otters may fish alone or in teams. Sheldon and Toll (1964) observed two otters catching fish near the shore of a reservoir. The otters swam on the surface until they were about 3 meters apart, when they dove and swam exceedingly rapidly toward a shallow cove; they seemed to be herding the fish into the cove. In their efforts to capture the fish thus driven into shallow water, the otters went through considerable contortions, splashing water in all directions. The maneuver, repeated five times, was highly successful since both otters caught a fish during each maneuver. On the other hand, an otter was less successful when fishing alone.

As noted by Jackson (1961), otters even play with their food. He watched one in-dividual carry a 25-centimeter fish to a flat place along the bank of a stream. The otter would grasp the fish with its mouth and toss it into the air. As the fish descended, the otter would use the top of its head or its nose to catch the fish or to butt it into the air again. The otter played with its meal for about 5 minutes before eating it. Also see Greer (1955), Hamilton (1961), Lagler and Ostenson (1942), Ryder (1955), and Wilson (1954).

Reproduction: The breeding season occurs from November through early April. Though otters are sociable for much of the year, males will fight among them-selves during the breeding season, particularly when a sexually active female is in the vicinity. Some males become very rough when attempting to mate and will not tolerate the interference of another male. A few males go "berserk" when they sense interference and will charge whatever they deem the disturbance to be. Others, however, remain unaggressive throughout the breeding season. Liers (1951, p. 5) wrote:

> One wild-trapped male, about 12 years old, was a perfect gentlemen [sic] of the old school. He never handled the females roughly. If I had a female in heat in my arms, this male, Biackhawk, would come over to me, take the cuff of my trousers in his mouth, and shake it, coaxing me to put the female down on the ground.

Females come into heat immediately after giving birth, and unless bred, they re-main in heat for 42 to 46 days but are most receptive at 6-day intervals. Because of delayed implantation, the gestation period ranges from 288 to 375 days. Implantation of the embryos occurs in late January or late February in New York and about the first of February in western Oregon. Since the embryos grow ac-tively for only about the last 2 months before birth, the young are born during March and April (Hamilton and Eadie 1964, Liers 1951, Tabor 1974).

The young are born in dens, cavities among the roots of trees, or in thickets of vegetation. Dens may be as much as 152 meters above the high-water mark and up to 0.8 kilometer away from water, or they may be at the water's edge. Dens normally are burrows that have been appropriated from some other animal and renovated by the otter. The dens of otters are well hidden; those located at the water's edge have the main entrance far enough below the surface to prevent their being frozen shut. Otters also use abandoned lodges of beaver and muskrats for dens (Jackson 1961, Liers 1951).

Otters normally breed every year and produce a single litter. Litters range from one to five young, but usually two or three. The process of birth lasts from 3 to 8 hours, depending in part on the size of the litter. As soon as the newborn are cleaned, their mother curls tightly around them so that they are almost completely protected from cold air. Babies weigh about 115 grams at birth. They are fully covered with hair that is about 6 millimeters long. Dorsally, the pelage is uniformly brownish black, but it is lighter and more grayish ventrally. The lips, cheeks, chin, and throat are paler than they are in the adult. The babies' eyes are closed, and the babies are toothless. The young are helpless for 5 or 6 weeks. Although adult

otters defecate and urinate outside their dens, the babies have to be cleaned by the mother until they are about 7 weeks old. Their eyes open in about 35 days, and when they are 5 or 6 weeks old, they begin to play with one another and with their mother. The mother allows her young to go outside the den for the first time when they are 10 to 12 weeks old (Hamilton and Eadie 1964, Liers 1951).

The young have to be coaxed into the water the first time; in fact, sometimes a mother has to drag one of her offspring into the water by the scruff of its neck. They appear to be head-heavy when first learning to swim and have trouble keeping their heads above water. Swimming lessons, therefore, are accompanied by much struggling and sputtering. In the beginning the mother catches food and calls her young to come and get it. At their arrival, she releases the alive prey which usually escapes into the water, followed by floundering youngsters trying to find it. Through repetition they learn to catch and hold onto their food. In traveling, the mother generally leads the way, calling her offspring. Should they become too adventuresome and try to rush ahead of her, she nips their noses. When so punished, a youngster drops to the ground and lies very quietly. When punished severely, a young otter remains lying on its back and will not move forward until the mother returns and caresses it (Liers 1951).

Otters become sexually mature at 2 years, but males, for some unknown reason, usually do not breed successfully until they are between 5 and 7 years old. Otters are known to live at least 11 years in the wild; in captivity, they have lived from 12 to more than 14 years (Hamilton and Eadie 1964, Liers 1951, Scheffer 1958b, Tabor 1974).

Predation: Otters have no natural predators. Jackson (1961) stated that an occasional otter is caught and drowned in a fish net or on a set line. During the winter of 1971-72 an otter was killed by an automobile near Otis, Lincoln County, Oregon, but this undoubtedly is a rare occurrence. Humans are the only persistent enemy of the otter, trapping them for their valuable pelts or shooting them in the mistaken belief that they decimate populations of game fishes-particularly trout and salmon-and waterfowl, such as ducks.

Economic status: People who fish or hunt ducks often blame the otter for depredating waterfowl and game fishes. Otters do eat a few waterfowl, probably many cripples, but studies of otters' food habits show that waterfowl is a minimal part of their diet. It is equally true that otters eat some game fishes, but not nearly to the extent that most people think. Otters prey on fishes in proportion to their abundance, but they tend to choose the slower, more easily captured species. Although otters tend to select fish that are over 15 centimeters long, they do not select a particular species. In fact, the otters' diet is composed primarily of non-game "pest" species, such as suckers; furthermore, some of the salmon eaten by otters are probably taken as weak, spawned-out individuals or as carrion (Erlinge 1966, Ryder 1955, Toweill 1974). Knudsen and Hale (1968) concluded that in areas where otters occasionally may cause substantial damage, such as fish hatcheries, control measures should be applied to each case rather than to the otter population as a whole. Part of their reasoning was that although river otters may be generally distributed, they are not overly abundant or common anywhere.

The river otter is an important fur-bearing mammal in Oregon. During the 29-year period from 1945-46 through the 1973-74 trapping season, licensed Oregon trappers reported taking 7,382 otters, mostly from the coastal counties. During the 20-year period 1952-53 through 1971-72, 5,474 otter pelts were sold for an average price per pelt of $21.37, bringing $116,979.38. The average price per pelt for the 298 otters taken during the 1973-74 trapping season was $35.77; they were sold for $10,659. 46 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a). The otter is a beneficial and economically important mammal and should be managed with extreme care.

Selected references: Field (1970), Friley (1949), Hooper and Ostenson (1949), Lankester and Crichton (1972), Seton (1928), Tabor (1974).

Family Felidae: Cats, Lynxes, and Allies

Derivation: The familial name Felidae is derived from the Latin word *felis* (a cat, the prolific one) combined with the Latin suffix *idae* (family).

General description: Walker et al. (1968, p. 1268-1269) wrote of the cat family:

> Much of the classification of mammals is based on the shapes and relative proportions of the different parts of the skulls of different mammals, but the cats have a remarkable uniformity of proportions between the various parts of the skulls in spite of the great variation in sizes of the animals and the proportions of the limbs and tail, and the side variation in markings. The latter range from almost the same color over the entire animal through spots, stripes, and blotches of various colors, sizes, shapes, and arrangement. This peculiar combination of characters has led to great diversity of opinion as to how the cats should be classified, with resultant multiplicity of names and groupings. One author used as many as twenty-three generic names for the cats, and other authors have taken the other extreme and recognized only two or three genera. Fortunately the cats are not as badly confused as the mammalogists.

Although cats come in a great variety of external forms, they are all recognizable as cats. The general cat type, once established, probably did not undergo much structural modification. The differences in size and color pattern seem to have arisen mainly from the influence of the size of the prey and the local habitat. Cats are lithe, muscular, compact animals with deep chests and short, round heads. The pupils of their eyes contract vertically; their ears range from round to pointed, and they have well-developed whiskers. The length of the head and body of cats ranges from 0.5 meter to 3.75 meters; the tail ranges from 10 to 114 centimeters in length and is well haired but not bushy. The limbs of cats range from short to long and sinewy; the forefeet have five digits whereas the hind feet have only four. Except for the cheetah, cats have retractile claws which can be withdrawn into a sheath, thus preventing their becoming dull. The claws are large, compressed, strongly curved, and sharp. Except for the naked pads, the feet are well haired which aids in the silent stalking of prey.

The pelage is soft and woolly. Its glossy appearance is maintained by frequent grooming with the tongue and paws. Color varies from gray to reddish brown to yellowish brown, generally with stripes, spots, or rosettes.

Most cats place the hind feet into the tracks left by the front feet. The possession of perfect register aids the cats in stalking their prey noiselessly because, having placed their front feet with care, they do not have to be concerned with the careful placement of their hind feet; this allows them to concentrate on their prey. Except for the cheetah which outruns its prey, cats normally stalk and ambush their quarry. They travel singly, in pairs, in family groups, or (the lion) in "prides" of about 23 individuals. Some cats are nocturnal whereas others are primarily diurnal. Felids take shelter in trees, hollow logs, caves, abandoned burrows of other animals, and amid ground vegetation. Cats either flee from danger or literally defend themselves with "tooth and claw." The normal facial expression of most cats is quite unlike the savage expression usually pictured when an individual is on the offensive or defensive.

Although some cats may have a poor sense of smell, their senses of sight and hearing are acute. They prey on almost any animal that they can overpower. The "big cats," the four species in the genus *Panthera* are especially powerful. The leopard, for example, frequently stores its prey in a tree. One individual is known to have pulled part of a young buffalo, weighing about 45.5 kilograms, nearly 4.6 meters up into a tree. A mature tiger's incredible strength is well known; a typical example is its shifting a buffalo 9 meters that 13 men could not drag.

Most cats produce one or two litters a year, but the large species may breed only every 2 or 3 years. Gestation periods range from 55 days to 9 months, and normal litters range from one to six young. Babies are blind and helpless at birth, but they are well haired and their coats are often spotted. They remain with their mother until they can fend for themselves. Cats may live 30 years.

World distribution: The geographical distribution of native cats is almost worldwide, except for Antarctica, the Australian region, Madagascar, the West Indies, and some oceanic islands. People have introduced the "domestic cat" into many areas, such as Australia, where cats had not existed.

Fossil record: In North America the fossil record of the cat family dates to the late Eocene or early Oligocene.

Number of species along the Oregon coast: Two.

General references: Adams (1896), Anderson and Jones (1967), Hillaby (1968), Matthew (1910), Simpson (1941), Walker et al. (1968).

Genus *Felis*: True cats

Derivation: The generic name Fe/is has the same meaning as the familial name.

General description: Members of the genus *Felis,* as herein treated, range in size from the puma (also called cougar or mountain lion) to wild cats that are smaller than the average domestic cat. These cats are medium to large carnivores; they usually have long tails and large feet. Like other members of the family, they walk on their toes. They have flat, short faces, with large eyes and well-developed ears.

With the exception of the domestic cat, most members of this genus are either some shade of brown, gray, or black. Members of most species have stripes, spots, or mottled patterns or dark colors on a lighter background, but there is much variation within a species. Members of some species lack markings.

These predators are nocturnal. They seek shelter in rock crevices, in hollow trees or logs, in holes in banks or the ground, or in tall grasses or underbrush. Cats are much alike in their habits; they prey on almost any mammal or bird that they can capture and overpower, as well as occasional reptiles. Although most cats appear to be fond of fish, only a few catch them regularly. Unless provoked, cats normally have a mild facial expression.

Females of most species become sexually mature at 12 to 15 months of age and thereafter may come into heat several times a year. The small species may have more than one litter per year, but the larger species may breed only every 2 or 3 years. Litters range from one to six young, usually two to four. (The domestic cat Fe/is *catus* may have more than six offspring per litter.) Gestation periods range from 55 days to 9 months. Young are cared for by their mothers until they are old enough to fend for themselves. Members of this genus have lived 22.5 years.

World distribution: Cats of the genus *Felis* occur as native mammals throughout most of the world, except the Australian region, Madagascar, the West Indies, and some other oceanic islands. People have introduced the domestic cat into many areas, such as Australia, making the genus almost worldwide in distribution.

General reference: Walker et al. (1968).

Species *Felis concolor:* Puma or mountain lion

Derivation: The specific name *concolor* is the Latin word meaning the "same color."

Specific description: Total length, 1500 to 2743 mm; tail, 534 to 900 mm; hind foot, 220 to 295 mm; ear, no measurements available; weight, 36 to 95 kg.

The puma is the largest cat in Oregon. The head, back, sides, and the outsides of the legs are dark tannish to reddish brown. The top of the tail is darker brown than the back, darkening into a relatively long, blackish tip. There is also black on the backs of the ears and on each side of the nose. The throat, chest, belly, and insides of the legs are whitish. The upper parts of young pumas are covered with coarse, irregular spots. Wright (1971) stated that about 7 percent of the pumas in New Brunswick and Nova Scotia, Canada, are black.

Distribution along the Oregon coast: Pumas occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Pumas may occasionally occur in or at least travel through most of the habitats except the beach, foredunes, moving dunes, deflation plain, stabilized dunes, coastal lake, and tideland river.

<u>Habits:</u> Bailey (1936, p. 262) wrote of this big cat:

> Few animals are more stealthy and secretive than mountain lions as they hunt through the shady forests and dense undergrowth or lie in wait near the deer trails for their prey. Soft-footed and silent they sneak away at the approach of hunters and are rarely seen even by those much in the woods and accustomed to catching every motion and sound of the forest.

A puma's normal gait is a rather long-strided walk, but when closely pursued it may cover 7.6 meters or more in long, graceful leaps. Regardless of what a puma is doing, it is always the epitome of grace and strength welded into fluid beauty. Although primarily a ground-dwelling mammal, a puma will ascend a tree to escape pursuit by hounds.

These big cats are curious and on occasion may follow a person traveling through their domain. I have been followed at least a dozen times while traversing the high Cascade Range of Oregon and Washington. Once, during the first snow flurries of winter, one of these cats stayed more or less abreast of me for the better part of 3 days. I never saw the cat but I easily found its tracks by backtracking or by circling. On one occasion, the cat had remained on a small bluff for some time while I made camp. Even though at times I could "feel" its presence, its stealth was remarkable. I "sensed" a distinct feeling of companionship with this silent traveler and felt sad when the cat departed.

Although there have been instances of pumas making unprovoked attacks on people and even killing them, this trait is neither general nor common (Young and Goldman 1946). The puma has been badly maligned and misrepresented as a "dangerous killer" in motion pictures; furthermore, many hunting stores treat killing a puma after it has been treed by dogs as an act of courage. Unfortunately, that is probably all that most people will know and remember about this magnificent animal.

Photo courtesy Oregon Department of Fish and Wildlife.

Over the years there have been many stories and much speculation about the "scream" of the puma. Bailey (1936, p. 263) wrote about this sound:

> That much-discussed subject, the "scream" of the mountain lion, is a delicate one because of some confusion in the interpretation of the scream. Generally the animals are silent, but they are by no means without vocal powers. When treed or cornered they have a repelling growl and snarl and hiss, and at times when they are free and alone they utter a loud call or cry that suggests a fair compromise between the caterwaul of a tomcat and the roar of a lion. It is heavy and prolonged, slightly rising and falling, and fairly well indicated by the letters o-o-W-0-U-H-u-u. On two occasions, in the woods on dark nights the writer has heard this cry repeated several times at frequent intervals, and once from a cage in a zoological park. There was no mistaking its catlike quality in any of these cases, but it could hardly be called a scream. . . . The most common mistake in regard to mountain lions is in attributing to them the shrill "woman-in-agony scream" of the full-grown young of the great horned owl, which is often heard, and when close on a dark night is fully as terrifying as any sound a real mountain lion could possibly produce.

Also see McCabe (1949) and Young and Goldman (1946).

The following explanation is the story most often heard about the puma's scream: Just before leaping for the kill, a puma screams to paralyze its intended victim with fright; the instantly paralyzed victim is then easily captured. Few of the storytellers, however, had ever seen a puma in the wild and none had actually seen the cat make the sound. Stories like this, without fact, cause people to be afraid of pumas, not because the cat is a "dangerous killer," but because people are ignorant about the puma.
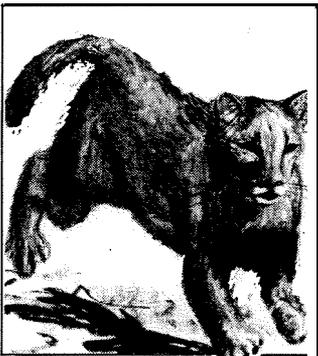
MOUNTAIN LION

Much of the early literature emphasized that pumas travel at random, without any particular destination, but Hornocker (1969) demonstrated that most mature, adult resident pumas confine their movements to specific areas year after year. There is also a component of younger, transient adults. Although residents occupy fairly distinct, contiguous winter-spring and summer-fall home ranges, use of these areas varies not only with season but also with time and individuals. Generally speaking, resident pumas use larger areas in summer than they do in winter, and males tend to travel more widely than females. The tendency of pumas to increase their movements during late winter is a result of the scarcity of food. Pumas hunt almost continuously, causing them to spend rarely more than 1 day in the same location. Except for the longer periods of heavy rain in spring and fall, the activity of pumas appears to be largely independent of the weather (Seidensticker et al. 1973).

Hornocker (1969) determined that during the winter the minimum area over which a male puma ranged was 40 square kilometers, whereas the minimum area of a female was 8 square kilometers and the maximum was 32 square kilometers. Resident male pumas occupied areas that were distinct from one another; however, a male's area overlapped with those of females. Females, on the other hand, shared common areas, and transients of both sexes moved freely through

occupied areas. The pumas exhibited a high degree of tolerance for other pumas in their areas but were decidedly unsocial in that they always avoided contact with another individual. There was no evidence that pumas defended an area, probably because the behavioral mechanism of mutual avoidance kept them distributed.

Seidensticker et al. (1973) found that pumas use all their senses in maintaining adequate distances from one another. Urine, "scrapes," feces, and scent from anal or other glands probably advertise a puma's presence, either bringing pumas together or maintaining the distance between them. Puma scrapes are areas where the cats scrape soil, or litter, or both into a pile in one to six places usually less than 1 meter apart. The cats may deposit feces, or urine, or both in or on the pile.

Among pumas, land tenure is based on prior rights, and home ranges are well covered. Home ranges are altered after deaths or movements of the residents. Young adults establish home ranges only as vacancies become available. The land tenure system acts to maintain the density of breeding adults below the carrying capacity of the available food supply (Seidensticker et al. 1973).

In the short term, a puma's home range is in a state of constant change created by the availability of prey. Over the long term, however, the conditions in certain parts of the home range are such that pumas tend to be more successful there in making kills; as a result they spend a greater amount of their total time in those parts. There is a definite advantage for a puma to be thoroughly familiar with its home range, especially for a female rearing kittens (Seidensticker et al. 1973).

Food: There has been a great deal of controversy concerning the food habits of pumas, mainly because they prey on deer and North American elk, and occasionally on livestock. Even though deer and elk are the puma's staple diet, they also eat other foods, such as snowshoe hares, porcupines, ground squirrels, beaver, some coyotes, grouse, and moose-as well as some carrion (Spalding and Lesowski 1971).

When traveling, pumas normally zigzag back and forth through thickets, move around large openings and under overhanging rock; they go up and down small draws and back and forth across creeks. This method of travel may better enable them to detect prey and to stage successful attacks. Pumas do not indiscriminately try to capture prey wherever it is found. Their mode of hunting (stalking) necessitates that they find the prey in a location where they can stealthily approach close enough to successfully attack (Hornocker 1970). After leaving a kill, pumas have no immediate further "attraction" to that area; instead, they seem to make a distinct effort to travel to other parts of their home ranges (Seidensticker et al. 1973).

Hornocker (1970), studying puma predation in Idaho, found that one female and her three 32-kilogram kittens killed four deer in an 18-day period, whereas another female and her three 32-kilogram kittens killed one North American elk in 12 days. He also found that some pumas go without killing a big game animal for more than 8 days. Hornocker stated (p. 26), "I believe that a mature lion. . . kills one deer every 10 to 14 days during the winter. This interval is longer when elk are killed, and I am certain it is longer in summer when many smaller prey are available."

From feeding experiments with captive pumas as well as data obtained from zoos, Hornocker determined that the pumas he studied ate about 1.8 to 2.7 kilograms of meat per day. When a puma has made a kill, it remains in the immediate vicinity; each kill is dragged to a protected place and covered with ground litter or snow. The kill, closely guarded against scavengers, is eaten over a period of 1 to 19 days. Young prey are almost entirely consumed, including the spinal column, skull, and feet, but only about 70 percent of older prey is eaten. The 30 percent that is left includes the rumen (stomach), some viscera, bones, feet, and some of the hide.

Hornocker (1970, p. 35) stated that there is no question that individual prey possessing "undesirable behavioral or physical characters" are the most vulnerable to predation by pumas and ultimately are culled from the herd. Spalding and Lesowski (1971) examined the ages of mule deer that had been killed by pumas and those that had been killed by sport hunters. They found the following:

Age of deer	Killed by pumas	Killed by sport hunters
	(Percent)	(Percent)
Juveniles:		
Less than 1% years	23	20
1% years	11	26
Adults:		
1% to 8 years	40	51
9 years or older	26	3

Predation by pumas has some definite beneficial effects on their major prey. Hornocker (1970, p. 35) elucidated some of these effects:

> Mountain lions keep deer and elk moving on the winter range. This alone is perhaps more important in an ecological sense than the actual removal of animals. The mere presence of a lion or family of lions in a locality of watershed does not appear to alarm game animals. When a kill is made, however, the reaction is striking. Deer and elk immediately leave the area, cross to the far side, and in some instances leave to enter a different drainage. This behavior, observed without exception, acts to distribute game animals. Its importance on restricted, overused range is obvious.

Such forced redistribution is important to the species of hoofed mammals that exhibit either weak territorial or nonterritorial behavior, such as deer and North American elk, which allows them to overpopulate an area and to severely damage the habitat. Furthermore, predation by pumas is a powerful force acting to dampen severe fluctuations in the population of the prey species. Hornocker's study showed that predation by pumas was inconsequential in its effect on the ultimate number of North American elk and deer. Hornocker (p. 37) culminated his paper with the statement: "The effects and influence of such predation are considered of great significance in the maintenance of ecological stability in a wilderness environment." Also see Robinette et al. (1959).

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Reproduction: Reproduction is confined to resident pumas, but a resident male may breed several resident females whose home ranges overlap his home range. Since transient pumas are nomads, the reproductive phase of a transient puma's life is restricted until it finds a vacancy and establishes its own home range. A home range is not inherited intact. Since the land tenure system of pumas is dynamic and flexible, there is a resorting of living space. The resorting takes place among the older pumas first, and the younger pumas must take what is left (Seidensticker et al. 1973).

Although pumas breed at any time of the year, individual females breed only every other year. Just before and just after the young become independent, a female associates with (or perhaps only tolerates) adult males and even adult females more frequently and for longer periods than at any other time. Such tolerance reaches its peak during estrus when a pair of pumas remain in one another's company, traveling together for as long as 16 days (Seidensticker et al. 1973). The longest estrus reported in a captive female was 11 days, but the shortest and most common was 8 days (Rabb 1959).

From data on 145 litters, Robinette et al. (1961) found that pumas gave birth to their young at any time of the year. Their data further indicated that although 60 percent of the litters were probably born from June through September, most arrived during July. The litters ranged from one to five young, but the usual litter consisted of three.

After a gestation period of 91 to 97 days, the young are born in a secure place, such as a shallow cave or a thicket, or under a rock overhang. Newborn babies weigh about 396 to 453 grams and are covered with short, soft hair that is dull tannish with darker blotches on the body and bands on the tail. Their eyes are closed at birth but open in 9 to 14 days. They weigh from 3.6 to 4.5 kilograms by the time they are 2 months old. At 6 months, they weigh about 18 kilograms and are beginning to lose their dark markings. They are weaned at 10 to 12 weeks (Jackson 1961).

A female with kittens less than 1 year old is greatly restricted in the use of her home range; her pattern of movement is also more complex. A female leaves her kittens at some protected site for a day or two, during which time she hunts. The female hunts in a loop, away from her young and back again. The family usually moves less than 1.6 kilometers at any one time. As the kittens mature, the family wanders proportionately farther, and during the 2d year of life, the kittens begin to cover their mother's home range. Young become independent during their second winter. The final break in the ties of one family was made during March in a portion of the female's home range that had been frequented earlier in the winter. The female left her kittens at a kill and did not return. Thereafter the siblings remained together or met for short periods before going their separate ways. The young independents become transients and wander about until they find a vacancy, take up residence, and thus achieve breeding status. Although age of independence may vary, two litters that had been observed became independent during their second winter when they were just under 2 years (Seidensticker et al. 1973). Even though Robinette et al. (1961) considered females physically and sexually mature when they weigh 36 kilograms, Hornocker (1971) postulated that reproduction in young females is suppressed until they are socially mature. Rabb (1959)

stated that female pumas first come into heat and can produce kittens when they are 2½ years old. One puma lived almost 18 years in captivity, but the lifespan of pumas in the wild is undoubtedly shorter (Jackson 1961).

Predation: Humans probably are the puma's main enemy, shooting them for sport as well as shooting and trapping them in an effort to control or eliminate the big cats; this activity inevitably causes the deaths of many baby pumas through starvation. Although not predation in the strict sense, adult male pumas occasionally kill young kittens, even their own; thus females with small kittens are sensitive about the presence of another puma (Seidensticker et al. 1973). Gashwiler and Robinette (1957) cited "hunting accidents" to which pumas have fallen victim.

Economic status: Over the years there has been much sentiment against the puma. Although some of this sentiment has been earned by individual pumas, it is inaccurate, unjust, and unwise to condemn the species as a whole. The American hunting public undoubtedly "wastes" more game animals during the annual hunting season through illegal and improper hunting methods than are killed by many pumas. Illegal, out-of-season poaching with small caliber weapons destroys many other game animals, many of which are never retrieved by the poachers. Individual pumas do prey on livestock, and such individuals are economically detrimental. We are just beginning to gain an unbiased understanding of this large predator, and we should be prudent in our evaluation of the species.

Pumas prey on such livestock as sheep, calves, colts, and pigs, but there were only five complaints of damage by pumas received by the Oregon State Game Commission from July 1, 1971, through June 30, 1972. During that time, eight pumas were killed on damage complaints (Oregon State Game Commission 1972). After many years, the puma is finally classified as a "game animal" in Oregon, and it is no longer legal to collect bounties for those that are killed. Eighteen pumas were reported killed by sport hunters during the 1971 hunting season (Oregon State Game Commission 1972). Although pumas are usually hunted only as trophy animals, their flesh is delicious to eat.

Selected references: Allen (1950), Bruce (1925), Hibben (1937), Hornocker and Wiles (1972), Hornocker et al. (1965), Johnson and Couch (1954), Jorgensen and Mech (1971), Musgrave (1926), Seidensticker et al. (1970), Seton (1928), Wade (1929), Wright (1948a, 1953a).

Genus Lynx: Lynxes, bobcats, and caracals

Derivation: The generic name Lynx is the Greek word for "the lynx."

General description: The length of the head and body of members of this genus range from 76.2 to 100 centimeters and the tail 10.2 to 30 centimeters. Lynxes weigh from 5.4 to 11.3 kilograms, but occasionally as much as 18 kilograms. On the average, they are larger than bobcats. These cats have relatively short bodies and long, heavy legs. Their well-haired feet are of particular benefit to individuals living in cold, snowy, northern climates. Except for the caracal (Lynx *caracal),* which has a short, smooth pelage, members of this genus have a long, soft pelage. Pelages vary from tannish gray to reddish brown, and except for the caracal, all have dark markings on light backgrounds.

These cats occur from the Arctic to the deserts. Tht v are expert tree climbers and swimmers. Although not large, members of this gem s are powerful fighters, using both teeth and claws as weapons. They are most act ve after dark, hunting by sight and sound. The population of lynxes, whose prir ~ipal prey is the snowshoe hare, fluctuates according to their food supply. Bobcats, on the other hand, whose diet is not constrained to one primary food species, do no exhibit such fluctuations in population. Lynxes and bobcats eat almost any bird or mammal they can kill, and their habits are much like those of other cats.

Lynxes and bobcats breed in late winter. After a gestation period of about 60 days, one to four young are born. Young weigh about 340 grams at birth; their eyes open in about 10 days, and they are weaned in about 2 months. Their life span is 10 to 20 years.

World distribution: The genus Lynx is comprised of four species. Members of the genus Lynx occur throughout North America as far south as southern Mexico. The European lynx was formerly native throughout the forested areas of Europe, but it is now greatly restricted in its distribution. The caracal is a native of Africa and southern Asia.

General reference: Walker et al. (1968).

BOBCAT

Species Lynx *rufus*: Bobcat

Derivation: The specific name *rufus* is the Latin word for "reddish." The subspecies *fasciatus,* the only subspecies of bobcat in western Oregon, was described as being from the "Northwest Coast," based on Lewis and Clark's description of specimens obtained near the mouth of the Columbia River. The specimens were taken on the "Netul" River which now bears the name "Lewis and Clark River," near Astoria, Clatsop County, Oregon, on December 13, 1805.

Specific description: Total length, 710 to 1252 mm; tail, 95 to 195 mm; hind foot, 143 to 223 mm; ear, 65 to 100 mm; weight, 5.4 to 31.0 kg.

Bobcats are short-tailed, long-legged animals with relatively small feet. The ears are slightly tufted and blackish with a white spot near the tip. The eyelids are white. The hairs along the sides of the face, from the ears to the throat, are long and like sideburns. The upper parts of the body are grayish, tannish, or reddish, usually with irregular black spots; the color is most intense along the middle of the back, becoming lighter on the sides. The rump and hind legs are tannish. The underparts, including the inner sides of the legs, are whitish with black spots. There are indistinct black rings on the tail, but the tip is black above and whitish below.

Distribution along the Oregon coast: Bobcats occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: They use, at least to some extent, all habitats except the coastal lake and tideland river.
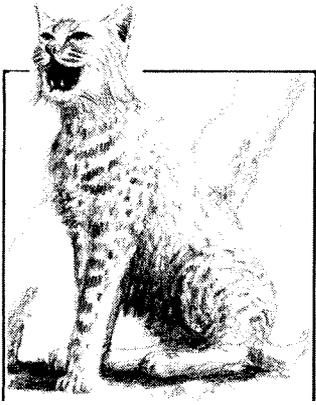
Habits: Bobcats are active mainly at night but on occasion may be abroad during the day. In western Oregon they occur most commonly in the brushy areas where they often travel along old logging roads. Although seldom seen, the main evidence of bobcats' being in an area is tracks, droppings, and marks on tree trunks where they sharpen their claws.

Their sight and hearing are particularly well developed. According to Jackson (1961), although they can see in the dark, they cannot see in total darkness. They do possess exceptionally sensitive vibrissae which aid them in gaining a "feel" of their surroundings. Like other cats, they have excellent balance.

The usual gait of these medium-size predators is a stiff-legged walk, but they cover the ground in bounds of 1.8 to 2.4 meters when they are in a hurry (Jackson 1961). Bobcats are quick, active, and lithe. Although their endurance does not seem to be great, physically they are exceedingly well coordinated and strong. Under normal circumstances, bobcats are silent, retiring animals, but when cornered there is no mistaking their intention to fight for survival. With ears laid back flat against their heads and eyes flashing, they snarl and spit their defiance. They are quick, vicious adversaries; with teeth and claws they will severely punish any dog foolish enough to attack. Taylor and Shaw (1927, p. 60) described the bobcat as "A beast of intelligent appearance, but an arrant coward." Seton (1928, p. 235) wrote of the bobcat: 'Shy as any wild thing is the Bobcat, rarely seen except by accident, and then is quite ready to forgo all battle honours and retreat in search of peace. Nevertheless, like many a timid, law-abiding citizen, he can be terrible when put to it by desperation."

Marshall and Jenkins (1966) determined the approximate home ranges of three bobcats. An adult female had a home range of 462 hectares (2.9 km^2), whereas that of a young male was 359 hectares (2.2 km^2) and that of a young female 247 hectares (1.5 km*). They also found that the average distances traveled by four bobcats in a 24-hour period were:

	Distance traveled	Range
	(Kilometers)	
Adult male	4.8	4.056
Adult female	2.6	0.8-4.4
Young male	1.9	1.1-3.4
Young female	2.2	54.1

The den of a bobcat may be in a crevice among rocks or in a hollow tree, stump, or log. The den is lined with a shallow layer of leaves, mosses, and other vegetation that is scratched into shape by the cat. Such a den is occupied as a shelter, but during fair weather a bobcat more often lies quietly concealed amid protective vegetation (Jackson 1961).

Food: When hunting, bobcats are both stealthy and patient; they are masters of ambush. Marshall and Jenkins (1966) observed that bobcats who were hunting spent much of their time sitting, watching, and listening. They appeared to hunt primarily by sight and by sound. One such cat was observed for 20 minutes. It would walk for 4.6 to 6.1 meters along the road, then sit and scan the shoulder of the road. After 2 or 3 minutes it would walk to the opposite side of the road and repeat the procedure. Anything attracting its attention would be immediately investigated. Three bobcats were also observed capturing prey during daylight hours in the summer. When first observed, one male was sitting on the side of a road peering attentively into a thicket. He suddenly crouched and leaped out of sight into the brush, returning with his prey. The second bobcat, a female, also was seen as she sat on the bank of a road intently watching something in the brush. As it began to rain hard, she retreated out of sight over the roadbank but moved only a few meters. The rain ceased after about 5 minutes, and she returned to her former observation point. She then crept slowly forward for about a meter, trapped something with her forepaws and ate it. It had taken her 13 minutes to cover the 1 meter. The third bobcat, a young male, was hunting in a stand of pine trees and was partially concealed behind a small bush when he was first observed at a distance of about 22.5 meters. He looked at the intruder momentarily, then walked cautiously and slowly away for about 1.8 meters, at which time a young cottontail rabbit was noticed about 9 meters from the cat. The bobcat watched both the intruder and the rabbit for about 10 minutes before slowly and carefully advancing toward the rabbit in a semicrouched position. During the advance he used all the available cover that lay between him and his prey. When he was within 1.8 meters of the unsuspecting rabbit, he took a few short leaps and caught it.

Bobcats along the Oregon coast follow more or less regular circuits when they hunt. Their tracks and feces show that they travel the same general routes over and over again, but not necessarily in a particular number of days. Their main prey along the southern Oregon coast is brush rabbits, which inhabit the dense thickets along the margins of the roads and trails. These little rabbits are easily ambushed.

From an analysis of 143 droppings, Nussbaum and Maser (1975) found that the following animals composed the diet of the bobcat along the Oregon coast from 1970 through 1972:

	Percent
Brush rabbits	28.6
Deer mice	9.3
Oregon voles	8.4
Townsend voles	7.9
Dusky-footed woodrats	7.0
Snowshoe hares	5.3
Mountain beaver	5.3
Large sea birds	5.3
Townsend chipmunks	4.4
Pacific jumping mice	4.0
Chickarees	3.1
Small birds	3.1
California ground squirrels	1.8
Unidentified shrews	1.3
Black-tailed deer	1.3
Wandering shrews	.9
Beetles	.9
Unidentified voles	.9
Fluffed grouse	.4
Domestic sheep	.4
Vole, genus *Arborimus*	.4

In addition, the stomach of a female bobcat trapped on June 3, 1972, 6.4 kilometers southeast of Bandon, Coos County, had two mountain quail, one brush rabbit, and one Pacific jumping mouse in her stomach.

Bailey (1936, p. 268) commented on bobcats' killing housecats. "One of the common complaints is that they kill all of the domestic cats introduced at some of the isolated ranches, and it has been generally observed that these Old World cats do not thrive where coyotes and bobcats occur." Also see Bailey (1972), Davis (1955), Gashwiler et al. (1960), Golley et al. (1965), Marston (1942), Progulske (1952, 1955), Rollings (1945), Yoakum (1965).

Reproduction: The breeding season commences in January and extends until at least July. The gestation period is about 63 days. A single litter is usually born from March through July but most arrive in April and May. Litters range from one to six young, but three or four is the usual number (Gashwiler et al. 1961). The female bobcat trapped on June 3, 1972, had recently given birth to five young.

Young are born in caves, hollow logs, or some other type of den. They are well clothed in short hair when they are born, but their eyes are closed. Three newborn bobcats (specimens in the Puget Sound Museum of Natural History, Tacoma, Washington) averaged 18.3 (17518.6) centimeters in total length. They weighed an

average of 87.8 (85-90) grams. According to Jackson (1961), their eyes open in 9 or 10 days. Gashwiler et al. (1961) found no evidence to indicate that male bobcats help care for their offspring. They did state (p. 82), however, that the females appear to be model mothers: "... there are several instances of their giving birth to young while trapped and giving the young the best care possible under the circumstances."

Although bobcats take good care of their newborn young, their fear of humans and dogs may cause them to abandon their young "without showing any evidence of fight." When the kittens are large enough to follow their mothers, at least some of the mothers display hostility if their kittens are threatened by people (Gashwiler et al. 1961, p. 82).

Young are weaned in 60 to 70 days (Jackson 1961), but they often stay with their mothers until they are two-thirds to three-fourths grown (Gashwiler et al. 1961). They become mature and essentially full grown when about 1 year old (Jackson 1961). One captive bobcat lived for 15 years and 10 months (Mann 1930); another lived in captivity for 25 years (Carter 1955).

There are three records of bobcats mating with domestic cats; some of the resultant hybrid offspring showed definite characteristics of the bobcats. In each instance, male bobcats mated with female domestic cats (Gashwiler et al. 1961, Young 1958). Additional references on reproduction in bobcats are: Duke (1949, 1954), Pollack (1950).

Predation: Jackson (1961) indicated that the great horned owl occasionally preys on young bobcats, but humans and their domesticated dogs are the bobcat's worst enemies. These cats are hunted for sport with the use of dogs and are trapped either for their pelts or for elimination.

Economic status: The economic status of the bobcat has long been in question because it occasionally preys on domestic sheep and poultry, as well as on game birds and deer. Much of the deer remains that are found in bobcat stomachs and feces, however, are undoubtedly consumed as carrion. Nevertheless, when the food habits of the species are considered in total, the bobcat is largely beneficial for its role in helping to control rabbits, hares, and rodents that are considered economically detrimental to human interest.

Bobcats have long been trapped for their pelts, which in recent years have commanded high prices. Although the flesh of the bobcat is excellent to eat, few people try it.

Bobcats have become one of Oregon's most important fur-bearing mammals. During the 29-year period from the 1945-46 through the 197574 trapping seasons, licensed Oregon trappers reported the capture of 22,438 bobcats. During the last seven seasons, 1967-68 through 197374, trappers reported taking 8,300 cats. The average price per pelt rose from $2.76 in 1957-58 to $53.55 in 1973-74. The reddish

bobcat pelts from western Oregon brought an average of $33.75, but the lighter more grayish pelts from central and eastern Oregon sold at an average price of $79.32 per pelt. During the 1973-74 trapping season, 1,644 pelts, sold at the average price of $53.55 per pelt, brought trappers $88,036.20 (Oregon State Game Commission 1972, Oregon Wildlife Commission 1974a).

Selected references: Conley and Jenkins (1970), Jorgensen and Mech (1971), Kight (1962), Little et al. (1971), Mace (1974), Pollack (1949), Young (1958).

Order Artiodactyla: Even-Toed Hoofed Animals

Derivation: The ordinal name Artiodactyla is derived from the Greek words *artios* (even numbered) and *dactylos* (finger or toe). The even-toed hoofed mammals are characterized by two or, more often, four toes on each foot; each toe terminates in a hoof.

General description: Artiodactyla encompasses such diverse members as deer, ox, bison, goat, sheep, antelope, camel, pig, giraffe, and hippopotamus.

In artiodactyls, the upper incisors are reduced or absent. The canines are usually reduced or absent; but in some species, such as some wild pigs, they are large and tusklike. The space between the upper incisors and the cheek teeth (premolars and molars) is greatest in the "cud-chewers" or ruminants. The molars are more complex than the premolars. Some species have horns, others have antlers. Antlers are usually present only on males and are normally shed in winter. Horns, however, are frequently found on both sexes and are not shed.

Artiodactyls have stomachs with as many as four chambers. Those with one, two, or three chambers, such as pigs, are nonruminating; those with four chambers, such as deer and cows, are ruminants. Ruminants graze and browse and eat great quantities of vegetation. They swallow food with little chewing and then retire to a secluded place to chew it more thoroughly. In a true ruminant, the food first enters the rumen or paunch. After undergoing a softening process, the food is regurgitated into the mouth where it is again chewed and mixed with digestive enzymes in the saliva. After the food has been chewed thoroughly and swallowed a second time, it enters the second chamber of the stomach, then progresses to the third and fourth chambers where the greatest digestive activity occurs. Bacterial actions are also involved in the digestive process of ruminants. Rumination has probably helped animals survive by allowing them to swallow food quickly when exposed to predation and to retire to more protected places for the time-consuming process of thoroughly chewing food. Rumination also results in maximum utilization of available nutrients.

Gestation periods range from 112 days in the pig family (Suidae) to 450 days in the giraffe family (Giraffidae). Numbers of young range from 1 or 2 in most artiodactyls to as many as 14 in the pig family. Young artiodactyls are precocial and capable of running shortly after birth. Many have protective coloration in the form of spots or stripes that disrupt their outlines and make them difficult to see and less vulnerable to predation.

As a whole, artiodactyls are gregarious, herd animals. They occupy a wide variety of habitats from arctic regions, to deserts, to jungles. Some artiodactyls are diurnal; others, nocturnal; and some, more or less active any time.

World distribution: Wild artiodactyls are native worldwide except in Antarctica, Australia, and most isolated islands, such as New Zealand. Humans have introduced artiodactyls as domestic animals almost everywhere in the world except Antarctica. Many have escaped from captivity and are now feral (living like wild animals).

Fossil record: Because of the usually large size and strong skeletons of artiodactyls, there is a good fossil record of many forms; the oldest fossils date to the early Eocene.

Number of species along the Oregon coast: Two.

General references: Anderson and Jones (1967), Walker et al. (1968).

Key:

Ia Rump patch white; top of tail black; hairs on neck same length and color as hairs on rest of back and sides, not forming a mane on the throat— *ODOCOILEUS HEM/ONUS* (mule deer), page 365

Ib Rump patch light to dark yellowish; top of tail same color as rump patch; hairs on neck longer and darker than hairs on rest of back and sides, forming a mane on the throat-CER *VUS ELAPHUS* (North American elk), page 355

Family Cervidae: North American Elk, Deer, and Allies

Derivation: The familial name Cervidae is derived from the Latin word *cervus* (deer), combined with the Latin suffix *idae* (family).

General description: Members of the deer family are proportionately slim, long-legged animals. They are best characterized by the presence of antlers. Except for caribou and reindeer (*Rangifer*), in which both sexes bear antlers, only the males have their heads adorned with the bony outgrowths. Antlers differ in size and shape from one species to another.

Antlers are not the same as horns. Whereas antlers are shed annually, horns remain permanently affixed to the skull. The latter are composed of bony cores that grow directly out of the skull near the top of the head, between the ears. They are covered with a hard sheath of horny material. Antlers, on the other hand, are supported on permanent skin-covered pedicels.

Antlers of most species are shed each year during the winter and spring; they are regenerated during the summer. Deer that are native to the temperate zones grow new antlers each year in synchrony with the annual light-dark cycle; this adaptation insures the maturation of antlers in time for the breeding season. Such synchrony is important if the young are to be born in the spring, but it is less important in equatorial climates where the reproduction of many tropical deer is uncoordinated with the time of year, reflecting the absence of significant seasonal fluctuations in the length of the days. Females of tropical species can give birth at

any time of the year, and males can grow antlers at any time of the year. Every 12 months, however, each male sheds and replaces his antlers (Goss 1969a, 1969b). Those interested in antlers are also directed to Goss (1963, 1968) and Jaczewski (1954).

In the temperate regions, antlers begin growing in early summer, during which time they are soft and tender and well supplied with blood. They are encased in a thin layer of skin covered with short, fine hairs called "velvet." Antlers attain maximum size by late summer. The supply of blood gradually decreases, then terminates. The velvet dries, loosens, and drops off; by this time the antlers are hard and dead. Once the velvet is off, the antlers serve as sexual characteristics as well as weapons.

Antlers begin to develop when an individual is 1 to 2 years old; the 1st-year antlers are generally short, almost straight spikes. They become larger and acquire more points until the animal attains maturity, at which time the antlers have assumed the shape that is typical of the species. Normal antler growth depends mainly on an adequate diet, and if certain minerals or vitamins are lacking, the antlers may be stunted or dwarfed.

The length of the head and body of cervids ranges from 0.75 meter to 2.9 meters; they all have short tails. Adults weigh from 9 to 800 kilograms. Females generally are somewhat smaller and more delicately built than males; this is particularly noticeable in the neck. Necks of females are not as heavily haired as those of males nor do they become as large and heavy during the breeding season. The coloration varies from brownish to reddish; some species are spotted as adults. The young are usually spotted, but most lose their spots as they mature.

Nearly all cervids have facial glands that are situated in a pit just in front of the eyes; each pit is lined with the skin of the face. Glands also occur on the limbs. The upper canine teeth (often referred to as "fangs") are larger and are saber shaped in members of some species.

Cervids usually associate in groups, but a few appear to be solitary, at least during the nonbreeding season. Within a species, males often fight for possession of a harem. During such combats, their antlers sometimes become locked and both opponents may die. Cervids occur from the Arctic to the Tropics. They are herbivores, feeding on grasses, lichens, bark, twigs, and other plants.

Cervids mate during the late fall and early winter in temperate climates. Gestation periods range from 160 days to about 10 months. One species is known to have delayed implantation. The usual number of young is one or two, but three or four are sometimes born. Cervids in temperate regions give birth only once a year.

World distribution: Cervids occur throughout North America, south to 40" latitude in South America, northwestern Africa, Eurasia, Japan, the Philippines, and most of Indonesia. They have been introduced into New Guinea, Australia, New Zealand, New Caledonia, Mariana Islands, Mauritius, Cuba, and the Hawaiian Islands, and have been reintroduced into Great Britain after they had been exterminated.

Fossil record: The fossil record of the family dates to the early Miocene in North America.

Number of species along the Oregon coast: Two.

General references: Anderson and Jones (1967), Walker et al. (1968). For information on the cervids of North America, see Taylor (1956); and for information on the threatened cervids of the world, see Cowan and Holloway (1973).

Genus Cervus: North American elk and allies

Derivation: The generic name Cervus is the Latin word for deer.

General description: Of the approximately 15 species of *Cervus,* C. *elaphus* (North American elk and the red deer of Europe) is the best known species. The height at the shoulder of members of this genus ranges from 0.6 meter to 1.5 meters. Their color generally varies from brown to reddish brown. On the whole, the species are quite variable, occurring from mountainous terrain to lowland swamps.

World distribution: Members of the genus are native to North America, Great Britain, Europe, Asia, the East Indies, and the Philippine Islands. Some species have been introduced into other areas, such as New Zealand (Caughley 1971).

General reference: Walker et al. (1968).

Species Cervus *elaphus:* North American elk

Derivation: The specific name *elaphus* is the Greek word for deer or stag.

Specific description: Total length, 2032 to 2972 mm; tail, 80 to 213 mm; hind foot, 464 to 660 mm; ear, 190 to 225 mm; weight, 159 to 454.5 kg.

The North American elk is the second largest deer in North America. It is a slender-legged animal with a neck that is thick in proportion to its head. The hair along the sides of the neck is long and dark, forming a dark brown mane on the throat. The hair of the back and sides is shorter and varies from light grayish, yellowish gray, yellowish brown, to brown. The head, neck, mane, and legs are dark brown to almost blackish; the underparts are darker than the back. The rump patch and the tail vary from light yellowish to dark yellowish or tannish yellow. Cows and calves are darker than the bulls. Young calves are brownish with large yellowish white blotches. There are whitish glands (metatarsal glands) below the hocks on the outsides of the hind legs. Females are antlerless, but the males develop large, widely branched antlers. The main backward sweeping beam may reach 1.2 meters in length. Adults have a well-developed brow tine or "dog killer" and normally five other tines.

NORTH AMERICAN COW ELK

Distribution along the Oregon coast: North American elk were once abundant throughout much of western Oregon, but they were killed indiscriminately by settlers and much of their habitat has been destroyed; they have been pushed into more and more remote areas. They either disappeared or were severely reduced in
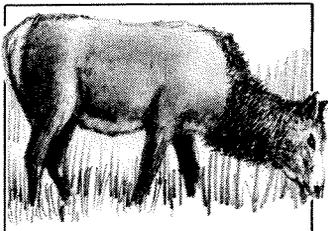
numbers in many coastal areas. In recent years, however, the Oregon Wildlife Commission has transplanted North American elk along the coast into areas where they had formerly occurred (Harper 1971); thus, they essentially occur along the entire coast.
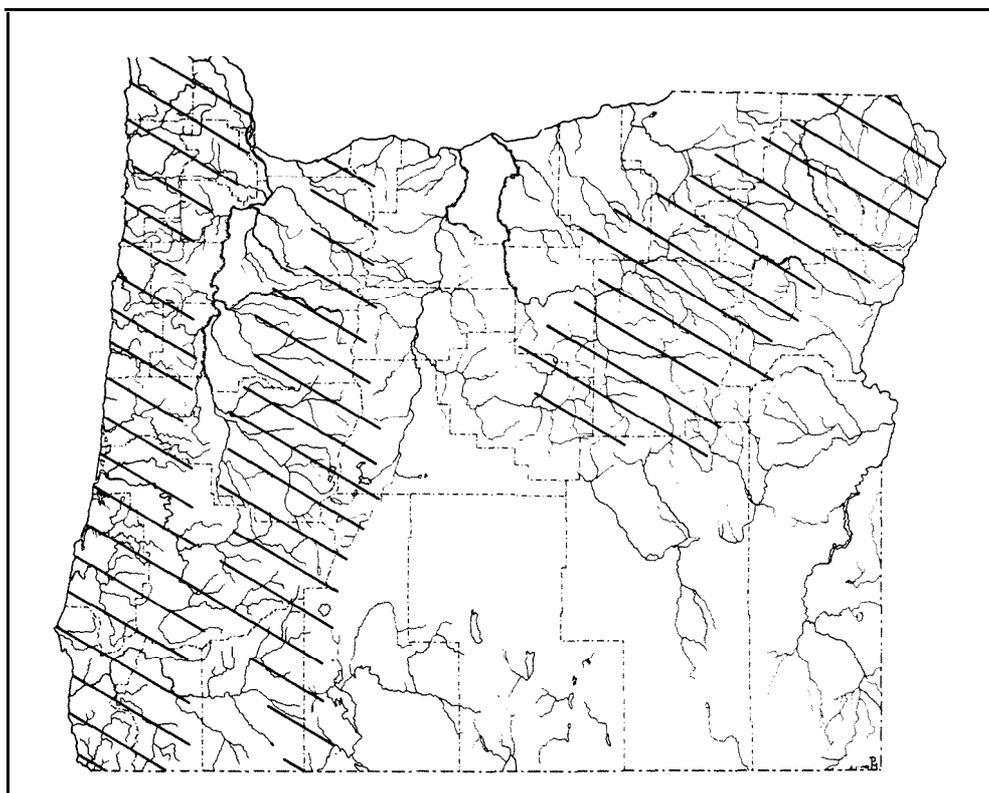
KNOWN DISTRIBUTION OF NORTH AMERICAN ELK

Habitat: North American elk use-at least to some extent-all habitats except the beach, foredunes, moving dunes, deflation plain, stabilized dunes, lodgepole pine, headland prairie, headland shrub, coastal lake, and tideland river.

Habits: Because the variation in natural history among the subspecies is beyond the scope of this book, the following discussion of North American elk is confined primarily to the western subspecies *roosevelti.* References are given, however, for other subspecies.

Bailey (1936, p. 82-83) reported on the numbers of North American elk in western Oregon from 1910 through 1932:

> Forest Service officials in 1910 reported elk as very scarce in the Siskiyou and Siuslaw National Forests, as formerly abundant in the Umpqua National Forest, and approximately 15 head ranging on each of the Crater and Cascade National Forests. In 1913, according to the Oregon Sportsman, there were 6 or 7 small herds in the Loon Lake district, about 35 miles [northwest] from Roseburg. In 1914 the same periodical mentioned about

48 elk in Lane County, a band of 25 on the head of Drift Creek in Lincoln County, and a small band in Wasco County near the southeast slope of Mount Hood. In 1915 elk were reported as increasing in southern Oregon, where 31 were counted in 1 day. One was seen in Tillamook County, and 2 or 3 small bands in Clackamas County. In 1916 the animals were said to be increasing in Lane, Lincoln, and Douglas Counties, 8 were counted in Coos County, and a few in Tillamook and Clatsop Counties. In 1917 numbers were reported in Lane County, a herd of 80 were estimated in the Fall Creek country in Coos County, a small band of 35 to 40 in Curry County, and a few in Columbia County.

In the official report of game animals on the national forests of Oregon for the years 1924, 1925, and 1926, a slight decrease in number of elk is shown on the Cascade and Siskiyou Forests, and an increase on the Crater, Hood, Santiam, and Umpqua. The number reported for 1926 on the Crater was 16, the Siskiyou 25, the Santiam 40, Mount Hood 130, and the Cascade 225 elk. This total of 436 elk on the national forests of western Oregon probably covers the greater part of the Roosevelt's elk [the subspecies roosevelti is the native North American elk in western Oregon] in the State in 1926. In 1929 the Forest Service reported on the Cascade 245, Crater 70, Deschutes 60, Mount Hood 129, Santiam 30, Siskiyou 30, Siuslaw 279, a total of 843 elk in western Oregon. Most of these however, were introduced Rocky Mountain elk [the subspecies *nelsoni* which is the native North American elk in eastern Oregon].

In the big-game report of the Forest Service for 1932, 40 elk were estimated on the Siskiyou National Forest and 390 on the Siuslaw, all that can be positively ascribed to *Cervus* c. *roosevelti*, although some of these from the west slope of the Cascades may belong to this native form.

(For a discussion of the past and present distribution of North American elk in northwestern California, the southernmost limit of the subspecies *roosevelti*, see Harper et al. (1967).)

North American elk are active during the night, but their preferred hours of activity are those of twilight and dawn (Jackson 1961). It is amazing how silent these large mammals can be. Dalquest (1948, p. 394) wrote:

In the forests the elk is capable of swift and almost silent movement. It is an eerie experience to trail a herd of elk through a dense forest in a winter rain, knowing that a number of the large animals are within a few feet, moving swiftly but silently away. When a herd is feeding and does not suspect the presence of an observer, the animals rustle branches, break twigs, snort and wheeze as they breathe.

The general social organization of North American elk is a matriarchal society in which the adult bulls live separately from the adult cows during the nonbreeding season. A matriarchal herd (cow-herd) is composed of cows, their calves, and subadults (adolescents) of both sexes; however, the degree to which a member of any particular sex and age class associates with the central cow-calf unit is determined by the behavioral interrelationships of that individual with the other

members of the herd. For example, yearling bulls show a strong cow-herd attachment at times of the year when they are not driven out by an adult bull in rut or when the cows are not giving birth to their calves. The composition of cow-herds dominated by an old "lead" cow appears to be most stable from November to May, and the association of subadult bulls with the cowherd reaches a peak during the winter. Adult bulls join a cow-herd only temporarily during the breeding season. When not accompanying the cow-herd, bulls gather into groups. Subadult bulls associate with the cow-herd primarily during the winter, but the duration of these visits decreases annually as the bulls approach maturity (Franklin et al. 1975).

When cervids occupy forested areas or other densely vegetated habitats, they tend to form small groups or are solitary, whereas larger groups are more typical of animals inhabiting open areas (Dasmann and Taber 1956). North American elk appear to react to their particular types of habitat in a similar manner. The size of groups varied from 1 to 27 individuals along the coastal area of northwestern California. Animals inhabiting the areas that had been clearcut formed groups of 3 to 27; the average group was composed of 13 individuals. North American elk inhabiting dense brushland were seen in groups of one to four; the average group was composed of three individuals. Such differences suggest that coastal populations of North American elk may adjust the size of their groups in response to the variety of habits (Franklin et al. 1975).

The home range of North American elk must be considered in terms of a particular herd, rather than individual animals. Franklin et al. (1975) found that the home range of the herd studied in northwestern California was 1.8 square kilometers. They also found that the groups of bulls (including those that associated with the cow-herd) had a home range that overlapped and extended beyond that of the cow-herd. Bulls spent up to 49 percent of their time in the nearby coniferous forest, whereas the cows spent only 6 percent of their time in the timber. Graf (1955) reported that the herds of North American elk in the Coast Ranges of Oregon had home ranges that encompassed 1.6 to 3.2 square kilometers, and Harper (1971) stated that average home ranges for bulls and cows combined are 2.2 kilometers in canyons, 3.7 kilometers on ridgetops, and 5.3 kilometers on flats. The cohesiveness of a particular herd, as well as its adherence to a particular home range, appears to be a process of development. Harper (1964), studying North American elk in the cutover Douglas-fir forests of southwestern Oregon, found free interchange of individuals between herds; the size, sex, and age composition were unstable and fluctuated continuously. Franklin et al. (1975, p. 115) found the antithesis inasmuch as the unity of the herd they studied was not disrupted when it temporarily associated with other groups. They hypothesized that

> Group development may entail two related processes; the increase of group size via natural reproduction within the group and outside recruitment, and also the semistabilization of the group's size and composition at some later point through the development of increasingly stronger social ties. Bonds between individuals based upon maternal attachment and a stable intragroup hierarchy may be important contributors to this stabilization process. In the earlier stages of group development, fluctuations in individual composition may be greater than in the later stages.

A cohesive herd has within its home range a core area used by the resident animals to the exclusion of other individuals or herds even though the area is not actively defended. As the distance from the central area increases, use by the resident herd decreases and competition with other groups of North American elk intensifies. A herd's strong orientation toward its core area is probably based on the area's abundance of preferred forage, as well as the availability of water and a knowledge of the escape routes. Although precise boundaries do not exist, there is seldom any overlap between closely adjoining home ranges and little trespassing by one herd into the home range of another (Graf 1955, Franklin et al. 1975).

Although no defense of the central core area was detected, it was monopolized by the resident herd; other groups could have entered it but did not. Trees that had been recently "sign posted" were more abundant within the core area than outside it, and it was suggested that sign posting is related to the frequency with which an area is occupied (Franklin 1968, Franklin et al. 1975). Graf (1956, p. 166) described "sign posting":

> For the cows, this activity consists of a highly ritualized pattern of behavior, starting with the careful "nosing" of a sapling or limb chosen for this operation. The nosing consists of carefully drawing the nose up and down the "post" as though sniffing it. This may be repeated a half dozen times, more or less. The second step is to scrape the "post" with the [lower] incisors, by drawing them in deliberate vertical strokes from bottom to top of the marked spot on the post and letting the shavings that result from this action, fall to the ground. Shavings are never taken into the mouth and may accumulate in quantity around much-used posts. The third step is to carefully rub the sides of the muzzle and chin on the scraped post by deliberate forward horizontal strokes of the head. The fourth step is to rub the sides of muzzle and chin against the flanks, again in the same careful and deliberate manner as in the previous steps. The order of procedure is invariably the same except that the flank rubbing or "preening" is sometimes skipped. The entire series of actions may be repeated over a period of 5 to 15 minutes.

> Adult males, that is those five years or older, with a harem have been observed to perform this same behaviorism only during the rut and with the following variation: Instead of the incisors, the base of the antler or bur is used for the scraping act and this scraping act is always the first step rather than the nosing as with the cows. The scraping is then followed by "nosing" the scraped part of the post. This is performed in the same manner as by the cows, and this is followed by the rubbing of the sides of the face and chin on the flank in the same manner and order as in the cows. The nosing, particularly, is performed with great delicacy and unhurried precision. Immature bulls under five years old without harems have never been observed in this behaviorism either outside of the herd during the rut, or in a herd between rutting seasons.

One tree that is commonly sign posted along the Pacific coast is red alder.

Territoriality reaches its highest development when a particular area is marked for identification and the "no trespassing" signs function even in the absence of the owner. The coastal populations of North America elk have developed this characteristic, which is expressed by sign posting and related behavioral patterns (Graf 1956, Franklin et al. 1975).

Food: Although North American elk eat a wide variety of plants that vary from one area to another, they are primarily grazing animals. Pedersen pointed out that, generally speaking, grasses form 82 percent of the diet during the spring, 11 percent during the summer, 62 percent during the fall, and 78 percent during the winter.[18] In addition to the grasses consumed during the summer, forbs (succulent green plants other than grasses) compose 75 percent of the diet. Forbs, such as buttercups and asters, are obtained by grazing. Pedersen also stated, however, that whereas North American elk west of the Continental Divide were primarily grazers, those east of the Continental Divide tended to be browsers (eating woody plants) because of a lack of suitable grasses.

Harper et al. (1967) studied the food habits of North American elk in coastal northwestern California. They found that the annual diet was composed of the following types of plants:

Months	Grasses and slough sedge	Forbs	Browse	Miscellaneous
	——————— (Percent) ———————————			
June, July, and August	57.6	20.2	22.1	0.1
September, October, and November	56.5	22.5	20.9	.1
December, January, and February	75.9	1.4	21.8	.9
March, April, and May	61.1	4.2	33.6	1.1

Loggers along the Oregon coast told me that North American elk would come at night into the areas where trees had been felled during the day and eat the lichens off them. See also Knight (1970), Martinka (1969).

Harper (1971, p. 1) wrote of North American elk in western Oregon:

> Average daily distance traveled is about 1,200 yards from October to June, 800 yards in July and 500 yards in August and September. These distances do not represent a straightline movement, but rather the wanderings of an animal as it feeds over an area. Few long-range movements occur at night. Normally elk feed over a more or less circular route, spending a few hours to two to three days in each feeding area and then moving, not to return for 15 to 20 days.

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[18] R. J. Pedersen, Oregon Wildlife Commission, personal communication, 1974.

NORTH AMERICAN ELK

Reproduction: In western Oregon, the rutting season normally begins in late August and continues until mid-November. The peak of activity occurs during the latter part of September through the middle of October. The rutting season for the Rocky Mountain subspecies begins during mid-September and lasts through the first part of November; rutting reaches its peak during the latter part of September through mid-October (Harper 1971). Bugling by the bulls is one of the first indications that the rutting season is commencing, and as the rut progresses, bugling increases in frequency as well as intensity (Harper et al. 1967, Murie 1951).

Graf (1956, p. 167-168) wrote of the bulls' rutting behavior:

> . . . in that part of the Roosevelt elk's range where territorialism occurs,. . . when two bulls meet on common ground at the beginning of the rut the first activity on the part of the bulls is to indulge in highly vigorous sign post activity even though one of the animals may be in a favorable position to take over the unattended herd, as when one of the bulls arrives well in advance of the other. Sign post activity is highly abbreviated at such a time and consists primarily of "burring" or scraping the "post" with the base of the antlers and bugling a great deal. Such a behavior may serve as a psychological intimidator through establishment of the first or most numerous sign posts and may enable a bull to take over a herd without having to contest physically for it. . . .

> Antler rubbing is generally given one of two interpretations by laymen and students alike, namely that it is for the purpose of removing the velvet or that it is a combat practice intended to intimidate a rival. A close and critical examination of the evidence leads me to conclude that antler rubbing for the sole purpose of removing velvet does not occur, though in some cases there may be removal of some velvet incidental to rubbing of antlers for other purposes where the rubbing occurs before all the velvet has dropped off the antlers. I have seen bulls. . . go about for days and even weeks with bothersome masses of stripped velvet hanging over their eyes without making an attempt to remove the velvet even though it was obvious that it was causing them a great deal of annoyance. It is my belief that velvet removal occurs only by accident or coincidence when the sign post behaviorism manifests itself early enough to occur before all the velvet has dropped off of its own accord. Such early rubbing is always rather gentle and hesitant as though the antlers are not yet completely hardened and capable of withstanding heavy pressure and rough use.

> A second type of antler use, other than for actual combat, is for slashing and whipping shrubs or saplings when "challenging" other bulls. However, even this may be misinterpretation, for this type of behavior often occurs when no other bulls are present. It may be significant that such behavior is more common to the resident bull than the challenger or unattached bull.

A bull's antlers are a dingy brown when the velvet has freshly dropped off. As the rut intensifies and a bull begins to thrash vegetation, his antlers become polished and gleaming. Not all bulls have antlers of the same color because they tend to become stained by whatever vegetation is most frequently attacked. For example, salmonberry turns antlers brownish red, but red alder stains them brownish (Harper et al. 1967).

Bulls attack vegetation in a similar manner. A bull thrusts his antlers into the vegetation and shakes his head vigorously. One bull was so savage in his attack that he broke a sapling red alder more than 5.1 centimeters in diameter. While engaging vegetation with his antlers, a bull unsheathes his penis and eliminates copious amounts of urine in spurts that carry a meter or more. Directing the urine along his belly, he thoroughly soaks the hair; lowering his head, he also saturates the hair of his throat as well as the sides of his face. After a few minutes of this activity, he steps backward and, by digging his antlers into the urine-soaked grass and tossing his head, throws the vegetation over his back. Finally he lies down and rolls in the urine-soaked area several times. A bull in the rut is easy to identify because the hair of the belly and neck is stained dark brown or blackish from urine (Harper et al. 1967). Graf (1956) considered this activity to be more a sign post behavior than a challenge. He stated (p. 168) that

> The effect on an unattached bull either immediately or later is, I believe, primarily through the signs of such activity rather than the activity itself at the time it is performed. Thus such a display even in the presence of an outrider bull may be more in the nature of an indirect rather than a direct intimidation by impressing territorial possession upon the potential rival and thereby creating a feeling of inferiority in such a rival. The effect of such a psychological condition. . . is a form of "cold war."

During the rut, bulls use wallows that are often filled with stagnant water and foul-smelling mud. One bull was observed to wade into a wallow and submerge his head and neck in the water. He then knelt and rubbed his chest, neck, and face in the slimy mud on the bottom. Bulls also roll in these wallows. Such behavior may be repeated at intervals (Harper et al. 1967).

Most rutting battles are terminated without injury to either opponent. Harper et al. (1967, p. 36) described the following fight:

> The bull with the saber-shaped antler left his cows and approached the large herd, the herd bull coming out to meet him. Each bull bugled several times. The bulls circled each other 3 times, a distance of approximately 50 feet separating the 2 animals. Suddenly, they stopped circling and charged, their antlers coming together with a loud crash. They pushed and twisted, neither able to gain the advantage. Finally, with a sudden twist of his head, the 5point bull threw his adversary to one side, and taking advantage of the opening, charged into the challenger's right side with his antlers. The bull with the malformed antler was knocked from his feet but arose, jumped the fence, crossed Highway 101 and entered the timber. . . .

Rutting battles may be so savage, however, that one of the opponents is killed or dies later of its wounds. Flook (1970) described the fatal battle wounds sustained by six rutting Rocky Mountain subspecies: (1) adult-neck broken; (2) adult-abdomen torn; (3) large adult-lungs punctured; (4) adult-body punctured; (5) adult, 12 years old-body punctured and testes torn out; and (6) adult, 7 years old-left eye knocked out and left side of chest punctured-this animal was still alive when found and was shot. Flook stated that, although rutting combats undoubtedly kill fewer bulls than succumb during winter snows, such combats, nevertheless, are selective for the age of greatest sexual activity and should not be discounted as an influence on the structure of a population.

There is a basic difference in the reproductive rates of cow North American elk between western and eastern Oregon; only 50 percent of the Roosevelt subspecies become pregnant annually as opposed to 88 percent of the Rocky Mountain subspecies. The following age classes of Roosevelt and Rocky Mountain subspecies were pregnant:

Age class (years)	Roosevelt subspecies	Rocky Mountain subspecies (Trainer 1971)
	(Percent)	
1	12	33
2	33	92
3	30	83
4	59	86
5 to 7	58	100
8 to 10	59	81
11 and older	0	100

Harper stated that reproduction in North American elk appears tc depend on an adequate and nutritionally sound diet that allows a cow to reach peak physical condition in the breeding season. The Roosevelt subspecies that are lactating apparently are in such poor physical condition that many cows breed only every other year. The Rocky Mountain subspecies, on the other hand, normally breed every year.

Most calves are born during the last week of May and the first week of June, after a gestation period of 255 to 275 days (see footnote 17, page 270). A cow normally gives birth to a single calf, rarely two. Just before giving birth, a cow leaves the herd and selects a birthplace. The cow and her new offspring rejoin the herd in a week or so, at which time the calf is quite well coordinated and able to keep up with its mother.

For the first 4 to 6 weeks, calves depend mainly on their mothers' milk, and they nurse five to six times a day. Calves are tended by a "babysitter" cow who keeps them together when the mothers are feeding. When it is time for a youngster to nurse, a cow calls her baby with a high-pitched "neigh." A mother simply walks away from her calf and commences to feed when the nursing period is over. Further attempts by the calf to nurse may bring a resounding whack across its back from a front hoof of its mother or a butt from the side of her head. Normally, a calf returns to the babysitter without hesitation. As calves become less dependent on milk, the babysitter cow becomes more lax in her efforts to keep them together. By fall the calves are feeding with the herd and have outgrown the need for a babysitter, but they still tend to remain together (Harper et al. 1967). Calves may suckle, however, for 8 or 9 months (Flook 1970).

When alarmed or frightened, cows emit a call similar to the bark of a dog; this call seems to warn the calves, especially before a cow and her newborn calf have returned to the herd. A newborn calf reacts immediately to the bark of the cow. It

conceals itself in any available vegetation by dropping to its belly, stretching its head out flat on the ground, and remaining motionless. The light blotches on its overall dark coat help to disrupt its outline, making it difficult to see. Once a cow and her calf return to the herd, however, a bark does not cause the calves to hide, but it does direct their attention to whatever made the cow give the alarm (Harper et al. 1967).

Both cows and bulls may reach sexual maturity when they are 1 year old (Harper 1971). North American elk live at least 19 years in the wild (Flook 1970); also see Johnson (1951).

Predation: The puma is probably the main natural predator of the North American elk (Hornocker 1970), but bear also get a few calves (Batchelor 1965). Harper et al. (1967) found that malnutrition and poaching were the major causes of deaths in the herds they studied in northwestern California. Out of 116 dead North American elk examined from 1956 through 1960, poaching accounted for 18.1 percent of the deaths; malnutrition, primarily among calves, also caused 18.1 percent of the mortalities. Accidents, such as rutting battles and being hit by automobiles, caused the deaths of 15.5 percent. Six percent died of parasites and diseases, and 22.4 percent died of unknown causes. In the last analysis, however, humans-sport hunters and poachers-are the main "predator" of North American elk.

Economic status: The North American elk is the largest game animal in Oregon. As such, whatever damage they do to commercially important timber or agricultural crops is outweighed by their appeal as a game animal. Consequently, many studies are undertaken to minimize their economically detrimental effects and, at the same time, to improve their habitats, thereby increasing the size of herds. During the 1972-73 biennium, 185,622 elk tags, valued at $1,883,687.50, were purchased by persons wishing to hunt North American elk in Oregon, and 24,301 were reported killed (Oregon Wildlife Commission 1974b).

Selected references: Altmann (1952, 1956, 1960), Carpenter et al. (1973), Craighead et al. (1972), Kingston and Morton (1973), Murray and Trainer (1970), Quimby and Gaab (1957), Rouse (1957), Stelfox (1964), Stevens (1966), Weber and Giacometti (1972).

Genus Odocoileus: Mule deer and white-tailed deer

Derivation: The generic name *Odocoileus* is derived from the Greek words *odon-*tos (tooth) and *koilos* (hollow), combined with the Greek suffix eus (pertaining to). The name alludes to the deep pits in the surface of the cheek (grinding) teeth.

General description: There are two species of deer within this genus. The length of their heads and bodies ranges from 1.16 to 2.10 meters; and the length of the tail from 10 to 28 centimeters. The height at the shoulder ranges from 0.8 meter to 1.1 meters. Adults weigh from 45.4 to 207.3 kilograms. Fall and winter coats are usually brownish gray with whitish underparts. Summer coats are brownish to reddish brown above and whitish below. The hairs, particularly those of the winter coat, are tubular and somewhat stiff and brittle. Because of the tubular nature of the hair of the thick coats of deer killed in winter, their skins float on water; winter skins have been used as life preservers. In North America, these deer shed their

antlers from January to March; new antlers begin to grow about April or May and lose their velvet in August or September. Bucks (males) attain full-size antlers when they are 4 or 5 years old. The antlers of mule deer branch into two nearly equal parts, whereas those of white-tailed deer (Odocoileus *virginianus)* have a main beam with minor branches.

Strictly speaking, these deer are not herd animals, but they do congregate on favorable winter ranges. Their diets include a wide variety of plants, such as grasses, forbs, twigs or shrubs, mushrooms, nuts, and lichens.

The rutting season usually occurs during November and December. The gestation period ranges from 198 to 210 days. Does (females) give birth once a year; they usually have one young (fawn) during their first pregnancy and twins thereafter. On occasion, a doe may give birth to three or four young. A fawn weighs from 1.5 to 2.5 kilograms at birth and is able to walk in a short time. These deer have lived 20 years in captivity.

World distribution: Deer of the genus *Odocoileus* occur from as far north as the southern Yukon and Mackenzie Districts of northwestern Canada, south across southern Canada, throughout the lower 48 United States and Mexico into Patagonia, South America.

General reference: Walker et al. (1988).

Species *Odocoileus hemionus:* Mule deer

Derivation: The specific name *hemionus* is derived from the Greek prefix *hemi* (half) and the Greek word *onos* (an ass); hence, the common name "mule deer."

Specific description: Total length, 1345 to 1800 mm; tail, 108 to 230 mm; hind foot, 390 to 585 mm; ear, 155 to 247 mm; weight, about 45.4 to 207.3 kg.

Mule deer are well-muscled animals with relatively large ears. They have long, slender legs and slender, pointed hoofs. Both sexes have longitudinal glands (metatarsal glands) on the hind legs above the hocks; these glands are conspicuously marked by long, coarse hairs. Coloration varies with season, locality, and subspecies. Dorsally, their coats vary from dull yellowish brown to reddish brown in summer and dark grayish to rich brownish gray in winter. The upper throat, insides of the ears, and insides of the legs are whitish; the belly varies from white to tannish. The nose, forehead, and chest are dark brown to blackish. The white rump patch varies in size, depending on the subspecies. The black-tailed deer *(Odocoileus hemionus columbianus*) has a rather bushy tail that is brown on top with a black tip; the mule deer *(Odocoileus hemionus hemionus),* on the other hand, has a "ropelike" tail that is white on top with a black tip. Youngsters are thickly spotted with white over tannish to reddish brown upper parts.

Distribution along the Oregon coast: Deer occur along the entire coast. They also occur in appropriate habitat throughout the State.

Habitat: Deer occur, at least to some extent, in all habitats except the coastal lake and tideland river.

Habits: The discussion of mule deer is confined primarily to the western sub-
-, *columbianus*, because the variation in natural history among the sub-
species is beyond the scope of this book. References are given, however, to other
subspecies.
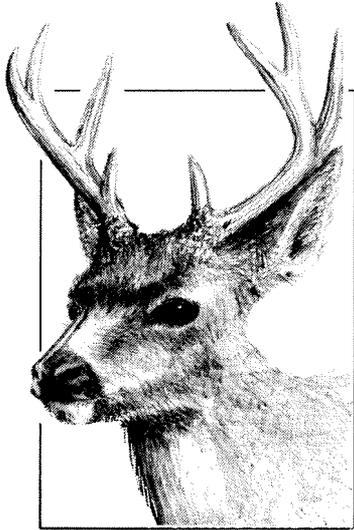
Bailey (1936, p. 88) stated, ". . . these timber-loving deer hide in the thickest parts
of the forest, coming cautiously out at evening to feed. . . ." Black-tailed deer are
not actually forest-dwellers in the sense that Bailey indicated, instead they are
primarily inhabitants of the forest's edge where there are openings and enough
thickets to adequately conceal them. Many older people do not understand this;
they only remember that deer used to be "everywhere." What they fail to grasp is
that 50 or 60 years ago the forests in many areas had just been logged and the
resultant conditions favored the deer. Today, however, these localities are over-
grown with rank brushy vegetation and are no longer suitable for large numbers of
deer. Vegetation passes through definite, orderly stages in its regrowth, and as
each stage changes, it becomes suitable for some animals while becoming un-
suitable for others.

Deer inhabiting high mountains are forced to make annual migrations to winter
ranges at elevations below the heavy accumulations of snow, but there seems to
be no regular seasonal migration among coastal black-tailed deer. Where deep
snows do not occur-on flat areas at middle and low elevations-deer are
residents throughout the year. These areas are dominated by vine maple and
huckleberry-salal communities on south- and southwestern-facing slopes. The
primary factors governing the selection of such areas appears to be the best sup-
ply of preferred forage, minimal duration of snow cover, and relative freedom from
cold winds (Crouch 1968b, Dasmann and Taber 1956, Gilbert et al. 1970, Miller
1970a, Russell 1932, Zwickel and Brent 1953).

Miller (1970a) found that the daily activity periods of black-tailed deer are in-
fluenced by extremes of or sharp changes in temperature, minimum relative
humidity, and precipitation-as well as by the sex, age, and reproductive status of
an individual. He characterized the daily and seasonal activity patterns as follows:
(1) January and February-most active at midday; (2) March through May-most
active in early morning; (3) June through August-most active in late morning and
twilight; (4) September-most active in early morning, less at twilight; (5) Oc-
tober-most active in early morning, at midday, less at twilight; (6) November—
most active at midday but highly active all day; and (7) December-highly active
from midmorning to twilight. The increased daily activity during November and
December was a result of the rutting season, during which bucks were in constant
pursuit of does.

Black-tailed deer are not herd animals and seldom form large groups. The stable
groups are small, consisting of the family groups-the most stable-and the
small groups of bucks. Other groups either are formed by chance or are tempor-
ary. A family group normally includes at least a doe and one fawn; at most a doe,
two fawns, and two yearlings. Birth of the fawns in May creates the initial family
group, and it is completed when the yearlings are again accepted by the doe in
June or July. Although extreme disturbance or occasional wandering may sepa-
rate a family, it reforms and normally stays together throughout the summer and
early fall. The rutting season in late fall disrupts the group when the doe may

BLACK-TAILED DEER

leave for several days to travel with bucks. A partial breakup of the family occurs during the winter and spring. Yearling males often leave during the winter to join groups of bucks. Male fawns occasionally also leave, but most remain with the does until the next winter. Yearling females leave the group between midwinter and spring when they may give birth to young of their own. A female fawn is the most closely attached to the mother. She usually remains with the doe until temporarily driven away when the doe is about to give birth to new fawns (Dasmann and Taber 1956).

Mutual grooming, which begins between a doe and her fawns, may form the initial social ties within a family group. Such grooming is most common when the large winter groups are dispersing into the small family groups. At such times grooming may help to reestablish strong bonds between members of a family if they were weakened by the frequent contacts among a relatively large number of deer during the gregarious wintering period (Miller 1971a). In addition to grooming, a fawn initially learns to recognize its mother by sniffing her metatarsal glands. Members of a family sniff the metatarsal glands on one another's legs once or twice an hour during the day and as often as six times an hour during the night (Brownlee et al. 1969).

Most bucks are solitary, but some have a strong tendency to associate together throughout much of the year. They usually disperse with the onset of the rutting season but may gather into groups again during the winter and spring. At times several families and groups of bucks come together-usually in the spring-forming large "feeding bands." These associations bear a resemblance to a social herd, but in reality each small group retains its integrity. When these small groups approach one another too closely, conflict often results. As the feeding period ends, each group usually goes its own way without paying attention to the activities of the others. No permanent social herd is formed (Dasmann and Taber 1956).

The home ranges of black-tailed deer vary in diameter from 630 to 1260 meters (Dasmann and Taber 1956) or encompass about 0.3 square kilometer to 1.3 square kilometers (Miller 1970a). Actually, a deer's home range consists of a series of small areas-centers of activity-in which it obtains food and water, rests, and has escape routes; these areas are connected by trails. In short, a deer's home range is familiar ground, over which it moves freely. On an average monthly basis, an individual uses only 12.8 to 39.6 percent of its home range (Dasmann and Taber 1956, Miller 1970a). Bucks not only have larger home ranges than does but also travel farther. Brown (1961) calculated that, in two different areas of Washington, bucks traveled an average distance of 3.4 to 4 kilometers from where they had been ear-tagged to where they were killed by hunters. In contrast, does traveled an average of 2.4 to 3 kilometers.

Adult does are mutually antagonistic toward one another much of the year, and conflict may arise when they come together. The result of such antagonism is a fairly regular spacing of does' centers of activity; these are separated by at least 90 meters and usually by 135 or more. These occasional conflicts may be remembered by does, causing one to avoid the area of another even when the

other has died. During late winter and spring, when the fawns have been weaned and family ties weaken, does tend to congregate in choice feeding areas. The birth of new fawns, however, renews the mutual antagonism and thereby the spac·ing (Dasmann and Taber 1956).

The bucks' centers of activity tend to be clustered, and other than maintenance of social rank and sexual aggressiveness, no antagonistic behavior occurs. Neither maintenance of social rank nor sexual aggressiveness seems to have any effect on spacing among individual bucks. Groups of bucks seem to remain aloof (Dasmann and Taber 1956).

It is generally assumed that bucks rub their heads against trees to get rid of the velvet on their newly matured antlers. But Graf (1956) interpreted the use of "rub-bing posts" as a manifestation of territoriality rather than a means of discarding the velvet. Although Graf's observations were correct inasmuch as a buck's rub-bing his forehead is not to remove the velvet, black-tailed deer are not territorial, nor do bucks gather harems during the rutting season. Muller-Schwarze (1972) studied the social significance of forehead rubbing by black-tailed deer, and he found that, instead of being "rubbing posts," these are "sign posts." Besides mature bucks, does and even fawns only 2 weeks old rub their foreheads against objects. They rub the trunks of trees, branches, twigs, and occasionally other things. An individual approaches a limb and sniffs before rubbing its head against it; rubbing is accomplished primarily in vertical strokes, but horizontal strokes are also used.

Black-tailed deer sniff and rub their foreheads against sign posts throughout the year, forming an intricate system of communication. The material from the scent glands on the foreheads of deer is apparently washed off the sign posts by rain and melting snow because there is an increase in rubbing activity after precipita-tion (Muller-Schwarze 1972). Refer to Quay and Muller-Schwarze (1970) for a de-tailed discussion of the scent glands.

Bucks share rubbing sites as well as having some that are strictly their own. Rub-bing sites are established at strategic places, such as resting areas and along commonly used trails. Males apply scent on sign posts, and both males and females sniff these sites. Among bucks there is a correlation between marking shared sign posts with scent and sniffing them. The dominant buck frequently marks rubbing sites but seldom sniffs, whereas the lower ranking bucks sniff more and mark less, depending on their social status. From spring to autumn there is an increase in the frequency and intensity with which bucks mark shared rubbing sites and a decrease in the number of exclusive sign posts that an in-dividual maintains. Black-tailed deer are "silent"; therefore, rubbing-which reaches its peak during the rut-may advertise the presence and possibly the physiological state of a particular male because both females and males sniff sign posts more frequently during the rutting season than at other times of the year. In addition to absentee communication, forehead rubbing-including thrashing vegetation with the antlers—may be one of the methods used by rutting bucks to establish dominance while expressing a threat, at the same time avoid-ing unnecessary conflict (Muller-Schwarze 1972).

Adult bucks often leave their home ranges during the rutting season and travel to other areas, apparently in search of receptive does. With the termination of rutting, however, they normally return to their home ranges. Does approaching heat or in heat are also more active during the rutting season and sometimes travel outside their home ranges, but not far (Dasmann and Taber 1956).

Combat between bucks involving the use of antlers apparently is not as common as are threats and aggressive displays without physical engagements (Dasmann and Taber 1956), but fights do occur.

Food: Black-tailed deer are primarily browsing (eating woody plants) animals, and they eat a variety of plants. In western Oregon and western Washington, their principal diet consists of trailing blackberry, red huckleberry, salal, grasses, and forbs during the fall, winter, and early spring; and thimbleberry during the summer and early fall (Brown 1981, Crouch 1988, Miller 1988). The deer along the southern Oregon coast also eat the acorns of tanoaks. Also see Dixon (1934), Kufeld et al. (1973), Nellis and Ross (1969), Reichert (1972), Robinette et al. (1973), Wallmo et al. (1972, 1973).

Probably most people who hunt deer in western Oregon are aware of the inordinate fondness of deer for apples in the fall. Knowing this, I have often hunted deer in old orchards that long since have been abandoned. Some years ago, I took much time and great care to get downwind of such an orchard. When conditions were just right, I very slowly crawled up the slope through the wet grasses and drizzling rain. I had a doe tag, so all I needed was to have a deer in the orchard. As I crested the knoll I saw two deer looking at me. Slowly I raised my rifle and took aim. I was just taking up the slack in the trigger when there issued forth a fantastic belch from the orchard-then another and another; I lowered my rifle and studied the deer. Slowly it dawned on me that they were not standing under the apple trees but were leaning against the trees, After a few moments I walked up to them, slowly at first and ready to shoot, then casually. Both deer-a doe and a yearling-gazed stupidly at me with glassy, sightless eyes and slobbering muzzles. They were drunk from eating fermenting apples.

Reproduction: The rutting season commences about October 23 and terminates about January 11. Brown (1981) summarized the females that were bred as follows:

	Percent
October 23-25	5
October 25 to November 10	18
November 10-25	75
November 25 to December 10	5
December 10-25	1
December 25 to January 11	.5

The gestation period, ranging from 183 to 212 days, averages 203 days (Brown 1981, Cowan 1958). Most fawns are born between June 5 and 10, which indicates that breeding takes place at about the same time each year (Brown 1981). Deer give birth only once a year.

Brown (1961) determined that 45.4 percent of the yearling does become pregnant, whereas 91.8 percent of females in the 2- to 6-year-old age class bear fawns. When black-tailed does are 7 years old or older, only 66.7 percent produce young. Yearlings give birth to single fawns, but 49 percent of the 2- to 6-year-old does and 60 percent of the 7-year-old or older does have twins.
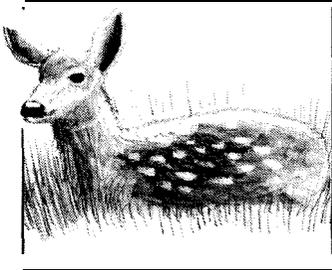
BLACK-TAILED FAWN

Miller (1965) observed a doe giving birth to a single fawn. The doe, which had been feeding, selected a previously used, secluded bed just before the onset of labor. Labor began shortly past midday and within 7 minutes a fawn was born. The doe immediately began to lick it clean. She was alert at all times. Miller approached the pair when the fawn was about 2 hours old; the doe left and the fawn lay flat against the ground with its neck outstretched and its ears laid back against its head. Also see Miller (1970b, 1971b), Ommundsen and Cowan (1970).

A doe and her fawn learn to recognize each other by sniffing one another's metatarsal glands. A fawn marks its sleeping site with urine. During the day, a fawn may bleat for its mother, but at night it "rub-urinates" to effect communication as well as a distress signal. Rub-urinating is highly ritualized. The hocks are rhythmically rubbed against each other while urine is slowly released over them. As a fawn matures, it uses rub-urinating to threaten other deer. Smelling of the metatarsal glands is normally the first stage of aggressive behavior. Adult bucks erect and rhythmically move the long hairs around the metatarsal glands, exposing the scent; this behavior is often combined with rub-urination (Brownlee et al. 1969, Müller-Schwarze 1969).

Several years ago I was camped near the top of a mountain in the Oregon Coast Ranges. It was a clear, cool night in June and there was a full moon. I lay against a large log under a small lean-to made of bark. Since I had not built a fire and I was downwind of a small, grassy clearing in the virgin timber, a doe did not detect my presence as she quietly crossed the little meadow to the edge of the forest. The doe and her youngster stopped within 15 meters of my head where a bright shaft of moonlight filtered down through the tall fir trees and lighted a small place on the forest floor. As the doe started to feed, the fawn discovered the moonbeam. With head outstretched and nostrils flaring, it approached the light; its legs were stiff and appeared to be tucked well beneath the body for instant retreat. The youngster suddenly "snorted" and fled to the doe whose head had snapped erect at the sound. The fawn nursed, and the doe returned to feeding. During the next half hour or so the youngster alternately struck the light with forefeet, kicked it with hind feet while twisting sideways in the air, and raced through it. These "feats" were often interrupted by sudden returns to the doe. At such times the youngster usually went to the far side of the doe and, with its head under the mother's belly, observed the moonbeam. After a few seconds of observation, the fawn would again "attack" the light. As the doe gradually drifted away from the light, the fawn ceased its play.

Black-tailed deer are experts at slipping quietly and unobtrusively through the forest. I have often "jumped" deer in dense vegetation without seeing them, but by turning around and watching the direction from which I had just come, I have been able to watch them sneaking across the trail as close as 15 meters behind me. They apparently learn as fawns to sneak through vegetation. Once, while

hunting, I saw the tips of some tall ferns wiggle slightly. The wiggling continued and came in my direction; I waited. Presently, a fawn was at my feet, then another one; since both were looking back over their shoulders as they came crawling through the ferns, I had to speak or they would have crawled against me. They did not tarry.

Some black-tailed deer reach sexual maturity at 1 year of age; in the wild, they may live more than 7 years (Brown 1961).

Predation: Other than legal hunting, the causes of the deaths of 11,117 black-tailed deer in Washington over a 10-year period, 1949 to 1958, were determined as follows (Brown 1961):

Cause of death	Percent
Automobiles and trains	66.3
Illegal killing and poaching	15.2
Malnutrition and disease	6.4
Predation	4.0
Damage control	3.1
Miscellaneous accidents	1.6
Undetermined causes	3.6

Pumas and coyotes and occasionally bobcats and black bear prey on black-tailed deer; humans, however, take the greatest toll.

Economic status: Black-tailed deer and mule deer cause considerable damage to commercially important timber and agricultural crops, but their value as game animals far outweighs the damage. Management direction always seems to be aimed at increasing the habitat available to deer while, at the same time, trying to deter the damage they cause (see, for example, Brown (1961), Campbell and Bullard (1972), Hines (1973)).

In 1972 and 1973, people wishing to hunt deer in Oregon purchased 562,912 deer tags valued at $1,195,127, and 176,870 deer were killed by the sport-hunting public (Oregon Wildlife Commission 1974b).

Selected references: Bauer et al. (1968), Cappucci and Longhurst (1972), Cowan (1946), Cowan and Geist (1961), Dealy (1971), Dixon (1934), Erickson and Seliger (1969), Erickson et al. (1970), Kramer et al. (1971), Lawrence and Biswell (1972), Leopold et al. (1951), Linsdale and Tomich (1953), Peterson et al. (1973), Presidente et al. (1973), Richens (1967), Thomas and Bandy (1973), Weinmann et al. (1973).

4. Marine Mammals

Bruce R. Mate

Introduction

As with land mammals, there is considerable diversity among the marine mammals. Such diverse groups as whales, porpoises, and dolphins (cetaceans), the polar bear and the sea otter (carnivores), sea lions and seals (pinnipeds), and dugongs and manatees (sirenians) are classified as marine mammals because of their adaptations to the marine environment. But polar bears, dugongs, and manatees do not occur along the Oregon coast.

References of general interest on marine mammals include: Haley (1978), Ridgeway (1972), Harrison (1972). An interesting first-person historical account of whaling and sealing in the eastern north Pacific is by Scammon (1968), which was originally published in 1874. A bibliography was published by the Marine Mammal Commission in 1979.

References of general interest on whales, porpoises, and dolphins include: Leatherwood and Reeves (1981), Norris (1966), Schevill (1974), Tomilin (1987). Specialty information on populations of large cetaceans and their historical management may be found in Gulland (1974), Allen (1980), and the International Whaling Commission (IWC) annual reports. Small whale harvests are discussed by Mitchell (1975) and Perrin (1980). Recent bibliographies are available for archaeocete (fossil) cetaceans (Fordyce 1980), whales and whaling (Magnolia 1977), and dolphins and porpoises (Truitt 1974).

Readers interested in taxonomy and anatomy will find Tomilin (1987) useful. Information on parasites can be found in Dailey and Brownell (1972), Tomilin (1967), and Yablokov et al. (1974). Population abundance and distribution have been taken mainly from Leatherwood and Reeves (1981) and supplemented by annual reports of the International Whaling Commission.

The physical description of individual species of whales may differ from those found elsewhere in general accounts, but I use descriptions that are specific to populations found in the north Pacific (along the Pacific coast of North America). Growth rates of individuals in various "stocks" (reproductively distinct populations of the same species) may differ; the information on Pacific stocks has been used when available.

Kenyon (1975) is an excellent reference on the sea otter; King (1964), Ronald et al. (1976), and Scheffer (1958a) are references of general interest on sea lions and seals. A bibliography by Ronald et al. (1976) will be useful to those who want specific information on sea lions and seals. Although much information on the habitats, behavior, feeding, and reproduction of sea lions and seals can be found in the scientific literature, there are few sources of quality information for the general reader. Two notable exceptions are the accounts of northern fur seals by Scheffer (1970) and California sea lions by Peterson and Bartholomew (1967). Information on the parasites of sea lions and seals may be found in Dailey and Brownell (1972).

Order Cetacea: Whales, Dolphins, and Porpoises

Derivation: The ordinal name Cetacea is derived from the Greek word *cetus* or *kētos* (a whale or a sea monster). Members of this group of mammals are highly adapted and wholly aquatic.

General description: A cetacean is distinguished from a fish by the following characteristics: (1) Cetaceans have tail flukes set in a horizontal plane; (2) the front limbs are modified skin-covered flippers or fins, and hind limbs are absent; (3) they have lungs and may have scattered bristles of hair on their heads; and (4) their nostrils open through blowholes, usually located on the highest point of the head.

Cetaceans range from 1.25 meters to 30 meters in length and weigh from 23 kilograms to 136 metric tons. The blue or sulphur-bottom whales are the largest known mammals, fossil or living; adults weigh about 907.2 kilograms for each 30 centimeters in length.

There are two basic groups of living cetaceans: (1) Those with teeth and (2) those with baleen or whale bone-although teeth are absent when they are born, rudimentary teeth are present in the fetuses.

Baleen whales have two nostrils and a double blowhole; they are strictly marine. Toothed whales (includes dolphins and porpoises) have only one nostril and a single blowhole. Although most toothed whales inhabit the oceans, a few inhabit rivers and at least one species lives in freshwater lakes. Regardless of the kind of cetacean, there is a direct connection between the nostril and the lungs; thus, when a youngster suckles, milk cannot enter its lungs. When an individual is submerged, the blowhole is closed by a valve. Cetaceans do not blow liquid water out of their lungs. The visible "spout" seen when a whale exhales is the water vapor from the lungs condensing as it enters the air; there may also be a discharge of mucous-oil foam that fills the air sinuses.
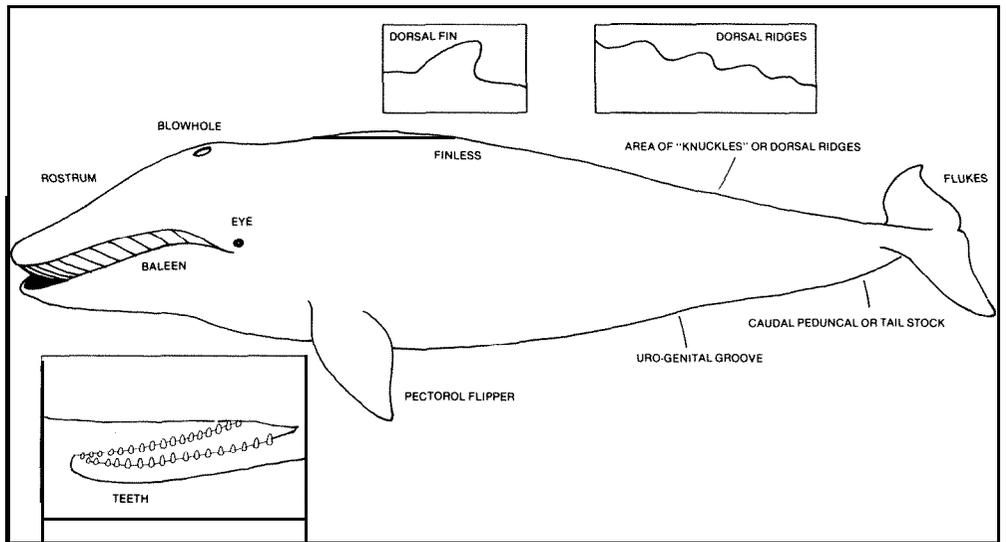
Anatomical parts of a typical cetacean.

GRAY WHALE

Except for elephants, cetaceans are the only animals that have larger brains than humans. They do not have sweat glands or skin glands, but they do have tear glands which secrete a greasy substance that protects their eyes from saltwater. Beneath the skin is a fibrous insulating layer of blubber filled with fat and oil, which assists in regulating the body temperature. The bones of cetaceans are spongy, and the bone cavities are filled with oil. In some cetaceans the vertebrae of the neck are fused. All cetaceans lack the complex articulation of vertebrae characteristic of land mammals. The dorsal fin and tail flukes lack bony support. The pelvic girdle is represented by only two sma!! bones embedded in ?he body wall; these are free from the backbone and serve only as attachments for muscles of the external reproductive organs. Since the tail provides the driving force in swimming, hind limbs are unnecessary and are absent. The flippers are used for stability and turning.
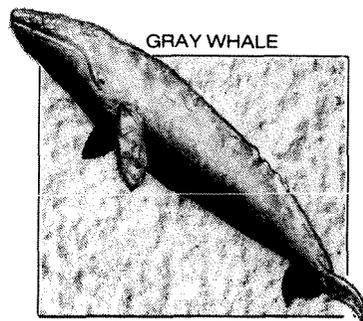
Cetaceans have more acute hearing and touch than vision; however, most species can see well both under and above water. They have little sense of smell. Some cetaceans have a large repertoire of underwater sounds and probably depend mainly on echo-location for orientation and finding food. Sounds may also be used in communication between individuals. Most cetaceans are gregarious; some species exhibit a distinct social organization.

Baleen whales are filter feeders, eating many kinds of tiny floating plants and animals, collectively called plankton. Toothed whales, on the other hand, feed on fish and cephalopods (nautili, squids, and octopi). The killer whale is the only species that eats aquatic birds and mammals, including other whales. The teeth of toothed cetaceans are adapted for seizing and holding slippery prey, but not for chewing.

The gestation period in cetaceans varies from 11 to 16 months. At birth, the single calf is usually one-fourth to one-third the length of its mother. Birth occurs in the water; breech presentation is normal, at least in the toothed forms. The umbilical cord is short, breaking after birth at a weak place near the navel. Young cetaceans are necessarily precocial; they have to be able to swim at birth. A mother may float on her side while suckling her youngster so the calf can breathe. Eventually the calf can nurse under water. The female has two teats, situated within slits on either side of the reproductive opening. The mammary glands have large reservoirs in which milk collects. When body muscles are contracted, milk is forced through the small teat into the youngster's mouth. The milk is rich in fat and protein but low in lactose; it has a high calcium and phosphorous content. Cetaceans grow rapidly and are weaned between 4 months and 2 years. They reach sexual maturity between 14 months and 10 years of age, depending on species. Because they live in an aquatic environment without having to support their own weight, cetaceans can attain great size.

Whales have been hunted by humans for many years. Even with present regulations, some species are nearing extinction.

World distribution: Cetaceans inhabit all oceans of the world and some rivers in South America and Asia. One species lives in Tangting Hu Lake, China.

Fossil record: The oldest fossil cetaceans date to the late Eocene in North America.

Number of species along the Oregon coast: 23.

General references: Anderson and Jones (1967), Walker et al. (1975).

Key:

1a Teeth absent; have horny plates of baleen that grow down from the upper jaw
and two blowholes on top of the head—*MYSTICETI* (baleen whales).   2
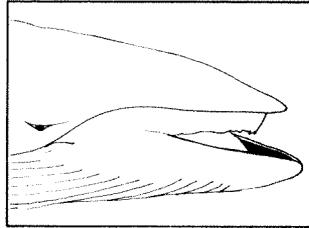
Mysticeti whales have baleen
growing from the roof of the
mouth; they lack teeth.

1b Teeth present (1 to over 250) but may be concealed in gum; single blowhole—
ODONTOCETI (toothed whales).   8
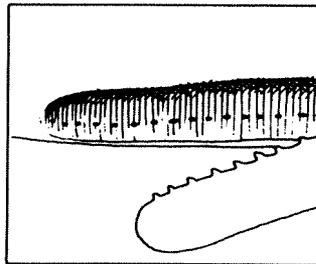
Odontoceti whales have true
teeth, although these may be
only in the lower jaw, few in
number, or not conspicuous.

2a Dorsal fin present, 12-114 throat grooves, top of head flat—*BALAENOP-*
TERIDAE (rorqual whales).   3

2b Dorsal fin absent, zero to four ventral throat grooves, top of head
somewhat round in profile.   7

3a Body large, about 24 to 33 m in length, bluish with white mottling; head broad and U-shaped, with a ridge running along **midback** from the blowhole to the small (3 to 5 cm) dorsal fin; baleen black with black fringe-BALAENOPTERA *MUSCULUS* (blue whale or sulphur bottom),   page   388
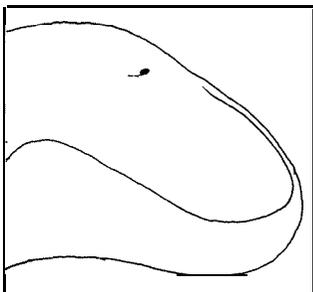
Blue whales **have** a U-shaped rostrum.

3b Body not as large as blue whale, not blue with mottling, head more V-shaped; baleen not all black; dorsal fin 5 cm or larger.   4
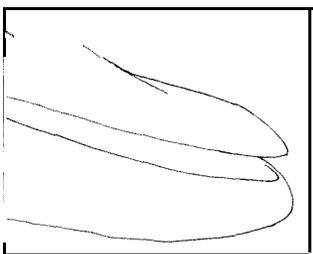
Balaenopterids (except blue whales) have a V-shaped rostrum.

4a Body large, up to 27 m in length, right lower lip and right front baleen white-BALAENOPTERA *PHYSALUS* (fin whale or **finback** whale),   page   391

4b Body length less than fin whale, up to 18 m in length, without white area on right side of head.   5

5a Baleen is black with grayish fringe; flippers one color; not ex-cessively large-BALAENOPTERA *BOREAL/S* (sei whale), page 393

5b Baleen is black without gray fringe or whitish; flipper either large or with white band.. . . . . , , , ...   6

6a Flippers with distinctive white horizontal band; baleen white or yellow; body gray, white on belly—*BALAENOP-TERA ACUTOROSTRATA* (minke whale or little piked whale), page 395

6b Flippers long, up to one-third body length; knoblike projections on dorsal surface of head and leading edge of flipper; baleen black, body black with white belly—*MEGAPTERA NOVAEANGLIAE* (humpback whale), page 397

7a Body black, lacks dorsal fin or humps; head large, about one-fourth body length, with patches of warty prominences; ventral throat grooves absent; baleen dark; blow V-shaped—*BALAENIDAE* (right whales), page 381

7b Body gray; posterior dorsal ridge on back with series of low humps; two to four ventral throat grooves; baleen yellowish and short; blow low and puffy—*ESCHRICH-TIIDAE* (gray whale), page 383

8a Teeth numerous and confined to the anteriorly constricted lower jaw; blowhole positioned on the front left side of the head—*PHYSETERIDAE* (sperm whales) 9

8b Teeth numerous in both upper and lower jaws or one to two pairs of teeth confined to the lower jaw; blowhole centered more on top of the head. . . . 10

9a Distinct dorsal fin absent; a hump followed by a series of "knuckles" is located along the posterior midline of the back; head is large, squared off, and approximately one-third of the total body length; body length up to 16 m—*PH YSETER CATODON* (sperm whale), page 400

9b Small, curved dorsal fin present; head relatively short, one-sixth to one-seventh of the total length; body length up to 4 m-KOGIA *BREVICEPS* (pygmy sperm whale), page 405

10a Two to four throat grooves; flukes not deeply notched; teeth restricted to lower jaw, adult males with one to two pairs, females and immature males generally without visible teeth-(consult species synopsis in text for key to the family) *ZIPHIIDAE* (beaked whales), page 406

10b Throat grooves absent; flukes deeply notched; usually numerous teeth in upper and lower jaws except in the genera Grampus (grampus dolphin). 11
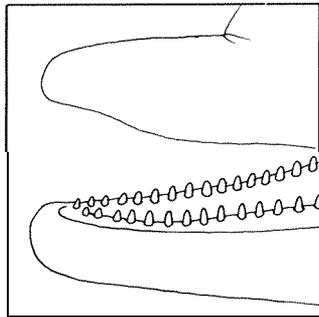
Members of the family
Delphinidae have peglike
teeth.
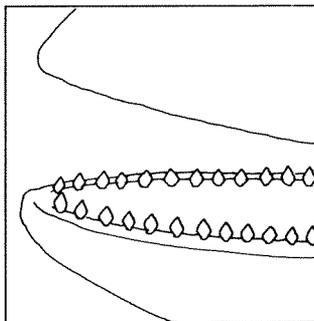
Members of the family Pho-
coenidae have spadelike
teeth.

12a Teeth, three to seven pairs in lower jaw; body gray or white, scarred with numerous scratches-GRAMPUS *GRISEUS* (grampus or Risso's dolphin), page 413

12bTeeth in upper and lower jaw, more than three to seven pairs; body usually darker color.   13

13a Dorsal fin thick, curved with a long base; flippers long (about one-fifth total body length), slender and sickle-shaped; a prominent "melon" forehead extending beyond the upper jaw in mature animals—*GLOBICEPHALA MACRORHYNCHUS* (short-finned pilot whale, pothead whale, or pilot whale), page 411
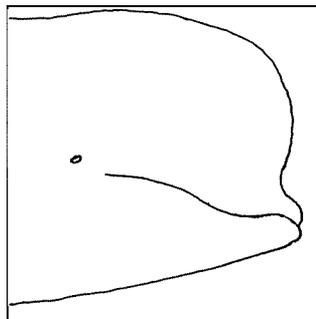
Pilot whales have a large
prominent "melon" forehead,
extending beyond the upper
jaw in mature animals.

13b Dorsal fin usually thin or absent; flippers less than one-fifth total body length; head not as bulbous.. 14

14a Dorsal fin absent; body black with white ventral hourglass pattern—*LISSODELPHIS BOREALIS* (northern right whale dolphin), page 421

14b Dorsal fin present, without white ventral hourglass pattern. 15

15a Teeth round, 8-14 in each side of jaw; body either all black or black with white patches; dorsal fin can be large, up to 2 m in height.. 16

15b Teeth peglike, more than 14 in each side of jaw; body variously colored; dorsal fin relatively small. 17

16a Dorsal fin large, 0.8 to 2 m; body black with white patches; flippers round, robust; teeth round, 10 to 14 in each jaw—*ORCINUS ORCA* (killer whale or orca), page 414

16b Dorsal fin medium size, less than 1 m; body entirely black with narrow, tapering head; teeth circular, 8 to 11 in each jaw-*PSEUDORCA CRASS/DENS* (false killer whale), page 417

17a Snout blunt; dorsal fin sharply curved back with a white patch; 22 to 23 pairs of teeth in each jaw— *LAGENORHYNCHUS OBLIQUIDENS* (Pacific white-sided dolphin), page 424

17b Prominent beak or snout; dorsal fin not sharply curved; more than 40 teeth each side of jaw. . 18

18a Body bluish; two dark bands extend from eye to anus and eye to flipper; 48 to 50 teeth each side of jaw-*STENELLA COERULEOALBA* (striped dolphin), page 422

18b Body black or brownish with hourglass pattern on gray side, yellow and white; 40 to 60 teeth each side of jaw—*DELPHINUS DELPHIS* (common dolphin, white-bellied porpoise, or saddleback dolphin), page 418

19a Body gray above, white ventrally; dorsal fin triangular; black band runs from gape of mouth to flipper-PHOCOENA *PHOCOENA* (harbor porpoise or common porpoise), page 427

19b Body black with patches of white on the sides and ventrum; tail stock dorsoventrally thickened; dorsal fin broadly triangular and slightly reduced at tip— *PHOCOENOIDES DALLI* (Dali's porpoise), page 426

**Family Balaenidae:
Right Whales**
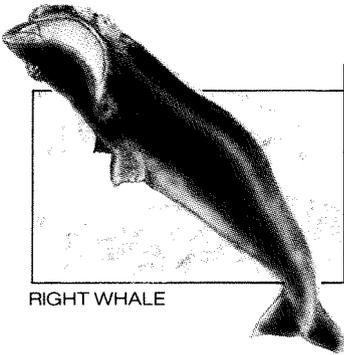
RIGHT WHALE

Derivation: The familial name Balaenidae is derived from the Latin word *balaena* (a whale) and the Latin suffix *idae* (family).

General description: The family Balaenidae is commonly referred to as the right whale family, because these were the "right" whales to hunt during the early days of whaling before explosive harpoons, steampowered catcher boats and air flotation (pumping compressed air into a dead whale to keep it afloat). These slow-moving whales were commonly found near shore, were easily killed, were buoyant so they floated when dead, and were extensively hunted. Some stocks were severely depleted. Although not exterminated, they have yet to recover from this exploitation.

The head of a right whale is one-fourth to one-third of its body length and has a characteristically large mouth with an arched upper jaw. The northern right whale has numerous horny excrescences that appear as white patches on the forward portion of the head. The largest of these excrescences is called the "bonnet." These whales do not have throat grooves and, except for the southern hemisphere pygmy right whale, none of the right whales have a dorsal fin. The neck vertebrae are fused into a single unit. Flippers are short and wide. The baleen (horny material forming a strainer for collecting food) is longer than in other whales and is typically dark, numerous, and narrow with a very fine fringe. These animals characteristically feed on very small organisms.

World distribution: Right whales are distributed throughout the Arctic, the temperate waters of the Pacific and Atlantic Oceans, and in the southern hemisphere north of the antarctic convergence.

Fossil record: The fossil record for the right whales dates to the early Miocene; in the north Pacific, to middle Miocene times.

Number of species along the Oregon coast: One.

General references: Leather-wood and Reeves (1981), Tomilin (1987).

Genus *Eubalaena*: Right whale

Derivation: The generic name *Eubalaena* is derived from the Greek prefix eu (good or true) and the Latin word *balaena* (a whale).

General description: There is only one species of this genus found off the Oregon coast. The generic description is under the species.

World distribution: Same as that under family.

General references: Same as those under family.

Species *Eubalaena glacialis:*
Northern right whale or Pacific right whale

Derivation: The specific name *glacialis* is the Latin word for frozen and probably refers to the cold waters that these whales inhabit.

Specific description: Adult males reach 15.5 meters in length; adult females, 18 meters; newborn calves are 4.5 to 6 meters long. Adult males may weigh 620 metric tons and adult females, 970 metric tons. The head of a Pacific right whale is one-fourth of its total length, with a narrow, arched rostrum. There are callosites on the dorsal surface of the head between the blowhole and the snout. These may form distinctive patterns that allow individuals to be identified. There is no fin or ridge along the back. The baleen ranges from 350 to 390 plates on each side (Tomilin 1967). Individual baleen plates are thin and black in animals from the eastern Pacific and may reach a length of 2.5 meters. The body is usually black or blackish gray except for variable white regions on the belly (Leather-wood and Reeves 1981). The blow is visible as two separate spouts forming a wide V.

Abundance and distribution: Right whales inhabit all temperate waters of the world, and two species are recognized: Northern and southern. The northern species is composed of four stocks: (1) eastern north Pacific, (2) western north Pacific, (3) eastern north Atlantic, and (4) western north Atlantic (Brownell et al. 1978). These whales are found in the eastern Pacific from the Bering Sea south to Punta Abreojos, Baja California, Mexico. Their summer distribution is in cool temperate waters in the north Pacific from the Bering Sea to latitude 50°N. The "Kodiak Grounds" (the Gulf of Alaska) in summer months yielded high numbers in the 19th century (Rice 1974). The winter distribution in most areas is along continental coasts and islands; this includes the area from Oregon to central Baja California, Mexico. The estimated population of whales for the north Pacific Ocean is about 220 (U.S. Department of Commerce 1978). Before exploitation, the population may have been about 50,000; populations were severely exploited in the 19th century. Between 1905 and 1937 only 24 whales were taken in waters from Alaska to British Columbia. The species is now considered endangered and has been under complete protection by international agreement since 1937.

Habits: Pacific right whales typically lie on the surface of the sea with their blow-holes protruding high above the water. They swim at approximately 6.4 kilometers per hour and when frightened are capable of 12.9 kilometers per hour (Tomilin 1967). Right whales can remain underwater up to 50 minutes.

Food: Pacific right whales feed primarily on copepods and euphausiids and occasionally on pteropods.

Reproduction: Male right whales become sexually mature when about 15.2 meters long; females mature at 15.8 meters. Females give birth to a single calf once every 2 or more years during winter months. Lactation time is unknown but is presumed to be 6 to 7 months. Mating occurs during winter. The gestation period is 1 year.

Mortality: Although no documented cases of predation are available, kilter whales may attack right whales. Little is known of natural mortality rates.

Economic status: The Pacific right whale is protected by international agreement.

Selected references: Leatherwood and Reeves (1981), Tomilin (1967), U.S. Department of Commerce (1978).

Family Eschrichtiidae: Gray Whale

Derivation: The familial name Eschrichtiidae is a proper name. The family was named after D. F. Eschricht, a Danish student of whales. The Latin suffix *idae* denotes family.

General description: There is only one genus and species in this family, the gray whale. The description is under the species.

Fossil record: The gray whale fossil record for the north Pacific dates to the Pleistocene.

World distribution: The gray whale is distributed in the coastal waters of the north Pacific.

Number of species along the Oregon coast: One.

General references: Rice and Wolman (1971), Coerr and Evans (1980).

Genus *Eschrichtius*: Gray whale

Derivation: The generic name has the same origin as the familial name, but without the familial ending.

General description: The description is under the species.

World distribution: Same as that under family.

General references: Same as those under family.

Species *Eschrichtius robustus:* Gray whale

Derivation: The specific name *robustus* is the Latin word for strong or robust.

Specific description: Adult males reach 14.3 meters (average 12.4 meters off California) in length and weigh 16 600 kilograms (Rice and Wolman 1971). Adult females reach 15 meters in length and may weigh as much as 33 850 kilograms when they are pregnant. Newborn calves average 4.9 meters in length. The gray whale is a mottled gray. The light coloring occurs naturally and as a result of barnacles growing in the skin. The gray whale lacks a dorsal fin but has a series of 6 to 12 small humps (termed "knuckles") along the dorsal ridge of the tail stock. The
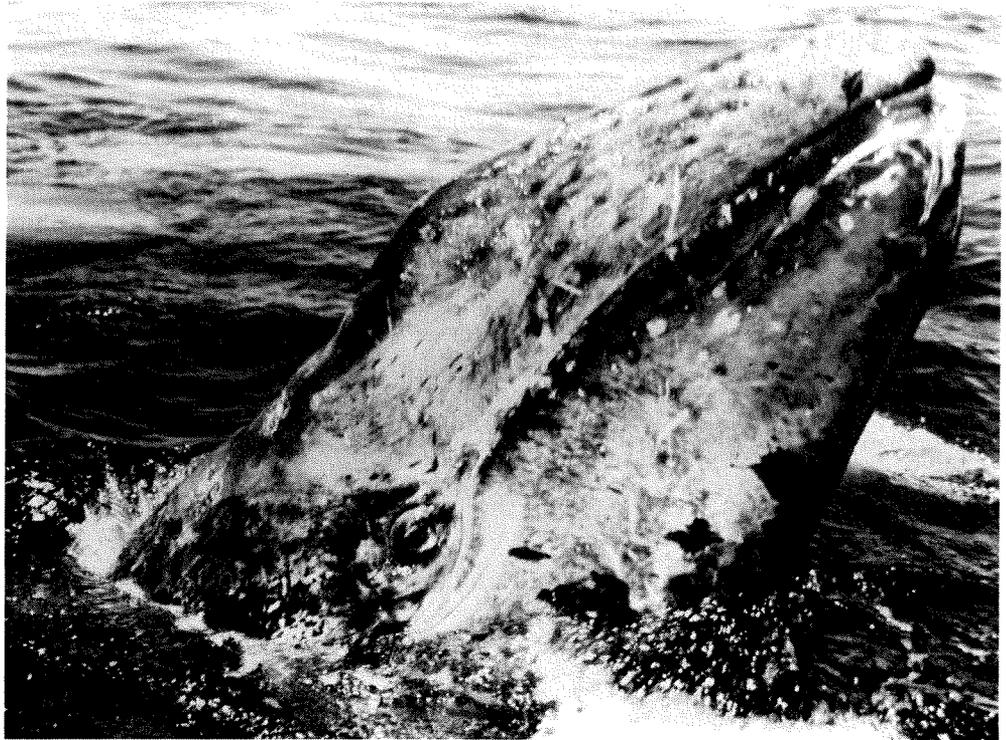
head is about one-fifth the body length. There is a slight constriction immediately behind the head and some lateral compression. There are two to four deep, broad furrows in the region of the throat. When viewed from above, the head is V-shaped and often covered with barnacles, especially between the blowhole and the snout. The thick elastic baleen is white to yellow and spaced about 0.5 centimeter apart. The number of baleen plates varies from 138 to 180 on each side of the mouth.

Abundance and distribution: Gray whales once occurred in the north Atlantic and may have become extinct as recently as the 18th century. The north Pacific population of gray whales is divided into two geographically isolated stocks.

The western Pacific (Korean) stock summers in the Sea of Okhotsk and migrates to the southern coast of Korea for the winter. The western Pacific population was estimated in 1910 at 1,000 to 1,500. Its status is now uncertain, and it may be in danger of extinction (Brownell and Chun 1976). The eastern Pacific stock (California) feeds during the summer in the Chukchi Sea, western Beaufort, and northern Bering Sea. Some gray whales are known to feed as far south as San Quentin in Baja California, Mexico, during the summer. They migrate from November through early February south to lagoons on the Pacific coast of central and southern Baja California to give birth and to mate. After the calving and breeding season, this species moves north from early February through May to its arctic feeding areas. Land and aerial census techniques have been used to estimate gray whale populations. The eastern Pacific stock is estimated at 11,000 to 15,000 individuals, which is thought to be close to its pre-exploitation numbers.

Habits: Congregations of gray whales in their breeding lagoons, combined with theirnear-shore migratory habits, allowed this species to be hunted to near extinction between 1850 and 1900. Granted total protection by international agreement in 1937 and by the International Whaling Commission in 1946, the population has increased and now appears to be leveling off.

These whales have the longest known migration of any mammal, at least 9 600 kilometers in each direction. The near-shore migration of gray whales has led to speculation that these animals are not good navigators. One activity of the gray whale is "spy hopping." During spy hopping, a whale's head is brought vertically out of the water. It has been suggested that spy hopping is for visual orientation with the shoreline, but this behavior is seen during nonmigrating periods far offshore in the Bering Sea and often the whale's eyes do not come above the surface of the water.

Records from the whaling industry and of the few animals taken for scientific research indicate that this species usually does not feed during its migration or winter calving periods. Whales are observed, however, coming to the surface with mud streaming from their baleens in the calving areas and along the migration route. Such behavior may indicate attempts to feed or to train calves how to feed. Many gray whales have been observed throughout the year apparently feeding along British Columbia and Oregon.

Perhaps the whales' most spectacular behavior is "breeching"; an animal comes one-half to three-fourths of its body length out of the water and falls on its side or back, causing a tremendous splash. Some of the hypotheses developed to explain breaching include knocking off external parasites, communication, or just recreation. Individual whales usually breach repetitively, and oftentimes other whales in the vicinity also breach.
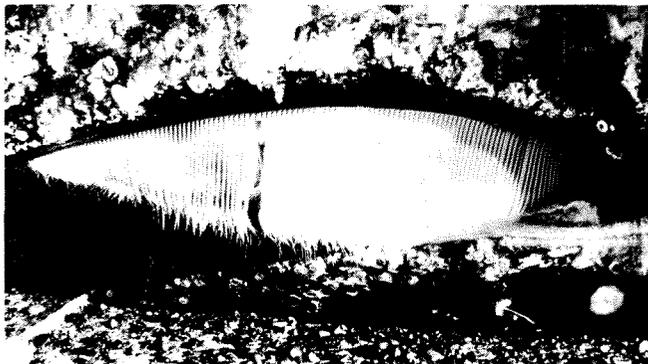
Food: Gray whales have the heaviest baleen of all the baleen whales, and they are the only ones known to feed extensively on benthic or bottom-dwelling animals. While in the Bering and Chukchi Seas, gray whales feed on a variety of gammarid amphipods (shrimplike), as well as mysids, mollusks, polychaete worms and hydroids (Rice and Wolman 1971). All of these prey are typically infaunal benthic (bottom-dwelling) species (burrowing or buried in sediments), and many no doubt are incidental to the main food source-amphipods. Both in the Arctic and

in the more temperate regions, rocks, pebbles, and mud may be found in the stomachs of gray whales. Gray whales have been observed with fewer barnacles and more abrasions on one side of the head, indicating that they may use one side more frequently while skimming the bottom.

Rice and Wolman (1971) calculated that gray whales burn 19 kilocalories per kilogram of body weight per day, resulting in a consumption rate of 7 percent of their body weight per day. The principal areas in which these whales feed contain 200-900 grams of food per square meter.

Reproduction: Males reach sexual maturity at an average length of 11.1 meters, whereas females mature at an average length of 11.7 meters. Sexual maturity occurs between 5 and 11 years of age, but 8 years has been given as an average (Rice and Wolman 1971). A pregnancy rate of 0.46 per year strongly supports the hypothesis that sexually mature females give birth to a calf every other year. The calving season is from late December through February. Calves are nursed from 6 to 8 months. Females not bearing a calf mate between November and January, followed by a 13-month gestation period. It is not known how much of the mating and calving activity is restricted to lagoons along the Pacific coast of Baja California. Females with calves, and courting pairs can be observed offshore and around the mouths of these lagoons.

Females are frequently found in the company of one or two males (termed a "courting triad"). Females trying to avoid copulation frequently roll on their backs with their flippers extended to avoid male advances. Females must roll to an upright position periodically to breathe, however, at which time males attempt copulation. Mating activity continues during much of the northward migration, since the males and the females without calves are together during this time. Females with calves leave the calving areas later in the season, after their calves have built up stamina and insulative blubber from their mothers' milk.

Economic status: The gray whale was an important element to the shore whaling industry during the late 19th century; overexploitation, however, caused economic extinction by 1880. Since the 1960's, increasing public interest in whales and the near-shore habits of the gray whale have led to a sizable tourist industry focused on this species. Tour boats run half-day trips from San Diego and Los Angeles during the migration and 10-day trips to selected breeding and calving areas off central Baja California. These activities have generated some problems of harassment to the whales, both during their migration and in their breeding and calving habitats. Mexico has therefore declared Scammon's Lagoon to be a whale refuge and has limited boat traffic in this lagoon and portions of other lagoons while the gray whales are there. The protected status of this species was removed by the International Whaling Commission (IWC) in 1978, and a quota of 178 given to the Soviet Union for native subsistence. Similar numbers were taken by the Soviets even when the species was protected from commercial harvest under an IWC provision for aboriginal use. The species is on the U.S. Endangered Species List.

Mortality: Gray whales have been found stranded on beaches with marks of shark bites, and killer whales have been observed attacking individual gray whales. In many cases disease may predispose animals to traumatic injury or predation by

slowing their reactions. Some carcasses may be eaten by predators after death from some other cause. Mortality rates have been estimated at 10 percent per year for females and 8 percent for males by Rice and Wolman (1971).

Evidence of *Leptospira* spp. (bacteria) in gray whales has been found; these bacteria may result in some premature births, although there have been no documented cases. *Leptospira* spp. are found in cattle, swine, and occasionally in people handling infected animals.

Selected references: Rice (1975), Rice and Wolman (1971), Tomilin (1967), U.S. Department of Commerce (1978).

Family Balaenopteridae: Rorqual Whales

Derivation: The familial name Balaenopteridae is derived from the Latin word *balaena* (a whale) and the Greek word *pteron* **(a** wing or fin) plus the Latin suffix *idae* (family).

General description: Members of the family Balaenopteridae are referred to as "rorquals," a term derived from a Norwegian word referring to the throat grooves typical of these whales. The head is flat and proportionally shorter than that of right whales. The parallel throat grooves or pleats range from 12 to 114. The baleen is shorter and stiffer than that of right whales and may reach 1 meter in length. The cervical (neck) vertebrae generally are not fused. Rorquals have small, basically triangular dorsal fins behind the middle of the back. Flippers are typically narrow and have four digits. Rorquals are faster swimmers than right whales and sink when killed, which delayed their exploitation until the advent of steam-powered catcher boats, explosive harpoons, and air-flotation systems.

World distribution: The members of the family Balaenopteridae are found in all the oceans of the world.

Fossil record: In the north Pacific, the fossil record of the rorquals dates to the late Miocene.

Number of species along the Oregon coast: Four.

General references: Mackintosh (1965), Rice (1974).

Genus Balaenoptera: Rorquals

Derivation: The generic name *Balaenoptera* is derived from the Latin word *balaena* (a whale) and the Greek word *pteron* (a wing or fin).

General description: The baleen whales of the genus *Balaenoptera* have from 12 to 114 throat grooves, which often run from the tip of the chin to the area of the umbilicus (naval). The head is flat, and the baleen is shorter than that of right whales. Rorquals have a small, triangular dorsal fin in the last one-third of the body. The neck vertebrae are not generally fused.

World distribution: Same as that under the family.

General references: Same as those under the family.

Species *Balaenoptera musculus:*
Blue whale or suiphur bottom

Derivation: The specific name *musculus* is the Latin word for muscle.

Specific description: Adult males reach 32.6 meters in length (26 m in the northern hemisphere) and may weigh up to 133 metric tons (Tomilin 1967). Adult females reach 33.3 meters in length (29.8 m in the northern hemisphere) and may weigh in excess of 151 metric tons. The weight of newborn whales has been estimated to be 2 600 kilograms. Calves are about 7 meters long at birth and reach 15 meters by the time they are weaned, about 8 months after birth. Blue whales are bluish gray with mottled lighter gray, or off white. The ventral surface, including the flippers, is lighter in color. A short dorsal fin is located along the posterior third of the back. A ridge runs along the middle of the back from the blowhole to the dorsal fin. The flippers are curved. The head is broad, has a U-shaped rostrum or snout, and frequently appears to be darker than the rest of the body. Approximately 270 to 400 plates of baleen are found on each side of the upper jaw (Leatherwood and Reeves 1981). The baleen is black, broad at the base, and less than 1 meter long. Ventral pleats run from the tip of the lower jaw to just beyond the umbilicus. The blow or spout is several meters tall and vertical.

Abundance and distribution: The blue whale is found from the equator to the polar icepacks in both the northern and southern hemisperes. Three geographically isolated populations are recognized in the north Pacific Ocean, north Atlantic Ocean, and southern hemisphere (U.S. Department of Commerce 1978). Each population has one or more discrete stocks. In the eastern north Pacific, blue whales range from the Aleutian Islands and the Gulf of Alaska to central California during the summer and from central Baja California, Mexico, south to 8°N latitude during the winter. Blue whales are most likely to be seen off the Oregon coast from late May through June and from August through October (Rice 1974). Over 600 blue whales were marked in Antarctica from 1932 to 1938. By 1952, 7 percent of these had been recovered in the same area, indicating that this species (like fin whales) returns to the same feeding grounds year after year (Tomilin 1967). Large numbers of blue whales were killed after the development in the 1860's of the explosive harpoon, steampowered catcher boats, and air-flotation systems. The peak of this whale industry occurred in 1931 when 29,649 were taken. Although it was recognized much earlier by the Scientific Committee of the International Whaling Commission that this species was being overharvested, full protection was not granted until 1966.

Various methods are used to estimate populations of whales, but since blue whales are no longer taken by the whale industry, figures on catch-per-unit effort and recovery of tags are not available. Estimates (based on sightings) indicate that as many as 13,000 blue whales may now exist compared with a pre-exploitation estimate of 200,000 whales. Most of the present population is located in the southern hemisphere, whereas populations in the western north Atlantic appear to be in the low hundreds. The north Pacific population increased slowly after 1966 to about 1,700 individuals (U.S. Department of Commerce 1978). Until recently, there was considerable concern that the numbers of blue whales may have been reduced to such a low level that they were doomed to extinction. Reevaluation of existing data and the new population estimates suggest that these stocks may increase in number if protection is continued.
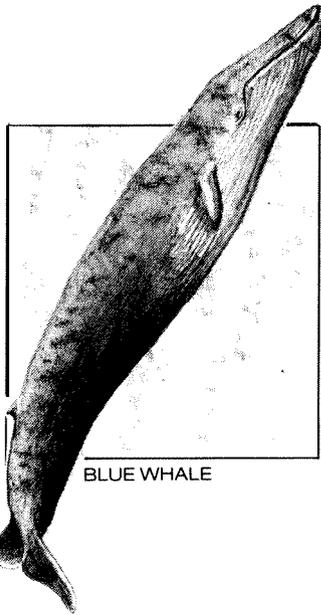
BLUE WHALE

Habits: Blue whales are typically found offshore either as individuals or in groups of two or three, although they may gather in small groups for feeding during migration. Lockyer (1976) estimated that the swimming speed of a blue whale while feeding is from 2 to 6.5 kilometers per hour, the migration speed may be from 5 to 33 kilometers per hour, and the maximum speed when alarmed may ap proach 48 kilometers per hour.

The typical diving pattern is a 10- to 20-minute submersion, followed by 8 to 15 blows at the surface in a series of dives lasting 12 to 15 seconds, and then another long duration dive. When sounding (diving), blue whales frequently show their flukes, unlike fin whales for which they may be mistaken. The name "sulphur bottom" comes from the appearance of a film of diatoms (minute one-celled plants), which frequently cover blue whales that have been in cold water for a long time.

Food: The principal food of blue whales in the Antarctic is the euphausiid, *Euphausia superba*, frequently termed "krill." Of secondary importance are other euphausiids and an amphipod. Blue whales feed primarily during the summer. Eighty-five percent of all whales taken during the summer in the Antarctic contained recently ingested food, whereas less than 50 percent taken in the winter contained food (Lockyer 1976). The fact that blue whales have fresh stomach contents in the evening and early morning hours suggests that they may feed at night to correlate their feeding with the peak abundance of prey in surface waters. Passage of food takes from 14 to 15 hours. The composition of *Euphausia superba* is about 78 percent water, 5 percent ash and chiton, 4 percent crude fat, and 13 percent crude protein, for a total caloric value of 1 000 kilocalories per kilogram of whole wet krill. Zenkovich (1937—quoted by Lockyer 1976) estimated that blue whales in the Antarctic daily consume 4000 kilograms of krill per animal. Klumov (1963) estimated that Antarctic baleen whales consume 30 to 40 grams per kilogram of body weight per day during a 120-day feeding season, and for the remainder of the year consume an average 3.5 grams per kilogram of body weight per day. Blue whales may gain 50 percent of their weight while in their summer feeding grounds (Lockyer 1976).

Reproduction: In the Antarctic, males become sexually mature at an average length of 22.5 meters, whereas females mature at about 24 meters. Before 1930, blue whales were mature at about 10 years of age. After the heavy exploitation of the mid-1930's, the age of sexual maturity dropped to 6 or 7 years (Gambell 1975).

Between 1925 and 1931, 48 percent of the adult females were pregnant. Between 1932 and 1941, 66 percent of the adult females were pregnant. The latter estimate seems exceptionally high since mature females are thought to give birth to a single calf once every 2 or 3 years. Since the mid-1950's, however, the pregnancy rate has stabilized at about 53 percent.

The calving season is in winter. Mating may occur throughout the year, although a sharp peak in mating activity has been observed in blue whales in the Antarctic during July (Tomilin 1967). The gestation period is estimated to be 11 or 12 months.

Economic status: Blue whales were once the most sought after of the baleen whales for their high yield of oil. The blubber depth (measured at the flank above the navel) ranges from 81 to 150 millimeters. A combination of the blue whale's large surface area and the depth of its blubber made this animal the most highly prized target for the whaling industry. Tomilin (1967) estimated that the difference in size between blue whales in the northern hemisphere and the southern hemisphere accounted for their different average yields of 16.7 and 22.2 metric tons of oil per whale, respectively.

Between 1911 and 1938, American whalers along the Pacific coast of North America took 31,475 whales, of which 3,536 (11.2 percent) were blue whales. By 1938, the number of blue whales had decreased so much worldwide that the catch continually dropped in successive years. Although this lower number of blue whales precluded whaling exclusively for them, whalers continued to take blue whales whenever possible while seeking other more abundant species as their principal targets.

Early attempts to reduce killing of blue whales included a 1937 regulation that prohibited taking blue whales below 70% latitude. Hunting of blue whales in the north Atlantic and adjacent arctic waters was prohibited by the International Whaling Commission from 1955 to 1959, although Denmark and Iceland objected and continued hunting until 1960, when complete protection for whales in these areas was established. In 1965, the International Whaling Commission voted to prohibit harvesting of blue whales, but Japan objected and was granted a quota of 20 whales. They were unsuccessful in obtaining blue whales that season, and in 1966 they agreed to the complete protection of blue whales which continues to the present (1981).

Since the United Nations Conference on "Man and His Environment" held in Stockholm, Sweden, in 1972, the blue whale has become a symbol of humanity's questionable compatibility with the oceans and the environment as a whole.

Mortality: Blue whales may live more than 40 years. Harvesting by humans has been prohibited by international regulation since 1966; therefore, most mortality is due to natural factors. Whether the diatom films adhering to the whale's skin and giving it a yellow cast cause blue whales any difficulty is not known. The darker yellow whales are thought to have spent more time in cold waters; they are also generally "fatter" whales.

Among the diseases documented in blue whales are several cases of exostoses (bony growths) of the sternum, scapula, hyoid bone, chevron bone, and caudal vertebrae and one case of fibropapillomatous growth on the pleura as a result of pleurisy or pulmonary abscess.

Selected references: Gambell (1975), Gulland (1976), Rørvik and Jonsgard (1975), Small (1971), Tomilin (1967).

Species *Balaenoptera physalus:*
Fin whale or finback whale

Derivation: The specific name *physalus* is derived from the Greek word *physalos* (a kind of whale).

Specific description: Adult males reach a length of 24.4 meters in the Antarctic but are somewhat smaller in arctic waters (Tomilin 1967). Adult females reach a length of 27.3 meters in the Antarctic and only 24.4 meters in the Arctic. Male blue whales in the Arctic may weigh up to 89 metric tons and the females 100 metric tons. Newborn calves average 6 to 6.5 meters in length and weigh about 2.2 metric tons. Fin whales are the slenderest of the rorquals. Fin whales vary from gray to dark gray on their backs, but without the mottling of blue whales or the scaling frequently seen on sei whales. The ventral surface of the flippers and flukes is white. The right lower lip and the right baleen are also white, but the rest of the head is gray and the left baleen is alternately striped with bands of yellowish white and bluish gray. There are 260 to 475 baleen plates along each side of a fin whale's mouth, some of which may reach 90 centimeters in length (Tomilin 1967). Throat grooves extend from the tip of the chin to beyond the umbilicus. The blow is a fairly compact V-shape. The head is V-shaped and about one-fourth the body length. The dorsal fin is from 35 to 53 centimeters in height, slightly curved backward, and located in the last one-third of the whale's back (Leatherwood and Reeves 1981).

Abundance and distribution: Fin whales are widely distributed throughout the world's oceans. In the Pacific Ocean, the wintering grounds are not well known but are reported to be from central California to Cabo San Lucas at the southern tip of Baja California, Mexico. They are apparently most abundant during the winter around the California Channel Islands. Their summer range, however, extends from California to the Chukchi Sea in the eastern north Pacific.

Gambell (1975) theorized that there are eight stocks of fin whales in the southern seas, and Rørvik and Jonsgard (1975) suggested that there are six stocks in the north Atlantic. Four stocks are suspected to be in the north Pacific in the east China Sea, western north Pacific, eastern north Pacific, and Gulf of California.

Fin whales generally spend the summer feeding in polar waters and the winter in more temperate latitudes where they breed and give birth. In the southern hemisphere, fin whales feed in the latitudes between 47" and 60°S in the summer and are found from 20" to 40°S in winter.

The American fin whale stock of the north Pacific migrates from lower Baja California to the Bering Sea, appearing at Vancouver Island about March (Tomilin 1967). When this species was harvested, the main whaling season off California, Washington, and Oregon was usually from May to September. Gambell (1975) reviewed the population estimates of fin whales and estimated the world population to be 107,000 (inclusion of immature whales too small to harvest would probably increase this estimate by 50 percent) in contrast to the pre-exploitation estimate of 470,000. Seventy-five percent of this population is in the southern hemisphere, whereas 9 percent and 15 percent are found in the north Atlantic and north Pacific. The latest estimates on trends and abundance indicate that

numbers of this species have declined because of hunting, to a point that stocks in the north Pacific and southern oceans are below their maximum sustainable yield levels. The exploitable population in the north Pacific is estimated to be between 17,000 and 19,000 individuals (Brownell et al. 1978).

Habits: Fin whales are one of the fastest of the baleen whales, with speeds recorded up to 37 kilometers per hour. As a result, they were not commercially exploited until the development of steampowered catcher boats. Also because of their speed, few fin whales are attacked by killer whales. This species often forages at 3.2 to 4.8 kilometers per hour, and migration speeds have been reported at 8.9 to 10.0 kilometers per hour. During the time the species was whaled commercially, there was one report of a fin whale pulling a whaling ship at 3.2 to 4.8 kilometers per hour.

Fin whales travel in groups or pods of 2 to 5 animals, although up to 35 have been observed. Fin whales do not usually breach unless wounded or excited.

Food: Apparently fin whales return to the same feeding areas year after year. In the Antarctic, they feed primarily on krill (*Euphausia superba*) which reaches 3 to 4 centimeters in the 1st year class and 5 to 6 centimeters in the 2d year class (Tomilin 1967). Antarctic fin whales rarely feed on fish or cephalopods. Feeding is much more varied in the northern hemisphere where fins feed primarily on euphausiids and secondarily on fishes and cephalopods. In the north Pacific, two genera of euphausiids, herring, and one species of cephalopod have been found in the contents of stomachs. In the north Atlantic, the fin whale's diet changes with the seasons and the availability of certain prey species (two species of euphausiids, a copepod, herring, capelin, cod, mackerel, and sand lances). In Asian waters, fin whales eat a euphausiid species and a variety of fishes, including herring, capelin, Pacific sand lance, Arctic cod, saffron cod, walleye pollock, Pacific cod, mackerel, rockfish, and chum salmon.
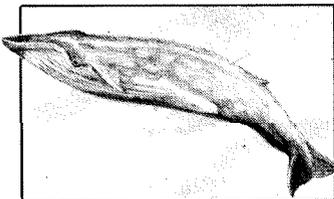
FINBACK WHALE

Fin whales move faster and more erratically when feeding on fishes; they lunge and turn over on their backs, presumably to retain more fish in their mouths than would be possible in a belly-down position. They usually swim slower when feeding on crustaceans. The fin whale frequently swims on one side with its mouth open when feeding. Kawamura (1974) estimated the daily food requirement of fin whales at 4.07 percent of their body weight.

Reproduction: Fin whales become sexually mature between 6 and 12 years of age. Males are mature when they are 17.7 meters in length, females at 18.3 meters (U.S. Department of Commerce 1978). Adult females are thought to give birth once every 2 to 3 years. It has been postulated that the pregnancy rate of sexually mature females may reach 60 percent. Both the birth and the mating season are in winter, although the latter may take place year round. Presumably females either calve or mate during alternate years. The gestation period is 11 to 12 months. The female suckles her young for 6 to 8 months.

Economic status: Fin whales were the principal target species of the whaling industry after the decline in the catch of blue whales. Despite scientific advice that these populations were approaching their maximum sustainable yield levels in the 1950's, quotas were not adjusted downward sufficiently to prevent their over-exploitation. Fortunately, a change in the demand for whale products, from oils to edible proteins, resulted in a shift of the whaling industry's efforts to the harvest of sei whales. The International Whaling Commission mamagement program effective at that time allowed three times as many sei whales as fin whales to be taken to reach a nation's quota, which was given in blue whale units (BWU). This relieved the pressure on the stocks of fin whales throughout the world. Fin whales are now completely protected except for one stock in the north Atlantic. Stocks in the north Pacific and southern oceans are still below maximum sustainable yield levels and are fully protected by the International Whaling Commission.

Historically, this species' blubber was used for soap, margarine, lard, lubricants, tanning oils, and fabric cleaners. The liver of fin whales has been used in the production of vitamin A.

Mortality: Little is known of direct predation on fin whales.

Stolk (1954) described an inflammation involving necrosis and calcification of the intercostal musculature in the adult female (Tomilin 1967).

Selected references: Gambell (1975), Leatherwood and Reeves (1981), Tomilin (1967), U.S. Department of Commerce (1978), Yablokov et al. (1974).

Species *Balaenoptera borealis:* Sei whale

Derivation: The specific name *borealis* is the Latin word for northern.

Specific description: Adult males reach a maximum length of 17.1 meters in the northern hemisphere and 17.7 meters in the Antarctic (Tomilin 1967). The average length in the northern hemisphere is 12.6 meters. One male, 13.6 meters long, weighed 16 080 kilograms. Adult females reach a maximum length of 18.6 meters in the northern hemisphere and 21 meters in the Antarctic; the average length of females, however, is 13.3 meters and the average weight 145 metric tons. Sei whales are gray to dark gray and may have a bluish tinge. The belly is lighter in color and may have white spots, but the white does not extend forward to the chin or posterior of the throat grooves. There are 32 to 62 throat grooves, but they do not extend as far as the umbilicus. Some of the white spots are attributed to lamprey scars. Neither the flippers nor the flukes are white underneath. The dorsal fin is taller than in the blue whale and more falcate (sickle shaped) than in the fin whale (Leatherwood and Reeves 1981). The baleen plates are black with a grayish white fringe and are more elastic and finer than those of other rorquals. The blow is not as tall as that of the blue whales.

Abundance and distribution: Sei whales are nearly worldwide in distribution but appear to favor more temperate waters than do fin whales. Their distribution, however, takes them seasonally into the ice of the north Atlantic, Chukchi Sea, and the Antarctic. In the latter, the sei is rare everywhere except around South Georgia (east of the southern tip of South America), where it is abundant in late summer and autumn when the water is warmest. In the southern hemisphere, the sei whale summer distribution is generally south of latitude 30°S. The winter distribution is north of 40°S. In the north Atlantic, sei whales are found from New England and the British Isles to the Arctic Ocean, wintering in the lower latitudes. There are two stocks in the north Pacific-eastern Pacific and western Pacific. The eastern stock is found from Alaska to Mexico and is not considered common north of the Aleutian Islands. The sei is found off central California in the late summer or early fall and appears to move farther south and offshore (southern California to Islas Revillagiges, 320 kilometers south of Baja California, Mexico) in the winter (Leatherwood and Reeves 1981).
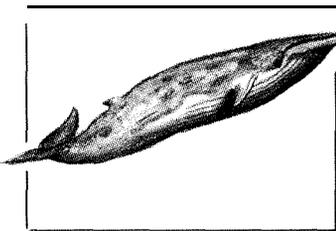
Of the 15,985 whales taken between 1919 and 1929, 704 were sei whales in the eastern Pacific; 11 were taken off the Alaska peninsula, 529 off British Columbia, 19 off Washington, 47 off California, and 98 off Baja California. Although this species seems to be abundant off British Columbia, it is even more abundant off Japan and Korea but is reported to be rare near Kamchatka and Chukot Peninsula. Sei whales usually migrate south in antarctic waters during the summer later than the other baleen whales, and their return to tropical and subtropical seas for winter breeding does not extend into the higher latitudes as does that of other baleen whales (Rice 1974).

Gambell (1975) estimated a harvestable pre-exploitation population (mature adults) of about 150,000 sei whales in antarctic waters. Addition of immature animals would increase this estimate by 50 percent. He estimated the 1972 to 1975 exploitable population at 50,000 to 55,000. In 1978, the IWC estimated the north Pacific population at 9,000 animals and 101,000 animals in the southern hemisphere. No estimates are available for the north Atlantic. All north Pacific stocks have been protected by the International Whaling Commission since 1975, and some north Atlantic and antarctic stocks are also protected. Some non-IWC countries have been accused of taking some sei whales in protected areas.

Habits: This species usually travels in pods of two to five individuals. Although some additional information on behavior of sei whales may be found under "Food," little is known of this whale's pelagic habits.

Food: The food of sei whales varies seasonally and geographically. In the Antarctic, these whales feed on four species of copepods, one species of amphipod, eight species of euphausiids, six species of fishes, and one species of decapod crustacean. In the northern portion of the northern hemisphere, they feed mainly on copepods; in lower latitudes, euphausiids, copepods, sauries, anchovies, herring, sardines, squid, and jack mackerel make up the major portion of their diet (U.S. Department of Commerce 1978). Sei whales do not appear to be well adapted for feeding on fishes as are fin or humpback whales. They chase fish at the surface without making sudden rotations around their body axis. When catching crustaceans, however, the sei whale swims slowly at approximately I-meter depth and rolls gently from side to side every 15 to 20 meters so that the upper margin

SEI WHALE

of each lip alternately touches the surface. After about 7 minutes of such activity, the whale rolls over on its side. Kawamura (1974) estimated that 150 to 1 000 liters of prey (110 to 885 kg) were consumed per day. The daily ration for the species is about 4.4 percent of the body weight.

Reproduction: Sei whales become sexually mature between 6 and 12 years of age. Males become sexually mature at 12 to 13.1 meters in length, whereas females are mature between 12.8 and 13.7 meters. Mating may occur throughout the year but appears to be concentrated in the winter. Pregnancy rates indicate that mature females bear calves every 2 or 3 years after a l-year gestation period, so the primary birth season is also winter. After a nursing period of 5 to 7 months, calves are weaned and are 8 to 9 meters long.

Economic status: Sei whales have been harvested most intensively since the 1960's, although harvesting rates dropped appreciably in the 1970's, probably because of refined methods of determining quotas. The species became commercially important under the old blue whale unit management system, under which one blue whale unit equalled six sei whales. This meant that each sei whale yielded about one-sixth the oil that a blue whale would yield. A sei whale yields one-third the oil a fin whale yields. The meat of sei whales is considered the best of all the rorquals and is canned or frozen for human consumption in Japan and many Scandinavian countries. The changed emphasis of the whale industry for meat, rather than oil, made this species attractive when management quotas were expressed in blue whale units. The baleen was considered the most elastic and supple of all the rorquals and had several commercial uses. Even before it became conventional practice on all species of whales, the bones of sei whales were boiled and used for cattle meal and fertilizer. The subcutaneous collagenous tissue was used in manufacturing leather.

Mortality: Nothing could be found regarding predation on sei whales. Sei whales have been found, however, without baleen and this is thought to be the result of a contagious disease (Rice 1974). Affected animals are still able to feed on anchovy, mackerel, and saury, and otherwise appear healthy.

Selected references: Gambell (1975), Tomilin (1967), U.S. Department of Commerce (1978).

Species *Balaenoptera acutorostrata:*
Minke whale or little piked whale

Derivation: The specific name *acutorostrata* is derived from the Latin words *acutus* (sharp or pointed) and *rostrata* (snout or beak).

Specific description: In the Newfoundland area, adult males average 6.8 meters in length. Adult females in the northern hemisphere have been measured to 10.5 meters in length, although the average is 8 meters. One female, 8.7 meters in length, weighed 5.6 metric tons (Tomilin 1967). Newborn calves range between 2.1 and 2.8 meters in length. Minke whales are dark gray on the back with a lighter gray on the sides, white on the belly and underside of both the flippers and flukes.

There can be a distinctive difference in coloration between minkes in the northern hemisphere and minkes in the southern hemisphere. In the northern hemisphere, minke flippers have a distinctive horizontal white band. In the southern hemisphere, the flipper band is absent in some whales. The dorsal fin is relatively large and curved posteriorly. There are between 50 and 70 pleats or grooves along the throat. The baleen is short (less than 0.3 m in length), coarse, and white or yellow (Leatherwood and Reeves 1981). The blow is not pronounced, and it is impossible to identify this species from it alone.

Abundance and distribution: The minke whale is cosmopolitan in its distribution, although it is only seasonally found in equatorial waters. Three geographically isolated populations are recognized: north Pacific, north Atlantic, and southern hemisphere. Most minke whales migrate between high latitude summer grounds and low latitude winter grounds. At least three stocks are suspected in the north Pacific. In the eastern Pacific, minke whales are found from the Chukchi Sea to central Baja California, Mexico, and are most common in Alaska waters. The winter range extends from central California nearly to the equator; the greatest abundance is near the California Channel Islands (Leatherwood and Reeves 1981). Because this species has not been extensively hunted, few estimates of population have been made. Most estimates have been made in the Antarctic on the basis of visual sightings. Prior to whaling, the exploitable population in the southern hemisphere was estimated to be approximately 183,000 whales and in 1978, 157,000 individuals (U.S. Department of Commerce 1978). The north Pacific population is thought to be stable.

Habits: Minke whales are frequently solitary animals and are found near shore. In the Antarctic, they are found closer to the ice edge than are other baleen whales. They may congregate in areas of concentrated food in polar seas. The largest aggregation observed, however, was 100 animals in the southern hemisphere. During summer feeding, sexually mature females without calves migrate to higher latitudes than do lactating or immature females.

Minke whales are thought to be slower swimmers than other rorquals and are easier to approach by boat. Minke whales frequently approach ships, apparently out of curiosity. This species seldom shows its flukes when diving.

Food: Minke whales feed in the Antarctic primarily on euphausiids and copepods. In the northern hemisphere, the species eats euphausiids and many small fishes, including cod, pollock, capelin, anchovy, herring, and sand lances, as well as dogfish and squid (Mitchell 1973). Kawamura (1974) estimated that the daily ration of minke whales was approximately 3.84 percent of their body weight. Mitchell and Kozicki (1975) estimated the growth of minkes in the Newfoundland fishery at

$L_t = 8 \text{ m } (1 - e)^{-0.25(t - 3.2)}$; ($L_t$ = length at time t in years).

Reproduction: Minke whales become sexually mature at about 7 to 8 years of age in the northern hemisphere which corresponds to a length of 7 meters for males and 7.9 meters for females. Females are thought to give birth every other year once they become sexually mature. Near Japan, mating may take place from December through March. The gestation period is 10 to 11 months, and the calving season is early to midwinter.

Economic status: The meat of minke whales is highly regarded as food for humans. Tomilin (1967) reported that an 8.7-meter female yielded 400 kilograms of blubber, about 2 400 kilograms of meat, and approximately 1.1 metric tons of oil. The subcutaneous layer of collagenous tissue is suitable for the manufacture of high quality leather.

The killing of minke whales increased in the late 1970's because of the reduced quotas for larger baleen whales. Between 1938 and 1954, Norway took 37,716 of this species, more than any other nation. Before the 1970-71 whaling season, fewer than 2,000 minke whales were caught per year. The next four seasons showed the increased importance of this species in the antarctic harvest when 3,054, 5,745, 7,713, and 9,522 were taken. In 1975, the number of whales reported caught in the following locations were: north Atlantic, 1,969; Japan, 376; Brazil, 1,039; South America, 110; and Antarctic, 6,034 (International Whaling Commission 1976).

Mortality: Predation of killer whales on minke whales appears to be fairly common in the north Pacific and in the southern hemisphere. Sharks are also considered potential predators. Mitchell (1975) cautioned that development of the antarctic krill fishery may affect populations of minkes in that area. In Newfoundland, minkes have been caught with trawl netting embedded in their snouts, but it is not known how many of the whales are incidentally captured during such operations.

Selected references: Mitchell (1975), Sergeant (1963).

Genus *Megaptera:* Humpback whale

Derivation: The generic name *Megaptera* is derived from the Greek words *megas* (great) and *pteron* (wing). The name refers to the large flippers of this genus.

General description: Same as that under species.

World distribution: Same as that under species.

Number of species along the Oregon coast: One.

General reference: Same as that under species.

Species *Megaptera novaeangliae:* Humpback whale

Derivation: The specific name *novaeangliae* is derived from the Latin words *novus* (new) and *eangliae* (origin of spelling unknown) which refers to England. So the specific name refers to the New England area.

Specific description: Adult male humpbacks may reach 15.0 meters in length in the north Pacific. One adult male 13.75 meters long weighed 40 823 kilograms. Adult females reach 18 meters in length (15.8 m in the north Pacific) (Tomilin 1967). Newborn calves measure 4.5 to 5 meters in length. Humpback whales are generally uniform black over the back and sides but may seasonally have a

brownish cast. Barnacles and whale lice, commonly found as external parasites, may cause a mottled appearance. The belly is white, and occasionally the underside of the fluke is white. The ventral aspect of the flipper is frequently white, and in some animals the entire flipper is white. The flippers may extend to one-third the body length and are somewhat curved, often with a scalloped forward edge. The small, hooked dorsal fin is typically back two-thirds the length of the whale (Leatherwood and Reeves 1981). The dorsal surface of the head is flat in front of the blowhole and has knoblike projections along the midline and edge of the rostrum. The humpback has from 12 to 36 throat grooves (Tomilin 1967). When the whale feeds, its lower jaw can form a 90" angle with the upper jaw. The baleen is black and less than 90 centimeters long.

Abundance and distribution: The humpback whale is found in both the northern and southern hemispheres, from tropical waters to the edge of the polar pack ice. Three geographically isolated populations are recognized: north Pacific, north Atlantic, and southern hemisphere. Each may have several completely distinct stocks. Each stock is thought to return annually to its traditional mating area. In the eastern Pacific, humpbacks have been observed from the Chukchi Sea to southern Mexico. Leather-wood and Reeves (1981) indicated that the major breeding and calving grounds in winter are off Hawaii, off both coasts of Baja California from Cedros Island in the Pacific and Isla San Jose in the Gulf of California to Islas Tres Marias, San Benedictio, Soccorro, and Clarion (islands south of Baja). The summer range of the eastern Pacific humpback is from the Chukchi Sea to southern California. This species formerly was caught off the Pacific Northwest coast between April and October; the bulk of the catch occurred in June, July, and August (Tomilin 1967). American whalers in this area killed 788 humpbacks from 1913 to 1915 and 1918 to 1919. Data on catch per unit efforts suggest a reduction in stock of 99 percent off California between 1956 and 1965 (Rice 1974). The 1978 north Pacific population was estimated to be about 1,000 individuals (U.S. Department of Commerce 1978). The best known seasonal populations occur off Lahaina, Maui, in Hawaii during the winter (about 800 individuals) and in southeast Alaska in the summer. The western north Atlantic stock is estimated to be about 1,000 animals and is seasonally abundant in the Bahamas. The southern hemisphere originally had an exploitable population of about 100,000 but in 1978 was estimated to be approximately 2,500 individuals (Chapman 1974a). Humpbacks have been totally protected by the International Whaling Commission since 1966. There is as yet no indication that these populations have increased as a result of protection.
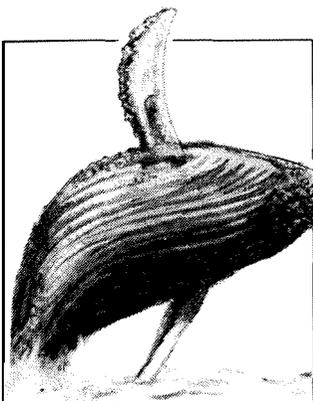
Habits: Humpbacks are perhaps best known for their spectacular breaching behavior underwater vocalizations. When breaching, an animal may come almost completely out of the water. Although other whales breach, humpbacks usually expose their very large white flippers, allowing positive identification. Individual whales frequently breach repeatedly. Slapping the water with the flippers or flukes is also common.

HUMPBACK WHALE

Underwater vocalizations ("songs") of humpback whales have been analyzed by Payne and McVay (1971). Each song is composed of lyrical segments that are repeated in the same sequence time after time. These songs have regional dialects that undergo minor changes from year to year (Payne 1979). Humpbacks also commonly follow ships.

Food: The humpbacks prey are basically benthic and pelagic (open ocean) euphausiids and small schooling fishes. The predominant prey in the Antarctic is krill. Tomilin (1967) summarized feeding habits in several oceanic areas, including the north Pacific, where he related the findings of Zenkovich (1937). In these studies, the stomach contents of humpbacks were examined and 48 percent were found to have fish, 9.6 percent with fish and pelagic crustacea, 10 percent with fish and benthic crustacea, 2 percent with just pelagic crustacea, and 32 percent with only benthic crustacea. Humpbacks have also been observed pursuing pink salmon near the Kurile Islands (northeast of Japan).

When feeding, humpbacks sometimes swim sideways with their mouths open, similar to fin whales. While feeding on crustaceans, humpbacks have been observed swimming in ever tighter concentric circles that concentrate the prey; the whale then turns on one side and cuts through the middle of the prey. A modification of this technique has been observed in southeast Alaska-whales expel air underwater while circling herring. This technique is called "bubble net feeding" and ends with the whale rising vertically through the center of the concentrated fishes with its jaw agape at 90" and its throat grooves bulging with water and fish. When chasing fish, a whale moves rapidly and suddenly with a distinct rotation around its body axis.

Reproduction: Sexual maturity is thought to occur between 6 and 12 years of age (U.S. Department of Commerce 1978). In the northern hemisphere females mature at 10 to 12 meters in length and males at 10 to 11.5 meters. In the southern hemisphere, whales are somewhat larger at sexual maturity; females are 11.6 to 12.5 meters in length and males 11 to 12 meters. Females do not give birth in successive years. In the northern hemisphere mating occurs from October to March, but in the southern hemisphere it occurs between April and September. The gestation period is from 12 to 13 months, and young are born from October to March in the northern hemisphere. Suckling probably lasts for 11 months, but its duration may vary.

Economic status: Although hunted extensively in the late 19th century and early 20th century, humpback whales are now fully protected by International Whaling Commission regulations, with the exception of small subsistence whaling efforts in Greenland, the Lesser Antilles, and the Tonga Islands. During the time humpbacks were extensively hunted, their blubber was considered typical of rorquals, their meat edible, but the whalebone inferior. The yield of oil was 3.3 to 6.6 metric tons and averaged 40 percent less than a blue whale's. Today the seasonal presence of humpbacks around the Hawaiian Islands and southeast Alaska attracts many tourists, but there is concern that the harassment in Hawaii from such activity may affect the reproductive success of this population.

Mortality: Little is known about the possible predators of humpbacks, nor is much known about their diseases.

Selected references: Earle (1979), Payne (1979).

**Family Physeteridae:
Sperm Whales**

Derivation: The familial name Physeteridae is derived from the Greek word Physeter (a blower) and the Latin suffix *idae* (family). The name refers to the whale's blowing or spouting when it exhales at the surface of the water.

General description: Members of this family are characterized by a large, bulbous head. The upper skull, adapted to house the organ from which spermaceti oil is obtained, is concave, with a broad asymmetrical rostrum. The blowhole is S or U shaped and positioned on the left side near the front of the head. The neck vertebrae are fused, except the atlas (first vertebra behind the head). The upper jaw is without functional teeth, but the lower jaw has well-developed, large, conical teeth. The lower jawbones join together in the front, forming the mandibular symphysis, which is quite long in members of this family, increases in length with age, and may ultimately account for one-third of the whale's length.

World distribution: Except for the pack ice in polar regions, sperm whales are distributed worldwide.

Fossil record: In the north Pacific, the fossil record for this family dates to the middle Miocene.

Number of species along the Oregon coast: Two.

General references: Berzin (1971), Tomilin (1967).

Genus Physeter: Sperm whale

Derivation: The generic name Physeter has the same meaning as does the familial name, but without the family designation.

General description: Since there is a single species in this genus, see the species description.

World distribution: Same as that under species.

General references: Same as those under species.

Species *Physeter* catodon: Sperm whale

Derivation: The specific name catodon is derived from the Greek words *kata* (downward or inferior) and *odontos* (a tooth). The name refers to the fact that this species has functional teeth only in the lower jaw.

Specific description: Sperm whales are the largest of the Odontoceti (toothed) whales. Adult males grow to 16.8 meters in length, although the average in the northern hemisphere is 14.6 meters and 37 metric tons in weight. Adult females grow to 11.7 meters in length and weigh 18.5 metric tons. Newborn calves range from 3.5 to 5 meters (average 4 m) in length and weigh about 1 000 kilograms (Berzin 1971). Adults are a uniform gray or dark brownish color, often with light spots. The belly and chin are often a lighter gray or white. Scars and abrasions are frequent, some of which may be the result of parasites, wounds, and disk-shaped sucker marks of cephalopods, such as squids. The skin is often wrinkled, giving it

a shriveled appearance. The dorsal fin is perhaps best described as a hump, followed by a series of three or four "knuckles" (Benin 1971). The flippers appear small compared with the size of the body. In contrast, the flukes are broad and thick (Leatherwood and Reeves 1981). A sperm whale's huge head-one-third the length of the body-is unlike any other. The head has a squared-off appearance with a large frontal area (forehead) that is slightly constricted in the center, forming an hourglass shape. The blowhole is located on the left forward edge of the head and is S shaped. The blow is characteristically forward at a sharp angle because of the configuration and location of the blowhole. The lower jaw is narrow, toothed, and does not run completely to the front of the head. The upper jaw lacks teeth but has sockets into which the teeth in the lower jaw fit when the mouth is closed.
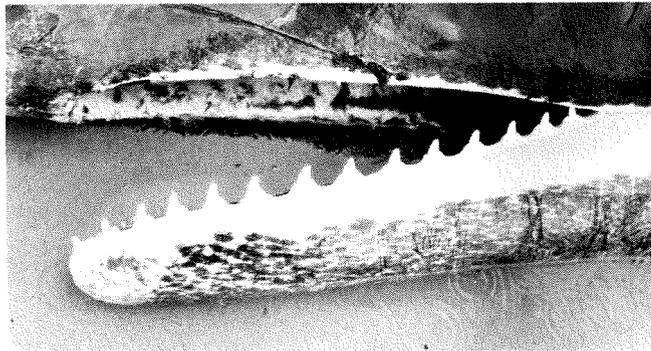
Abundance and distribution: The sperm whale is worldwide in distribution, except for the pack ice of polar regions. Female and immature whales are generally found between 40°S and 50°N. Like baleen whales, this species migrates toward polar regions during summer and to more temperate regions during winter. In the north Pacific, groups of males of specific ages and sizes move farther north than do females, reaching the Bering Sea and the Sea of Okhotsk. Sperm whales are managed by geographic location. Best (1975) indicated that there are three stocks in the north Pacific: western (west of 170°E longitude), eastern (east of 150°W longitude), and central (between 170°E and 150°W longitude). In the north Pacific, the animals summer predominantly in the southwest Bering Sea and the northern Gulf of Alaska, but a few may be scattered as far south as southern California. During the winter, they are usually found below 40°N latitude, and aggregations of breeding whales are generally seen along the continental slope of California, Baja California, and mainland Mexico (Leatherwood and Reeves 1981). Populations are estimated by several techniques, including sightings, "mark and recapture" density estimates using discovery tags, "catch-per-unit-effort" data, and a comparison of actual versus expected catches. In 1946, the world exploitable stock of males (greater than 9.2 m in length) and sexually mature females was estimated to be over 1 million, with approximately equal numbers of males and females. Tillman (1975) indicated that 72,000 males and 125,000 females were in the north Pacific.

The 1978 world population was estimated to be approximately 700,000, one-third of which were males. Estimates of exploitable populations by ocean systems are (Mitchell 1974, Chapman 1976, International Whaling Commission 1977):

	1946	1976
North Pacific	400,000	300,000
South Pacific	360,000	180,000
North Atlantic	22,000	22,000
South Atlantic	120,000	90,000
Indian	229,000	140,000

Sperm whales are seen off the Oregon coast (occasionally from shore) from March to September.

Habits: Females and immature males may form schools-frequently called harems-of 10 to 50 individuals (average about 45). Young, but sexually mature males (11 to 13.4 m in length and 15 to 25 years of age), may also form "bachelor" schools of up to 10 animals (U.S. Department of Commerce 1978). Older males (larger than 13.4 m in length and 22 to 27 years of age) may be solitary, except for a 5-month period in the spring and early summer when they join groups of females to breed. Growth in this species continues until 45 to 60 years of age. Sustained speeds of 13.0 to 22.2 kilometers per hour have been recorded for frightened sperm whales, and peak bursts of 37 kilometers per hour have been observed. Sperm whales are capable of dives lasting well over an hour, and they have become entangled in transatlantic telephone cables at depths of 900 meters (Berzin 1971). Sperm whales have been tracked to 2200 meters on sonar (Rice 1978). They appear to sleep soundly on the surface, and there have been many reports of ships running into them.

The first sperm whale taken by white whalers in America was killed in 1712, and the U.S. whaling industry peaked between 1835 and 1845 but then dropped off sharply (Kugler 1976).

Ambergris, a yellowish brown material, is apparently formed in the digestive tract of the sperm whale and is thought to be regurgitated. It was once as highly valued as gold for its use in quality perfumes. It was prized as a beachcomber's find and was sought after in the course of whaling activities. Natural as well as synthetic substitutes have been found, and this product no longer has a marketable value.

Food: The basic prey of sperm whales are fishes (38 species in the north Pacific, mainly demersal and mesopelagic) and cephalopods (25 species in the north Pacific, principally squid). The squid beaks found in the stomachs of sperm whales and disk-shaped sucker marks on their bodies indicate that sperm whales occasionally feed on squid longer than 18 meters. Benin (1971) reviewed the regional differences in feeding habits. Of those discussed, the species consumed in the California region are probably most relevant to the Northwest and include five deepwater squids and octopuses, as well as the brown cat shark, Pacific angel shark, sablefish, lingcod, and blue lanternfish. Kawakami (1976) reported finding five species of squid in eight sperm whales taken off the Pacific Northwest coast. Harvey (personal communication on file at Oregon State University

Marine Science Center, Newport, Oregon) found only squid and traces of lampreys in the stomachs of 39 of 42 sperm whales stranded or beachcast along the Oregon coast from 1978 to 1980. Nonfood items are also common in the stomachs of sperm whales and have included rubber hip boots, bundles of insulated wire, glass floats, plastic toys, coconuts, and wooden boxes (Tomilin 1967). Lockyer (1976) estimated the basal metabolic rate at 6.4×10^4 to 1.1×10^5 kilocalories per day and food consumption rates at 3 to 3.5 percent of body weight per day. Lockyer (1976) also calculated the net growth efficiencies of sperm whales of different age-size categories (in percent): calf, 20.6; sexually mature female, 4.5; puberty male, 6.1; sexually mature male, 3.1; and socially mature males, 2.8.
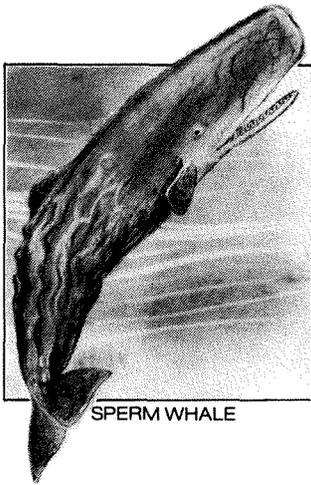
Reproduction: Sexual maturity in sperm whales falls within a range of 8.3 to 9.1 meters in length for females, corresponding to 8 to 11 years of age. For males, sexual maturity occurs at 10 to 12 meters in length, corresponding to an age of 10 or more years (Berzin 1971, U.S. Department of Commerce 1978). Sexually mature females bear calves once every 3 to 5 years. Although mating may occur throughout the year, the principal mating season in the northern hemisphere is from January to July, whereas in the southern hemisphere it is from July to December. The gestation period is between 14 and 17 months, resulting in births in the northern hemisphere from May to October and in the southern hemisphere from September to May (Berzin 1971). Of nine large females examined along the Oregon coast in July 1979, three had near-term fetuses (Mate, unpublished data on file at Oregon State University Marine Science Center, Newport, Oregon). Calves are weaned after 1 or 2 years at a length of 6.7 meters and an approximate weight of 2 800 kilograms. Sperm whales continue to grow until 45 to 60 years of age.

Economic status: The sperm whale industry in the United States began in the 18th century but did not blossom until the late 19th century. Internationally, sperm whales are now the most important species to the whaling industry for harvest by number and weight (not by value). The quota on this species was reduced in the late 1970's until it reached zero in 1980. The two most intensely harvested areas in the 1970's were the southern hemisphere and the north Pacific.

Sperm whale meat is oily and, therefore, generally not considered fit for human consumption. It is used, however, for animal food. The fatty acids are used in the production of soap, detergents, and cosmetics. The liver is a source of vitamin A, the teeth are used for handcrafts, particularly scrimshaw (Berzin 1971).

The most desirable product from this whale was spermaceti oil, which is not available in commercial quantities from any other whale. There is still a high demand for this oil because its high waxy-ester content allows it to hold up well under high heat and prevents foaming. Products of three cultivated plants appear to be suitable substitutes for spermaceti oil: crambe (*Crambe* sp.), meadowfoam (*Limnanthes alba*), and jojoba (*Simmondsia chinensis*). The latter grows in arid regions, including the Southwest United States and Mexico, but the others require a temperate climate and more moisture. Crambe and meadowfoam produce triglycerides, which must be converted to wax esters.

Mortality and diseases: Berzin (1971) indicated that diseases include periostosis of the jaw, subdermal tumors, and tooth deformities. Mass strandings of sperm whales have occurred worldwide without definitive diagnosis, including 41 individuals in July 1979 at Florence, Oregon. Individual strandings of adults have occurred in May, June, July, and August, and one newborn was found live in September.

Selected references: Benin (1971), Best (1975), Tillman (1975), Rice (1978).

Genus Kogia: Pygmy sperm whale

Derivation: The generic name *Kogia* is thought to be a proper name. The genus is thought to have been named after Cogia Effendi, who observed whales in the Mediterranean Ocean.

General description: The members of the genus Kogia resemble the larger sperm whale in that they both possess a large spermaceti organ that produces a large bulbous head, an inferior mouth, and an asymmetrical skull. Whales of the genus Kogia are, however, different from sperm whales; they have very small heads (about one-sixth to one-third the body length) and sickle-shaped dorsal fins. The blowhole is located above the eyes rather than at the front of the head as in the sperm whale, and there are 12 to 16 pairs of teeth in the lower jaw.

World distribution: Although whales of the genus Kogia are thought to be relatively rare, there are records of *Kogia* distributed worldwide in tropical and temperate oceans.

General reference: Handley (1966).

Species *Kogia breviceps:* Pygmy sperm whale

Derivation: The specific name *breviceps* is derived from the Latin *brevis* (short) and the New Latin word *ceps* (head). The name refers to the short head of this species.

Specific description: Adult males reach 4 meters in length, although the average is thought to be 2.9 meters for an approximate weight of 417 kilograms (Tomilin 1967). The average adult female is 2.5 meters in length. Calves are 1.1 meters in length at birth. Pygmy sperm whales are black dorsally with light gray or white ventral surfaces. The dorsal fin is small, curved, and located two-thirds of the animal's length from the head. The head is relatively short but robust, one-sixth to one-eighth of the total body length, and has a prominent spermaceti organ situated above the jaw and in front of the cranium (Handley 1966). The blowhole is shaped like a horseshoe and is located to the left of the midline toward the back of the head. The blow itself is hard to see, and identification of this animal at sea is difficult. The mouth is sharklike in appearance. The lower jaw does not extend to the front of the head and is narrow like that of the sperm whale. In the lower jaw are 12 to 16 pairs of slender, pointed, curved, functional teeth (Tomilin 1967). Some taxonomists place this species in its own family, Kogiidae.

Abundance and distribution: The pygmy sperm whale occurs primarily in tropical and warm temperate waters throughout the world. It is seldom sighted in colder waters. The eastern Pacific, the northern extent of its range, is represented by two animals cast on the beach in Washington State (Rice 1978) and one in Oregon (Mate, unpublished data on file at Oregon State University Marine Science Center, Newport, Oregon). In the Atlantic, it ranges north to Nova Scotia and The Netherlands. The only information available on seasonal distribution seems to coincide with that for the large baleen whales, indicating that this species moves toward the poles for food in the summer and returns to warmer waters to breed and give birth.

Habits: Information from whales stranded on beaches and pelagic observations indicates that these animals are usually shy and solitary; however, they have been observed in small groups of two to six (Mitchell 1975). No population estimates are available.

Food: The principal prey is squid, but pelagic crustaceans-such as shrimp and giant mysids—are also eaten. Data on feeding habits from France, The Netherlands, northern California, and New Jersey all support a strong preference for cephalopods (Tomilin 1967).

Reproduction: Females mature at an approximate length of 2.2 meters. Specimens have been examined which reveal pregnancy concurrent with lactation, suggesting that this species may give birth each year (U.S. Department of Commerce 1978). The gestation period is 9 months, although the calves are thought to accompany their mothers for about 1 year. There appears to be no distinct calving period, but there are records of newborn young in November, February, and throughout the spring.

Economic status: Pygmy sperm whales are occasionally taken (with a hand harpoon) in southern Japan. Although they are not the principal target of the whaling industry, they are taken as opportunity allows, about three to six per year (Mitchell 1975). The species may still be hunted, however, in the Timor Sea, Indonesia.

Mortality and diseases: No information could be found about mortality or diseases, although the species is found stranded in the western north Atlantic rather frequently.

Selected references: Handley (1966), Hubbs (1951), Rice (1978).

Family Ziphiidae: Beaked Whales

Derivation: The familial name *Ziphiidae* is derived from the Greek word *xiphos* (a sword) and the Latin suffix *idae* (family). The name refers to the slender rostrum in members of this family, hence the vernacular "beaked whales."

General description: Members of this family have a slender rostrum or beak and two throat grooves, although one or two smaller grooves may be present between the larger ones. Males have one or two pairs of teeth visible in the lower jaws, but the teeth in females and juveniles generally do not protrude above the gumline. Beaked whales have a dorsal fin set well back on the body, and small flippers. The flukes are not as deeply notched as in the Delphinidae.

World distribution: Although members of this family are rarely encountered, they are thought to inhabit temperate and tropical seas and some may be found in polar waters.

Fossil record: The fossil record for this family in the north Pacific dates to the middle Miocene.

Number of species along the Oregon coast: Four. (Three genera are known, but there is confusion about the number of species within the genus *Mesoplodon*.)

General references: Moore (1963), Scheffer and Slipp (1948).

Genus Mesoplodon: Middle toothed beaked whales

Derivation: The generic name *Mesoplodon* is derived from the Greek words *meso* (middle), *plos* (that from which something arises), and *odontos* (tooth). The name refers to the placement of the teeth in the middle of the lower jaws in some members of the genus.

General description: The genus *Mesoplodon* is comprised of a number of rare species that are difficult to distinguish from one another. What little information is known about these species was gleaned from individual beach-cast animals. Only species within the genus *Mesoplodon* that are known to have occurred along the Oregon coast are discussed.

World distribution: Members of the genus *Mesoplodon* appear to be distributed throughout the tropical and temperate waters of the north Pacific and north Atlantic Oceans.

General reference: Moore (1966).

Species *Mesoplodon s tejnegeri:*
North Pacific beaked whale

Derivation: The specific name *stejnegeri* is a proper name. The species was named in honor of Leonhard H. Stejneger (1851-1943), who was curator of biology at the Smithsonian Institution from 1911 to 1943.

Specific description: This species was first described from the skull of a specimen found at Bering Island in 1885, and the identification was confirmed from a specimen from Newport, Oregon, in 1904. The latter was 5.18 meters in length, and its skull is housed in the National Museum of Natural History.

Adult males reach 5.2 meters in length. Tomilin (1967) indicated that the body is black, although somewhat lighter on the abdomen. The area near the blowhole, anterior part of the back, and the anterior edge of the fins may be white or light gray. Linear or circular scars on the back may be from teeth marks of other whales or parasites. The species has a pronounced beak. Males have two broad teeth in the lower jaw. The teeth of females generally do not protrude above the gumline. The flippers are small, and the dorsal fin is curved toward the rear. This species is endemic to the north Pacific Ocean. In the western north Pacific, it ranges from the Commander and Pribilof Islands south to the Sea of Japan; in the eastern north Pacific-from Bristol Bay, the northern Gulf of Alaska, and south to Oregon. One male north Pacific beaked whale was stranded on the North Beach Peninsula, Washington, in 1980. Additional information on the biology of this species is lacking.

Selected reference: Moore (1966).

Species *Mesoplodon carlhubbsi:*
Hubbs's beaked whale or arch-beaked whale

Derivation: The specific name *carlhubbsi* is a proper name. The species was named in honor of Carl Hubbs (1894-1979), who was a marine biologist at Scripps Institution of Oceanography.

Specific description: Adults may exceed 5 meters in length. This species has been recorded from the Hokkaido coast of Japan in the western Pacific and from British Columbia to southern California in the eastern Pacific. Coloration is similar to the other members of the genus, in that these whales have dark backs and lighter bellies. Males have functional teeth in the lower jaw, but the teeth of females barely (if at all) protrude above the gumline. The dorsal fin is small and far back on the body. A specimen originally described by Roest et al. (1953) from a stranding at Oceanlake, Lincoln County, Oregon, was later thought to be *Ziphius cavirostris.* Little additional information is known about this species.

Genus Ziphius: Cuvier's beaked whale

Derivation: The generic name Ziphius has the same meaning as does the familial name, but without the family designation.

General description: There is only one species in this genus. The description is the same as that of the species.

World distribution: Same as that of species.

General reference: None.

Species *Ziphius cavirostris:*
Cuvier's beaked whale or goose-beaked whale

Derivation: The specific name *cavirostris* is derived from the Latin words *cavus* (hollow) and *rostrum* (a snout or beak).

Specific description: Adult males in this species may grow to 8 meters in length (Tomilin 1967). Adult females are somewhat smaller. Newborn calves are 2 to 3 meters long. The back varies from dark gray to reddish brown. An individual may be either darker or, more commonly, lighter below, with denser light-colored splotches on the belly. Older males frequently have a white head and are scarred (Leatherwood and Reeves 1981). Both males and females often have a single pair of erupted teeth in the tip of the lower jaw. The dorsal fin varies in shape but is most commonly of medium size and smoothly curved. It is located behind the midpoint of the back. The blow is small, indistinct, and not clearly visible at a distance.

Abundance and distribution: This species is found in all oceans except the Arctic and Antarctic. It is probably the most common beaked whale in the Pacific. Its range in the north Pacific is from the Commander and Aleutian Islands south to Hokkaido, Japan, in the western Pacific and to the tip of Baja California in the eastern Pacific. A stranded adult male was found at Oceanlake, Lincoln County, Oregon, in February 1952 (Roest et al. 1953). Another stranding occurred at Agate Beach, Lincoln County, Oregon, in 1976. Three additional Cuvier's beaked whales were stranded near Netarts, Oregon, in 1979 and 1980.

Habits: This species travels in tight schools of up to 10 individuals. Older males are often solitary.

Food: The species' food includes squid and deepwater fishes.

Reproduction: Mitchell (1975) indicated that males mature at about 5.4 meters in length and females at 6.1 meters, and Tomilin (1967) suggested that autumn is the principal calving season.

Economic status: The Japanese small whaling industry has taken this species for some time. Between 1948 and 1952, 51 males and 34 females were taken (Tomilin 1967). In 1953, 36 were taken (both males and females). From 1965 to 1970, the industry took from 13 to 60 animals per year, and from 1972 to 1977 between 13 and 16 were taken annually. Mitchell (1975) reported a small whaling industry for this species in the Lesser Antilles.

Mortality: Little information about mortality is known.

Selected references: None.

Genus Berardius: Giant bottlenose whale

Derivation: The generic name *Berardius* is a proper name. The genus was named after Dr. Bernard, a French physician who discovered the individual on which the generic designation was made.

General description: The members of this genus have two pairs of teeth situated in the lower jaw with some space between. When whales of either sex reach maturity, the two pairs of teeth usually erupt. The length of an adult is greater than 10 meters. One to four cervical vertebrae are fused.

World distribution: *Berardius* is found primarily in the offshore waters of the north Pacific and southern oceans, mainly near New Zealand.

Selected references: McCann (1975), Moore (1963).

Species *Berardius bairdii:* Giant bottlenose whale or
Baird's beaked whale

GIANT BOTTLENOSE WHALE

Derivation: The specific name *bairdii* is a proper name. The species was named in honor of Spencer Fullerton Baird (1823-87), founder of the U.S. National Museum of Natural History.

Specific description: Adult males reach 11.9 meters in length, and adult females may reach 12.8 meters (Pike 1956). Newborn calves measure between 4.2 and 4.5 meters in length. The species varies from light gray to almost black over the back and sides, with blotches of white along the ventral surface. Individuals are frequently scarred over the dorsal surface. White patches may be found around the umbilicus and around the genital openings of males. The fin is short and triangular or may be slightly curved back and located two-thirds to three-fourths of the way along the back. The head is bulbous and less than one-fifth of the body length. The lower jaw on adults extends past the tip of the upper jaw. In the tips of the upper jaw there are two pairs of teeth that may be exposed even with the mouth shut. The teeth are triangular and erupt in both males and females when they reach sexual maturity. The blow is low and indistinct.

Abundance and distribution: This species is limited to the north Pacific. Animals are primarily seen offshore around the Pribilof and St. Matthew Islands in the Bering Sea, south to Baja California. In the western Pacific, giant bottlenose whales
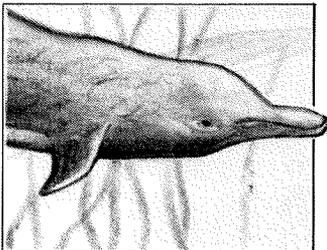
occur from Kamchatka and the Sea of Okhotsk to southeastern Japan (Mitchell 1975). Little is known of the seasonal distribution of this species. These whales have been sighted off northern California from June through October and off British Columbia in August (Leather-wood and Reeves 1981). Whaling records indicate that there may be some geographical segregation by sex at certain times of the year. Concentrations of animals, thought to be breeding aggregations, are found in Japanese waters north of 30°N in the summer and autumn (McCann 1975). These whales are caught from April through November; the peak is in July and August. No population estimates are available, and the animal is considered uncommon but not rare.

Habits: The species is principally found farther offshore than 16 kilometers where its in groups of up to 20 animals that are difficult to approach.

Food: This species eats squid, octopus, small bait fishes, and rockfishes, as well as some deep-sea fishes.

Reproduction: Males become sexually mature between 9.8 and 10.9 meters in length. The little data available for females suggest that they mature sexually between 10.0 and 10.4 meters (Tomilin 1967). These lengths correspond to an age of over 3 years. McCann (1975) indicated that most mating in the southern hemisphere takes place in February in contrast to the concentration of whales thought to breed in summer and autumn in Japanese waters. A IO-month gestation period results in most births occurring during December. No data are available on pregnancy rates, but it has been suggested that females probably give birth once every 3 years (Mitchell 1975).

Economic status: The principal whaling industry for giant bottlenose whales occurs in Japan, where 100 to 400 have been taken annually from 1958 to 1978. Between 1950 and 1958 the Canada whaling industry took 13; between 1959 and 1962 the U.S. industry took 8; and the Union of Soviet Socialist Republics (USSR) took a few individuals incidental to their pelagic whaling operations (Mitchell 1975).

Mortality and diseases: One observation of this species being attacked by a swordfish has been recorded; sharks and killer whales are presumed predators.

Selected reference: McCann (1975).

Family Delphinidae: Dolphins

Derivation: The familial name Delphinidae is derived from the Greek word *delphis* (a dolphin) and the Latin suffix *idae* (family).

General description: Members of this family have an asymmetrical skull. The blowhole on top of the head is crescent shaped. There are no throat grooves. Except for *Grampus* and *Monodon*, dolphins have numerous teeth in both the upper and lower jaws. The area where the lower jaws join (mandibular symphysis) is relatively short (less than one-third the length of the lower jaw). The dorsal fin varies in size and shape and is situated in the midback, except in the species *Lissodelphis* borealis, which has no dorsal fin. The flukes are deeply notched in the center of the posterior margin. The lateral projections (called processes) of the lumbar vertebrae are very large.

World distribution: The members of this family are distributed throughout the oceans of the world.

Fossil record: The fossil record for this family in the north Pacific dates to the middle Miocene.

Number of species along the Oregon coast: Eight.

General references: Leatherwood and Reeves (1981), Tomilin (1967).

Genus *Globicephala*: Pilot whale

Derivation: The generic name *Globicephala* is derived from the Latin word *globus* (a globe or ball) and the Greek word *kephale* (a head). The name refers to the bulbous forehead of this genus.

General description: The pilot whale is generally black, with a lighter area behind the doirsal fin. The bulbous forehead extends beyond the upper jaw in mature animals. The dorsal fin is located in the front half of the body, is curved, and has a long base. There are 8 to 12 pairs of teeth in each side of both jaws.

World distribution: The genus is distributed throughout the temperate and tropical waters of the world and in the southern hemisphere north of the antarctic convergence.

General reference: Reilly (1978).

Species *Globicephala macrorhynchus:*
Short-finned pilot whale, pothead whale, or pilot whale

Derivation: The specific name *macrorhynchus* is derived from the Greek words *makros* (long or large) and *rhynchos* (a beak or snout).

Specific description: Adult males reach 6.7 meters in length and adult females 4.9 meters (Orr 1972). Newborn calves range from 1.4 to 2.8 meters in length (Mitchell 1975). The species is completely black or dark brown, except for an occasional lighter area behind the dorsal fin. The dorsal fin, located in the forward half of the body, is thick, curved, and has a long base and a low profile (Leatherwood and Reeves 1981). The flippers are long, slender, and sickle shaped. The caudal peduncle is proportionately robust compared with most other cetaceans. The head has a prominent "melon" (a bulbous forehead) that extends beyond the upper jaw in mature animals. There is a slight depression around the crescent-shaped blowhole. There are 8 to 12 teeth in each side of both jaws (Orr 1972).

Abundance and distribution: Pilot whales are widely distributed in tropical and temperate seas of the eastern north Pacific where four population centers have been identified. Major currents and the migratory pattern of squid appear to influence the seasonal distribution of the whales (Reilly 1978). Pilot whales have been recorded from the Aleutians to Guatemala and may be found as far south as
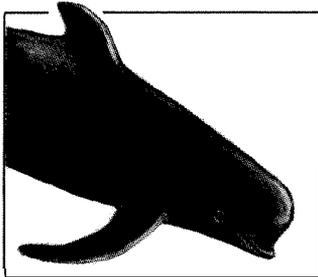
PILOT WHALE

Peru in the western Pacific. They have been observed in Hawaii and in the western Pacific as far south as northern Japan. In winter they are most common in the eastern north Pacific. The population may move north in summer and south in winter in response to water temperatures. There also is a population in the area of the Channel Islands that appears to migrate inshore where squid are spawning during the winter and spring (Norris and Prescott 1961). The species is usually found in deeper, offshore waters the remainder of the year.

Habits: Pilot whales are relatively slow swimmers, traveling in schools of up to 50 individuals at 7.4 to 9.3 kilometers per hour (Daugherty 1979). They rest or sleep by floating almost motionlessly at the surface. Large groups are often composed of smaller groups of two or three individuals. The species shows little fear of humans and will permit close observation by boat.

Orr (1972) speculated that the term "pilot whale" is derived from this whale's habit of following a "leader" and that this tendency may contribute to the mass strandings common to this species. Such strandings are usually on gently sloping shores. Possible explanations for mass strandings include either difficulties in echo-location or pathologic problems. The strong tendency for these animals to stay together also makes it possible for humans to drive them ashore where they can be killed and harvested (Mitchell 1975).

After observing captive animals, Norris and Prescott (1961) thought that the large, fatty melon may serve a protective function during mating behavior. A male and female swam head first into each other before pairing and swimming close to one another around the pool. Norris and Prescott also speculated that the melon probably does not extend beyond the jaw until sexual maturity, at which time it provides functional protection during these mating bouts.

Pilot whales adapt well to captivity and are on display at many oceanariums. The species also learns rapidly and has been used by the U.S. Navy for the recovery of objects from the ocean floor, at depths of 1 304 meters.

Food: Pilot whales eat cephalopods (particularly squids) and fishes, including clupeids and gadids. Daugherty (1979) reported that pilot whales in captivity eat 2.2 to 4.4 kilograms per day, depending on their size.

Reproduction: Females become sexually mature between 3 and 3.2 meters in length, but males mature at approximately 4.8 meters (Mitchell 1975). The apparent difference in the age of sexual maturity, as implied by length of body, is compensated for by the polygynous nature (one male mating with many females) of pilot whales, which requires fewer males. Mature females may give birth once every 2 years, but the average is once every 3 years (Mitchell 1975, Tomilin 1967). Walker et al. (1975) reported pilot whales breeding in warm water during winter with a gestation period of about 21 months; full term embryos have been found in spring, autumn, and winter (Tomilin 1967). Norris and Prescott (1961) indicated that the birth season is probably long, at least from August through winter. Young whales may nurse from 12 to 16 months (Tomilin 1967, Walker et al. 1975). Pilot whales have been known to live for 50 years (Walker et al. 1975).

Economic status: Norris and Prescott (1981) reported that pilot whales had been taken alive since 1955 from the Channel Islands off southern California for oceanariums. Mitchell (1975) discussed the Japanese whaling industry harvesting 890 individuals of this species in 1941 and 91 in 1971. A similar species, *Globicephala melaena,* is harvested in the Newfoundland area at the rate of 3,000 to 4,000 per year (Mitchell 1975). A smaller whaling industry occurs in the Lesser Antilles.

Mortality and diseases: Slijper (1931) found exostoses on spinal processes of dorsal vertebrae and the lower surface of the pectoral flippers.

Selected references: Mitchell (1975), Norris and Prescott (1961), Orr (1972), Walker et al. (1975).

Genus *Grampus:* **Grampus dolphin**

Derivation: The generic name *Grampus* is derived from the Middle French words *gras* (fat) and *pois* (fish). These French words, in turn, are from the Latin words *crassus* (thick or heavy) and *piscis* (a fish).

General description: There is a single species in this genus. The description of this genus can be found under the species.

World distribution: Same as that under species.

General references: Same as those under species.

Species *Grampus griseus:* Grampus or Risso's dolphin

Derivation: The specific name *griseus* is the Middle Latin word for gray.

Specific description: Adult males and females reach 4 meters in length. Newborn calves are dark gray and are 1.5 meters in length. Mature animals are light gray to white with a white head and numerous scars over the body. The sides of the body may have a tinge of blue or purple. The belly is white. Tail flukes and flippers remain dark on adults. The dorsal fin is tall, curved, pointed, and located in the middle of the back. The head is bulbous and has a shallow crease along the midline from the blowhole to the tip of the snout (Leatherwood and Reeves 1981). Three to seven pairs of teeth are found in the lower jaw, and one or two vestigial teeth are occasionally present in the upper jaw (Walker et al. 1975).

Abundance and distribution: This species is found throughout the world in temperate and tropical seas deeper than 180 meters. It is found from the Kurile Islands and British Columbia to Japan and Chile, and it has also been sighted near Hawaii. In the eastern Pacific, it is reported from Stuart Island, British Columbia, to Acapulco, Mexico, and offshore from Costa Rica. Its common range is from central California to Mexico, where it is sighted throughout the year. The range extends to the north during spring and summer when the water is warm. The most

recent sighting in the Northwest was by Stroud (1968) in Neah Bay, Washington. Sightings in the Northwest are most common during the summer. Although uncommon, the species is not rare throughout most of its range. This species was described as abundant in Monterey Bay in 1894.

Habits: Grampus dolphins are thought to be solitary. The species has been seen in small groups of up to 12, however, and occasionally in larger groups. Grampus are commonly seen repeatedly leaping clear of the water. Walker et al. (1975) described a famous member of this species named "Pelorus Jack" who from 1896 to 1916 frequently played about the bows of ships and "guided" them into Pelorus Sound, New Zealand, for which the animal received lifelong protection by order of the New Zealand Council.

Food: Grampus feed on cephalopods and fish (Walker et al. 1975). A beach-cast specimen found by Stroud (1968) in Neah Bay, Washington, contained four species of squid.

Reproduction: Males are thought to be sexually mature at a length of 3 meters (Mitchell 1975). The birth season is probably in December (Leather-wood and Reeves 1981). Individuals may live to 24 years of age (Mitchell 1975).

Mortality and diseases: Information on mortality is lacking for the species.

Selected references: Mitchell (1975), Stroud (1968), Walker et al. (1975).

Genus Orcinus: Killer whale

Derivation: The generic name *Orcinus* is derived from the Latin words *orca* (a kind of whale, the great killer) and *inus* (like).

General description: There is only one species in this genus, and the generic description is under the species.

World distribution: Same as that under species.

General references: Same as those under species.

Species *Orcinus* orca: Killer whale or orca

Derivation: The specific name *orca* has the same meaning as the generic name.

Specific description: Adult males reach 9.4 meters in length. One 8.2-meter specimen weighed 8 000 kilograms. Adult females reach 8.2 meters in length. One 7-meter female weighed 4 000 kilograms. Newborn calves are from 2 to 2.7 meters long. One calf, 2.4 meters long, weighed 180 kilograms. The killer whale has a heavy body with a relatively short head. These whales, the largest member of the dolphin family, are primarily black with white on the belly from the lower jaws to the anal region, with a branch of white extending onto the flank behind the dorsal fin. A gray, saddle-shaped patch is on the midback just behind the dorsal fin. A white oval patch is located on the side of the head above and behind
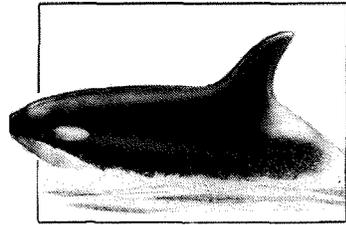
KILLER WHALE

the eye. The dorsal fin in killer whales is distinctive. In males it may reach 2 meters in height, whereas in females and immature whales it is less than 1 meter (Leatherwood and Reeves 1981). The fin is black, basically triangular, and slightly curved. In some animals, the tip of the fin may be hooked; in large males, the upper portion may actually bend to one side. The flippers are rounder and more paddle-shaped than are those of other cetaceans. On each side of the jaw are 10 to 14 conical teeth.

Abundance and distribution: Killer whales have a worldwide distribution but are most common in subarctic, temperate, and subantarctic waters. They are found throughout the Pacific Ocean. The subarctic concentrations include the Straits of Georgia in British Columbia, Prince William Sound in Alaska, and Puget Sound in Washington (Leatherwood and Reeves 1981). Migratory habits are probably determined by food supplies. Animals may shift to the south in winter, following colder currents. Killer whales are most numerous in Puget Sound in November and late summer. Most of the southern California records are for fall, winter, and early spring, although some sightings occur throughout the year. The Japanese take killer whales primarily from April to November. In Norway, the number of killer whales observed appears to be correlated with the distribution and migration of herring, capelin, and cod. The Fisheries Research Board of Canada, the Washington Department of Game, and the Marine Mammal Division of National Marine Fisheries Service have made counts in the waters off Washington and British Columbia. The maximum number of killer whales counted in 1971 was 459.

Habits: Killer whales usually travel in small groups, although groups as large as 50 have been observed (Leatherwood and Reeves 1981). Pods, or groups, of killer whales appear to have some stability in composition over several years. Photographs of distinctive coloration and fin marks of individual whales during capture operations indicate that some pods have been captured several times. Each pod usually has a dominant male that can be identified by his large dorsal fin. Males breed with more than one female (polygyny). The usual speed of killer whales is between 10 and 13 kilometers per hour. Breaching is a common behavior. These whales may jump out of the water to heights of 1.5 meters and can cover up to 13.6 meters before reentering the water (Walker et al. 1975).

Food: Killer whales feed primarily on fish and marine mammals. In the Antarctic they also feed on penguins and have been known to take other aquatic birds and large amounts of cephalopods. When hunting in areas with ice, they are known to spy hop in an effort to scan the ice floes for potential prey. They have been observed breaking the ice from beneath or tipping small ice floes to knock prey into the water. Some pinnipeds porpoise (leap out of the water while moving forward) at great speed when killer whales are in the area. Several areas where pinnipeds breed are thought to have resident populations of killer whales during the breeding season. Although pinniped pups appear to be the primary food source in this instance, adults are also eaten; and killer whales have been observed nearly beaching themselves in an effort to capture pinnipeds. Between 1948 and 1957, 364 killer whales were taken off Japan. The stomachs of these animals contained fish (cod, flatfish, salmon, and sardines), squid, octopus, dolphins (Trues, Dall, and Pacific whitesided), whales, and seals (Nishiwaki and Handa 1958). In the

Johnston Straits area of British Columbia, killer whales feed heavily on spring chinook salmon. When recordings of killer whales are played in the presence of spring chinook, they move into shallow waters. Killer whales are estimated to require food equal to 4 percent of their body weight per day (Mitchell 1975).

Reproduction: Bigg and Wolman (1975) estimated that males become sexually mature at 5.8 meters in length in the Pacific, whereas females'mature at 4.9 meters. In Norwegian waters, males mature at 6.7 meters (Mitchell 1975). Breeding may occur throughout the year, but it is apparent in spring and summer off the Washington coast (Walker et al. 1975). The gestation period is estimated to be 12 to 16 months. Births in the northern hemisphere usually occur in autumn (U.S. Department of Commerce 1978). These animals may live more than 25 years.

Economic status: The economic value of killer whales may be viewed several ways: harvest, live capture for oceanariums, and impact on fisheries. From 1948 to 1974, the Japanese took 1,439 killer whales between the Okhotsk Sea and Japan. From 1938 to 1974, the Norwegians harvested 2,096 in the northeastern north Atlantic. From 1958 to 1974, the USSR took 444 animals in the Antarctic and north Pacific. From 1972 to 1974, Africa took 27 (U.S. Department of Commerce 1978). Between 1962 and 1973, 263 killer whales were captured live in British Columbia and Washington, of which 50 were kept for display in oceanariums, 12 died during capture, and the rest either escaped or were released (Bigg and Wolman 1975). As of April 1974, 48 percent of the whales held in captivity were still alive. In 1965, a live killer whale for an oceanarium cost $8,000. By 1970 the cost had risen to $20,000, and it is estimated that 48 whales sold from British Columbia and Washington waters between 1962 and 1973 cost about $1 million.

The competition between the commercial fisheries and whales may be important. The harvest of fish by one may limit the harvest by the other; therefore, the fishing industry complains about the competition from whales, and the whales may be adversely affected by the harvest of fisheries.

Mortality and diseases: The most common disease known for killer whales is caused by the wearing of tooth crowns and denudation of the pulp cavity, which results in abscesses. Other diseases include bony outgrowths and bone tumors (U.S. Department of Commerce 1978). The killer whale is not known to have any natural predators.

Selected references: Bigg and Wolman (1975), Mitchell (1975), Norris and Prescott (1961), Walker et al. (1975).

Genus Pseudorca: False killer whale

Derivation: The generic name *Pseudorca* is derived from the Greek word *pseudes* (false) and the Latin word *orca* (a kind of whale, the great killer); thus the vernacular, false killer whale.

General description: There is only one species in this genus. The generic description is found under the species.

World distribution: Same as that under the species.

General references: Same as those under the species.

Species *Pseudorca crassidens:* False killer whale

Derivation: The specific name *crassidens* is derived from the Latin words *crassus* (thick or heavy) and *densus* (dense or compact).

Specific description: Adult males reach 6.1 meters in length and weigh 1 360 kilograms; females reach 4.9 meters in length. Newborn calves measure from 1.7 to 2.0 meters in length. The body is entirely black. The head is narrow and tapered. The dorsal fin is shorter, more slender, and more curved than the fin of the killer whale *Orcinus orca.* The flippers are narrow and tapered, with a distinctive hump near the middle on the forward margin (Leather-wood and Reeves 1981). In each side of the jaws are 8 to 11 conical teeth.

Abundance and distribution: False killer whales are found offshore in temperate and tropical waters. Sightings near shore are rare, although mass strandings may occur. In the Pacific, the species is known from the Aleutian islands to 5°N, including the Gulf of California, and it has been observed in Hawaiian waters (Leatherwood and Reeves 1981). The species is also known in the western Atlantic from North Carolina south through the Gulf of Mexico. Uncommon throughout most of its range, it is seldom caught in the small whale industry of Japan. The species is more commonly sighted on the Pacific side of Honshu, Japan, than in any other area.

Habits: False killer whales probably feed and travel in groups of up to several hundred individuals, composed of males and females of different ages. The species occasionally takes fish from longline fishing gear. The social bonds of groups may be responsible for mass strandings. Much of what is known of this species comes from such strandings, which frequently include 75 to 300 individuals. The species adapts readily to captivity, learns quickly, and is compatible with other captive dolphins.

Food: Stomach contents and observations of surface feeding indicate that this species feeds on cephalopods and fishes, such as mahi-mahi and tunas, including Bonito (Orr 1972).

Reproduction: Sexual maturity occurs between 3.3 and 3.8 meters in length, and there apparently is no well-defined breeding season (Walker et al. 1975).

Economic status: Aside from occasional catches by the Japanese coastal small whale industry, 30 to 50 false killer whales are caught incidentally each year in the tuna fishery in the Pacific (Mitchell 1975).

Mortality: There is little information about mortality of this species.

Selected references: Orr (1972), Walker et al. (1975).

Genus *Delphinus*: Common dolphin

Derivation: The generic name *Delphinus* is derived from the Greek word *delphinos* (a dolphin).

General description: There is a single species in this genus, and the generic description is under the species.

World distribution: Same as that under the species.

General references: Same as those under the species.

Species *Delphinus delphis*: Common dolphin,
white-bellied porpoise, or saddleback dolphin

Derivation: The specific name *delphis* is the Greek word for a dolphin.

Specific description: In the eastern north Pacific, adult males are from 1.7 to 2.3 meters in length; adult females, from 1.5 to 2.1 meters. Newborn calves are from 0.75 to 0.85 meter in length, but males are slightly larger than females. Individuals in the Black and Mediterranean Seas are smaller. The common dolphin is similar to the Pacific white-sided dolphin, although the large beak and less curved fin of the common dolphin may distinguish the two. *Delphinus* is black or brownish along its back, with variable stripes of gray, yellow, and white on the sides, forming an hourglass or crisscross pattern. The belly is white. The dorsal fin varies in shape and color but is most often slender and slightly curved. The head has a well-defined, narrow beak. There are from 40 to 65 teeth in each side of each jaw. The teeth are small, conical, and sharply pointed.
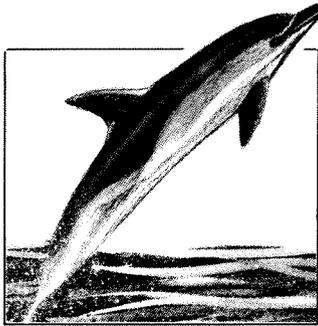
COMMON DOLPHIN

Abundance and distribution: The common dolphin is worldwide in distribution in temperate and tropical waters; however, there is local variance in its appearance in the Black Sea, Mediterranean Sea, Atlantic coasts of Europe and Africa, Indian Ocean, and Pacific coastal waters of Japan and South America (Evans 1976). The most northern record of this species was a dead beach-cast animal in the vicinity of Victoria, British Columbia (Guiguet 1954). The major distribution in the northeastern Pacific is from the equator to 36°N latitude and from 83" to 132°W longitude. Evans (1976) speculated that the species may be extending its range because of the capture and removal of its potential competitors, *Stenella* spp.

Evans (1976) noted that live animals have not been observed north of Santa Cruz, California, and that sightings north of Point Conception are generally in spring and summer when warm water extends north. The normal distribution in the eastern north Pacific is from San Miguel Island to the southern tip of Baja California, throughout the Gulf of California, and along the mainland of Mexico and Central America to several hundred kilometers offshore in tropical waters.

Two types of common dolphins are distinguishable: long-snouted individuals that generally live in the southern extent of the range and short-snouted ones that generally live in the northern portion of the range. The distribution of these two types overlaps in southern California and shifts with water temperature.

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Mitchell (1975) designated three morphologically distinct populations: (1) a northeast Pacific population along coastal northern California, coastal and offshore along central California, and in the Gulf of California, (2) a neritic population in southern California and along the eastern coast of Baja California, and (3) a warm water population off Central America. Common dolphins move northwest during July through November from the southern California continental border, and south from December through June (Evans 1976). Further, the warmest temperatures at the surface of the sea in southern California (18°C) occur in September and October, which coincides with the peak abundance of common dolphins. The lowest abundance coincides with the lowest temperature (13°C) in this area from March to May. At the same time, the waters of Baja California are from 16" to 18°C, and this species is assumed to migrate between these areas to calve in both areas only when the water is about 18°C. There is speculation that males and females segregate between mating periods, particularly when females are nursing calves or are about to bear young.

The Southwest Fishery Center of the National Marine Fisheries Service conducted an aerial survey in 1974 and shipboard surveys in 1974, 1975, and 1976 (U.S. Department of Commerce 1978). These surveys resulted in a combined estimate for the stocks of 1.4 million animals in the temperate and tropical waters (95-percent confidence interval: ± 0.2 million). Evans (1976) reported on monthly aerial surveys, beginning in 1968 in a study area of about 580 000 hectares, from Point Mugu to Ensenada and out to 120°W longitude. During these surveys, common dolphins were the most common small cetacean in the study area. Herds were extremely mobile but not randomly distributed. The number of individuals per square kilometer peaked at 7.0 in January. Animals were also abundant in June, September, and October. Minimal numbers were observed in April and July.

Habits: Common dolphins are normally found in water less than 28°C, and their distribution may be limited because of their preference for temperate and subtropical waters (Evans 1976).

Size of a herd ranges from 5 individuals to 3,000, and they move from 1.3 to 5.9 kilometers per hour. The usual traveling speed for this species is 7.4 to 11.1 kilometers per hour, with a capability of 46.3 (Walker et al. 1975). A radio-tagged female moving in a south-southwest direction at a speed of 3.0 kilometers per hour was tracked for 72 hours; 10 days after its release it was sighted 500 kilometers from the release site.

The maximum depth that common dolphins dive is reported to be 280 meters. During dives, feeding dolphins stay underwater for 2 to 3 minutes. In some parts of this species' range, individuals may ride the low wake created by boats and may come from a considerable distance to a moving vessel, often leaping clear of the water (Leatherwood and Reeves 1981).

Common dolphins are seldom found in water less than 200 meters deep, although they show a definite preference for sea mounts (underwater mountains), escarpments (steep underwater slopes), and other offshore features. The common dolphin was worshipped by the ancient Greeks and Romans. Its image is depicted on ancient temples, coins, and medals.

Food: This species feeds primarily on squid and small schooling fishes. Walker et al. (1975) found otoliths, representing 9,000 small fish, in the stomach of a single individual. Evans (1976) examined the stomachs of 30 animals collected between September and January in the temperate and subtropical north Pacific; 63 percent contained fish and 37 percent, squid. Ninety-three percent of all the fish were anchovy, and 99 percent of the squid were *Loligo opalescens.* Eighty-three percent of the commercial catch of anchovy and 50 percent of the commercial catch of squid are caught in this area during the winter; this corresponds with increasing numbers of common dolphin and supports the hypothesis that abundance and distribution of food significantly influence the distribution of this species. Stomachs of six common dolphins examined during March and July contained 70 percent fish, 23 percent cephalopods, and 7 percent crustaceans (Evans 1976). Of the fish, 56 percent were bathylagids; 37 percent, myctophids; 3 percent, hake; and 2 percent, anchovy. Other species reportedly consumed included herring, sardines, pipefish, walleye pollock, and jack mackerel.

Sergeant (1969) estimated that the consumption of fresh fish for captive animals was 3 to 10 kilograms per day. Evans (1976) indicated that spotted dolphin (*Stenella attenuata*) and spinner dolphin (S. *longirostris*) occupy areas of the temperate east Pacific in high numbers. These same areas have low numbers of *Delphinus*, which suggests the possibility that the common dolphin cannot successfully compete with the *Stenella* spp. for food in this area.

Reproduction: Males and females become sexually mature at a length of 1.7 to 1.8 meter and a corresponding age of 3 to 4 years (Nishiwaki 1972). Individuals in the Black Sea mature at 3 years of age (Mitchell 1975).

Mating in the northeast Pacific occurs from January to April and August through November (U.S. Department of Commerce 1978). Sexually mature females give birth every 1 to 1.3 year (Mitchell 1975, Tomilin 1967). The gestation period is 10 to 11 months. A birth season from March to May and from August to October is reported for the northeast Pacific (U.S. Department of Commerce 1978). Young are nursed from 5 to 6 months but may stay with the mother up to 1 year. These animals may live 25 to 30 years (Mitchell 1975).

Economic status: Common dolphins do not thrive in captivity, and, therefore, are not captured for display purposes. One hundred twenty thousand common dolphins were once harvested annually in the Black Sea, but the catch declined dramatically in the 1960's and they are no longer harvested there (Mitchell 1975). The largest mortality now occurs incidentally in the yellowfin tuna purse seine fishery. Approximately 4,200 dolphins were killed in 1971, 8,900 in 1972, and 21,100 in 1973 (Evans 1976). About 4,000 were killed in 1974 (U.S. Department of Commerce 1978). The population level is thought to be near or above the level needed to maintain an optimum sustainable population (U.S. Department of Commerce 1978). The incidental kill by domestic fisheries is regulated by the National Marine Fisheries Service and for other countries by the Inter-American Tropical Tuna Commission. Because anchovy and squid constitute the main portion of this species' diet seasonally, increases in these fisheries may affect populations of the common dolphin.

Mortality and disease: Diseases observed include ureteric calculi and pathologic changes in the skeleton. Three cases of synostosis of the chevron bone and one case of synostosis of the rib have been recorded. The brains of 12 stranded dolphins contained flukes and fluke eggs, which resulted in abscesses and lesions. Large sharks and killer whales are natural predators. Incidental deaths related to the yellowfin tuna fishery are discussed under "Economic status."

Selected references: Evans (1976), Mitchell (1975), Nishiwaki (1972), Southwest Fisheries Center (1976), Walker et al. (1975).

Genus *Lissodelphis*: Northern right whale dolphin

Derivation: The generic name *Lissodelphis* is derived from the Greek words *lissos* (smooth) and *delphis* (dolphin).

General description: The most distinctive feature of this genus is the lack of a dorsal fin. Both upper and lower jaws have 40 to 47 pairs of small teeth. Members of this genus are generally black and white.

World distribution: This genus is found in the north Pacific and southern hemisphere, mainly north of the antarctic convergence.

General references: None.

Species *Lissodelphis borealis* :
Northern right whale dolphin

Derivation: The specific name *borealis* is the Latin word for northern.

Specific description: Adult males reach 3 meters in length and adult females 2.3 meters. Newborn calves are 0.6 meter in length. The body of this species is long and slender, with a slender tail and small flukes. The back and sides are black. The white chest extends laterally to both flippers, narrows posteriorly, and runs the entire length of the tail stock (Leatherwood and Reeves 1981). The undersides of the flukes and the tip of the lower jaw may be white. The most characteristic identifying feature is the lack of a dorsal fin, this being the only species in the north Pacific that lacks a dorsal fin. In profile the top of the head slopes smoothly to the muzzle. The eyes are located several inches back from long jaws, in which are set 42 to 45 pairs of teeth per jaw (Daugherty 1979). The teeth are small and sharply pointed. The lower jaw protrudes beyond the upper jaw.

Abundance and distribution: Records show that this species ranges from British Columbia (50°N latitude) to San Clemente Island (32°N latitude), indicating its preference for temperate waters (Leatherwood and Walker 1978). The species has been found far offshore, and sighting it from northern California, Washington, and Oregon is rare.

Portions of the population appear to shift south and inshore from spring through autumn, to waters below 19°C; this movement coincides with spawning of the squid *Loligo opalescens*, a principal prey (Leatherwood and Walker 1978).

The population in the northern Pacific was estimated to be 10,000 (Nishiwaki 1972). Aerial surveys and ship surveys between October and May from Alaska to Baja California indicate a population of more than 10,000 animals in the eastern Pacific (Leatherwood and Walker 1978). The highest monthly abundance occurred in January when an estimated 4,800 were observed; thus, the estimate of 10,000 individuals for the entire north Pacific is very conservative.

Habits: Northern right whale dolphins travel in schools of 200 to 2,000 individuals, frequently with common dolphins and Pacific white-sided dolphins and sometimes with the Dall porpoise or Risso's dolphin.

Schools of northern right whale dolphins are often tightly packed and may move at 27.8 kilometers per hour. Individual animals have been observed swimming 33.3 kilometers per hour. During high-speed swimming, the animals make low leaps that may cover 7 meters. This species usually does not ride the bow wake of ships and in fact frequently avoids them.

Food: Northern right whale dolphins feed primarily on squid, although myctophids and engraulids may also be eaten (Leatherwood and Walker 1978). Food may influence the migrations of this species.

Reproduction: Males become sexually mature at 2.2 meters in length and females at 2.1 meters. No other information regarding reproduction is known. The harvest of squid by humans may significantly reduce the prey available for this species and thus contribute to regulation of the population of this dolphin.

Selected reference: Leatherwood and Walker (1978).

Genus Stenella: No common name

Derivation: The generic name *Stenella* is derived from the Greek word *stenos* (being narrowed) and the Latin suffix *ella*, which-added to a noun-means "small."

General description: *Stenella* spp. have a curved, dark dorsal fin, pronounced beak, and may possess a dark line that runs from either the eye or the "gape" (corner) of the mouth to the flipper.

World distribution: The members of this genus are distributed throughout the tropical and temperate waters of the world.

General reference: Perrin (1975a).

Species *Stenella coeruleoalba*: Striped dolphin

Derivation: The specific name *coeruleoalba* is derived from the Latin words *coeruleus* (dark colored or dark blue) and *albus* (white).

Specific description: Adult males reach 2.6 meters in length and females 2.5 meters (Kasuya 1972). Young are about 1 meter long at birth. The body is characterized by a dark blue back, with oblique bands on the flanks, beak, dorsal fin, flippers, and flukes; the thorax, lower half of the flanks, and abdomen are white. On

each side, several dark blue bands originate at the eye. One band passes from the eye as far as the flipper; another begins at the eye, runs along the side, and ends in the anal region. The long beak is black on top. The dorsal fin is dark and has a long base and a concave rear margin. The flukes are deeply notched. There are 48 to 50 pairs of teeth in each jaw.

Abundance and distribution: The striped dolphin frequents temperate and tropical waters of both the Atlantic and the Pacific Oceans. Seasonal migrations in the western north Pacific show that many local stocks probably exist, as in other species within the genus (Mitchell 1975). Three separate stocks may be caught incidentally with catches of the eastern tropical Pacific tuna fishery. Beach-cast striped dolphins have been found in Japan, Washington, Oregon, and British Columbia. One individual died in the surf at Seaside, Oregon, in 1952 (Scheffer 1953). Another was stranded in 1940, 16 kilometers south of the Columbia River, near Seaside (Kellogg and Scheffer 1947). A third was found dead near Florence in 1980 (Mate, unpublished data on file at Oregon State University Marine Sciences Center, Newport, Oregon). Scheffer (1953) summarized information about individuals that were beach-cast in 1948, 1949, and 1950 in Washington and British Columbia. The population in the western Pacific was estimated to be 200,000 individuals by Mitchell (1975). The numbers inhabiting the eastern tropical Pacific yellowfin tuna fishery area were estimated at 248,000 (U.S. Department of Commerce 1978). Captures of this species in the yellowfin tuna fishery are regulated by the National Marine Fisheries Service for domestic fisheries and the Inter-American Tropical Tuna Commission for other nations. Few observations of this species are recorded because of the difficulty of distinguishing it at sea from the common porpoise *Delphinus delphis* (Tomilin 1967). There is some reason to believe that striped dolphin may be somewhat segregated by age and sex off Japan (U.S. Department of Commerce 1978).

Food: Striped dolphins feed primarily on mesopelagic fishes, including four species of myctophids, as well as individuals from the families Nemichthyidae, Emmelichthyidae, Chauliodontidae, Paralepididae, Sternoptychidae, Argentinidae, Gempylidae, Lutjanidae, Priacanthidae, and Gonostomatidae. Other prey includes three species of squid and four species of shrimp (Miyazaki et al. 1973).

Reproduction: In Japanese waters, males become sexually mature at 2.2 meters in length and females at 2.1 meters, which corresponds to 9 years of age for both (Kasuya 1972). Sexually mature females are thought to reproduce once every 3 years (l-year gestation, 1% year of lactation, and a 4- to 6-month interval before copulation). In Japan the mating season is from November to December and from May to June. Births occur during the same time, following a 12-month gestation period. The oldest striped dolphin known was a 26-year-old female (Kasuya 1972).

Economic status: Up to 20,000 striped dolphins are harvested annually by drive and harpoon fisheries in Japanese waters throughout the autumn and early winter and are marketed as suki-iruka (Mitchell 1975, Miyazaki et al. 1973). Incidentally taken in the yellowfin tuna fishery of the eastern tropical Pacific are about 700 individuals each year.

Mortality and disease: There is little information about natural mortality in this species.

Selected references: Kasuya (1972), Mitchell (1975), Miyazaki et al. (1973), Perrin (1975a).

Genus Lagenorhynchus: White-sided dolphins

Derivation: The generic name Lagenorhynchus is derived from the Greek words *lagenos* (a flask) and *rhynchos* (a beak or snout).

General description: The genus is characterized by a short beak, curved dorsal fin, and generally some lighter coloration on the sides. The body length is usually less than 3 meters. In each jaw are 22 to 40 pairs of small teeth.

World distribution: The genus appears to be distributed throughout most of the oceans of the world, except the Arctic Ocean of the Pacific.

General reference: Tomilin (1967).

Species *Lagenorhynchus obliquidens :*
Pacific white-sided dolphin

PACIFIC   WHITE-SIDED
DOLPHIN
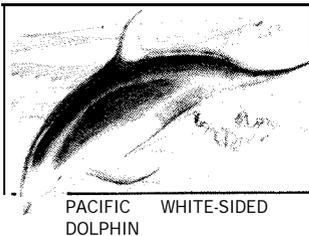
Derivation: The specific name *obliquidens* is derived from the Latin words *obliquus* (slanting sidewise) and *densus* (dense or compact).

Specific description: Adult males reach 2.3 meters in length and 180 kilograms in weight; adult females, 2.3 meters and 100 kilograms. Newborn calves are about 1.2 meter long. Pacific white-sided dolphins are black on the back, with light gray sides and a white belly. The black back is interrupted on each side of the dorsal fin by a white strip that begins at the head and extends to the dorsal fin where it widens and curves toward the anus. The dorsal fin is sickle shaped, pointed, black anteriorly, and pale gray posteriorly (Leatherwood and Reeves 1981). The flippers are pointed. The head has a short rostrum. In each side of each jaw are 22 to 33 teeth (Tomilin 1967).

Abundance and distribution: The Pacific white-sided dolphin is found in the north Pacific only from the southern tip of Baja California, Mexico, to southeastern Alaska; and in the western Pacific, through the Commander and Kurile Islands to Japan. It is found throughout the year off California, Washington, Alaska, and the Kurile Islands. The species is more common inshore in southern California during winter and spring but is found only in offshore waters during summer and fall (Norris and Prescott 1961). Pacific white-sided dolphins are apparently abundant when populations of the squid *Loligo opalescens* become abundant in late fall and winter. It may be the most abundant dolphin north of southern California (Pike and MacAskie 1969). The population in Japanese waters was estimated to be be tween 30,000 and 50,000 individuals (Nishiwaki 1972). This species is most numerous in the Kurile Islands in late summer and fall.

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Habits: Pacific white-sided dolphins frequent the continental shelf and slope in schools of up to 2,000 individuals and are often found with the common porpoise, and less often with the northern right whale dolphin. In southern California it is easy to capture individuals alive from traveling schools. In the eastern tropical Pacific, the yellowfin tuna fishery has harassed schools in the course of fishing, and some schools have become wary of approaching boats. This species is active throughout the 24-hour cycle. They often follow ships, dashing around a ship's bow wake and occasionally jumping clear of the surface.

This species has been successfully maintained in captivity in the United States for about 20 years (Mitchell 1975). There is, however, about 50-percent mortality in the first 6 months of captivity, but the average age of 10 individuals that survived the 1st year of captivity was about 5 years. Five of these individuals lived in captivity over 8 years.

Food: The species feeds on cephalopods (especially squid) and small fish, including herring, sardine, anchovy, saury, jack mackerel, and capelin (Mitchell 1975, Walker et al. 1975).

Reproduction: Males become sexually mature at 1.7 to 1.8 meters in length and females at 1.75 to 1.85 meters (Mitchell 1975). The mating season is from late spring through autumn, and a gestation period of 10 months results in a birth season in late spring and summer.

Economic status: Pacific white-sided dolphins are captured for display in oceanariums and aquariums. The species is caught incidentally in the yellowfin tuna fishery.

Mortality and disease: Information is lacking.

Selected references: Mitchell (1975), Norris and Prescott (1961), Orr (1972), Walker et al. (1975).

Family Phocoenidae: Porpoises

Derivation: The familial name Phocoenidae is derived from the Greek word *phokaina* (porpoise) and the Latin suffix *idae* (family).

General description: Members of this family have spadelike teeth (as opposed to conical teeth in delphinids). With the exception of the genus *Phocoenoides*, all porpoise have a triangular dorsal fin.

World distribution: The members of this family are distributed throughout the north Pacific, including the Gulf of California, southeast Pacific, southwest Atlantic, and around Indonesia.

Fossil record: Representatives of this family occur in the fossil record of the north Pacific to the middle Miocene.

Number of species along the Oregon coast: Two.

General reference: Tomilin (1967).

Genus Phocoenoides: No common name

Derivation: The generic name Phocoenoides is derived from the Greek words *phokaina* (porpoise) and *oeidos* (a suffix that denotes likeness of form). The generic name means "like a porpoise."

General description: There is only one species in this genus. Therefore, the description is the same as that of the species.

World distribution: Same as that under the species.

General references: Same as those under the species.

Species Phocoenoides *dalli*: Dall's porpoise

Derivation: The specific name *dalli* is a proper name. The species was named in honor of William Healey Dall (1845-1927), an American naturalist.

Specific description: Males are larger than females and may reach 2.1 meters in length and 145 kilograms in weight. Newborn calves are 1 meter long. The robust body is predominantly black, with a white patch on the flanks and belly from mid-body to just short of the flukes (Leather-wood and Reeves 1981). The upper portion of the dorsal fin and the dorsal margin of the flukes are white. The tail is vertically thick. The dorsal fin is broadly triangular and slightly curved at its tip. The flippers are relatively small for the size of the body. There are from 19 to 27 spade-shaped teeth in each side of both jaws, with horny protuberances of the gums between the teeth. These "gum teeth" may function as gripping organs and probably wear down with use to expose the teeth (Walker et al. 1975).

Abundance and distribution: The Dall porpoise is found from Japan and central Baja California north into the Bering and Okhotsk Seas. Not found in waters warmer than 13°C, it is uncommon below 35°N latitude. The Dall porpoise is frequently sighted off southern and central California from October to June, and off central Baja California in winter. It is perhaps the most common porpoise in southeastern Alaska and British Columbia where it is a year-round resident. Juveniles are seen inshore in Monterey Bay throughout the year, but more heterogeneous groups are found offshore. Individuals have been found along the Oregon coast (Mate, unpublished data on file at Oregon State University Marine Science Center, Newport, Oregon).

Habits: The Dall porpoise is one of the fastest species of porpoise. When traveling, the head produces a spray as an animal comes up to blow, frequently coming halfway out of the water while taking a breath. It also commonly plays in the bow waves of ships. Although these porpoises are found in groups ranging from 5 to 500, groups of less than 24 are more common. They may be found with Pacific white-sided dolphins and pilot whales.

Food: Squid, hake, herring, jack mackerel, saury, and some deepwater benthic fishescomprise the food base of this species (Norris and Prescott 1981).

Reproduction: Males become sexually mature at 1.85 meter in length and females at 1.7 meter. The gestation period is thought to be 1 year, and the birth season is from late July through early August (Mitchelf 1975).

Economic status: Between 10,000 and 20,000 animals are taken incidentally each year in the Japanese high seas salmon gillnet fishery in the northeastern north Pacific and the Bering Sea. The number caught does not appear to be decreasing. In addition, the Japanese take between 4,500 and 7,500 animals from their east coast, Sanriku region (Kasuya 1972).

Mortality and diseases: Little information is available.

Selected references: Kasuya (1972), Mitchell (1975), Norris and Prescott (1961), Walker et al. (1975).

Genus Phocoena: Harbor porpoise

Derivation: The generic name Phocoena is derived from the Greek word *phokaina* (porpoise).

General description: The members of this genus are small, up to 2 meters in length. The snout is essentially beakless, the dorsal fin is triangular. This porpoise is generally white on the belly, with a gradual change to gray or black on the back.

World distribution: This genus is found in near-shore waters of the northern hemisphere and around the lower half of South America.

General reference: Nishiwaki (1972).

Species *Phocoena phocoena:*
Harbor porpoise or common porpoise

Derivation: The specific name *phocoena* is derived from the Greek word *phokaina* (porpoise).

Specific description: Adult males reach 1.7 meter in length; adult females 1.8 meter. Individuals may weigh up to 90 kilograms. At birth, calves are 0.8 to 0.9 meter (about one-half the length of the female) and weigh 5 to 6 kilograms. The back is dark gray to black and the belly white, with intermediate or distinct separation of colors along the sides. The body is robust; the dorsal fin is small, triangular, slightly curved, and is located in the middle of the back. The head is round without a noticeable beak. The mouth is relatively small and contains from 16 to 27 pairs of spade-shaped teeth in each jaw. The teeth are entirely crowned or have two to three lobed crowns (Orr 1972, Walker et al. 1975).

Abundance and distribution: The harbor porpoise is circumpolar in the northern hemisphere in ice-free waters. In the eastern Pacific, it ranges from Point Barrow, Alaska, south to San Diego, California, but it is less common below Monterey Bay (Norris and Prescott 1961). In the western Pacific, the species is found from the

Bering Sea to Honshu, Japan. The species has been reported 32.2 kilometers off-shore, but it is more commonly found near the shore where it may be seen entering bays and harbors. Although this is the smallest cetacean in the eastern north Pacific and perhaps the most common in waters near the Pacific Northwest shore, no population estimates have been developed. The species is considered abundant in waters of Washington (Scheffer and Slipp 1948) and western Canada (Pike and MacAskie 1969). The Black Sea population is estimated to be 25,000 to 30,000 (U.S. Department of Commerce 1978).

Habits: Individual harbor porpoises swim just below the surface and rise about four times a minute to breathe. They are less playful than most dolphins. They seldom leap out of the water and usually ignore passing boats. Individuals have become entangled in gillnets at a depth of 75 meters (Scheffer and Slipp 1948). They are occasionally found stranded and may return to shore when taken back to sea. Herds of bachelor males have been observed.

Food: Most of what is known about the feeding habits of this species comes from the Atlantic where the animals eat herring, squid, hake, pollock, whiting, and many species of cod. In the Pacific they eat bottom fish, cod, herring, squid, clams, and occasionally crustaceans (U.S. Department of Commerce 1978).

Reproduction: Males become sexually mature between 1.3 and 1.5 meters in length, and females between 1.4 and 1.6 meters which corresponds to an age of 3 or 4 years (Fisher and Harrison 1970, Gaskin and Blair 1977). The mating season is from June through August, but females apparently do not become pregnant every year (Fisher and Harrison 1970). After a gestation period of 10 to 11 months, young are born in June and July and suckle for about 8 months. Animals may reach 8 to 10 years of age in the north Atlantic (Gaskin and Blair 1977); but Mitchell (1975) reported 13 dentinal layers for an animal 1.65 meter long, which may correspond to an age of 13 years.

Economic status: A harvest for human consumption as well as oils flourished as far back as the times of Henry VIII (16th century) and may still occur to a limited extent.

Mortality and diseases: Harbor porpoises have been found in the stomachs of Greenland sharks, white sharks, and killer whales. Incidental captures in gillnets occur throughout the northern hemisphere. Other mortalities induced by humans may occur since high levels of chlorinated hydrocarbons and polychlorinated biphenyls (PCB's) have been recorded in this species from the Baltic, United Kingdom, and the Bay of Fundy.

Selected references: Fisher and Harrison (1970), Gaskin and Blair (1977), Walker et al. (1975).

Family Mustelidae:
Martens, Weasels,
Skunks, Otters, and Allies
(see pages 287-338)

Genus *Enhydra*: Sea otter

Derivation: The generic name *Enhydra* is derived from the Greek prefix en meaning in, on, or among and the Greek word *hydōr*, water.

General description: There is only one species in this genus. The generic descrip tion is found under the species.

World distribution: Same as that under the species.

Fossil record: Early Pleistocene evidence of sea otters from the California coast shows no substantial differences from the modern species, suggesting a north Pacific origin of the genus (Mitchell 1966).

Number of species of marine carnivores along the Oregon coast: One.

General reference: Same as that under the species.

Species *Enhydra lutris*: Sea otter

Derivation: The specific name *lutris* is derived from the Latin word *lutra* (an otter) and the Greek suffix is (daughter **09.**

Specific description: Total length, 1070 to 1450 mm; tail, 273 to 360 mm; hind foot, 220 to 222 mm; ear, about 20 mm.

Sea otters are the smallest marine mammals. Adult males weigh up to 45 kilo-grams, although the average weight may be closer to 28 kilograms; adult females average 21 kilograms. The maximum recorded weight for a female is 33 kilograms. Newborn pups are 0.6 meter in length and weigh 1.8 to 2.3 kilograms.

Adults are generally dark brown, but the head may vary from tan to light gray (thought by some to be a sign of age). There are an average of 70 underfur hairs for each guard hair. External ears (pinnae) are visible. The webbed hind feet are horizontally flat and relatively large; they are the primary source of power in swimming. The front feet have retractile claws and are used to pull food from rocks and to manipulate food during eating. The horizontally flat tail appears to aid swimming through vertical movements. Sea otters are the only members of the mustelid family that do not have functional anal scent glands.

The teeth behind the fangs of sea otters (postcanines), such as molars, are flat and lack cutting edges or cusps. Such construction facilitates the grinding of food. In addition, sea otters are the only carnivore with four incisors in the lower jaw.

Abundance and distribution: Unless otherwise stated, the following discussion is from Kenyon (1975). Sea otters once occurred from central Baja California, Mexico (27°N latitude), north to Prince William Sound, Alaska (60°N latitude), west through the Aleutian, Pribilof, and Commander Islands, and south in the western Pacific to

at least northern Hokkaido, Japan (47°N latitude). Although the limit of their northern distribution normally coincides with the usual southern extent of the winter pack ice in the Bering Sea, some otters have been observed as far north as 65°N latitude along both the eastern and western shores of the Bering Sea.

Sea otters were hunted by Indians on the northwestern coast for their fine fur. Exploitation by Europeans began shortly after Vitus Bering discovered large numbers of sea otters along the Aleutian Islands in 1741.

An estimated pre-exploitation population of 150,000 otters yielded at least 369,000 (and possibly as many as 637,000) skins in the subsequent 170 years. Such rapid exploitation brought the sea otter close to extinction. By 1911, the total population was estimated to be between 1,000 and 2,000 individuals scattered in small groups around the Aleutian Islands, primarily in the northern portion of their range. A few persisted, however, in the Queen Charlotte Islands, British Columbia, along the central California coast near Monterey, and in the San Benitos Islands of Baja California. The last Oregon sea otter apparently was killed at Otter Rock, north of Newport, Lincoln County, in 1906 (Jameson 1974).

The species was given complete protection in 1911 under Article V of the Convention for the Preservation and Protection of Fur Seals (U.S. Department of State 1928). Since 1911, the sea otter population of the Aleutian Islands has grown in some areas at an estimated rate of 5 percent per year; a relatively stable population averages four to six individuals per square kilometer. The Baja California population is now thought to be nearly extinct.

Sea otters from Amchitka, one of the Aleutian Islands in Alaska, were transported to the Washington and Oregon coasts in 1970 and 1971, but success of the transplants was limited. Although some of the otters appear to have become established around Danger Island, Washington, those released at Cape Arago, Coos County, and Port Orford, Curry County, Oregon, have dwindled in numbers. Despite known reproduction in Oregon, a maximum of three individuals was observed at any one time in 1978, a single individual at Port Orford in 1979, and none in 1980 (Mate, unpublished data on file at Oregon State University Marine Science Center, Newport, Oregon).

The population of sea otters in California, under complete protection, has grown to an estimated 2,000 individuals. Under protection, sea otters have reestablished themselves throughout most of their historical central California range, from Año Nuevo Point (north of Santa Cruz) south to Pismo Beach (just north of Point Arena). Males appear to predominate at the extremes of the range, whereas females appear more abundant toward the center of the range (Morejohn et al. 1975).

The 1972 estimate of the world population of sea otters was 40,000 (Kenyon 1975), and continued population growth is anticipated in several areas. In California, however, there are proposals to limit further population expansion because of conflicts between the diet of sea otters and the commercial seafood interests. Such proposals include translocation to the California Channel Islands and/or to areas in or outside California State waters.

Habits: Sea otters have little body fat and must depend on their thick underfur to insulate their bodies from the cold water. It is imperative, therefore, that their fur be kept clean, which requires constant grooming. Air entrapped in the thick underfur allows sea otters to float on the surface of the water. They typically float on their backs while resting, eating, and grooming. The latter entails "scrubbing" the fur with the forefeet and "chewing" it, both accompanied by frequent rolling in the water. Grooming is particularly intense immediately after an individual has eaten.

Sea otters have a high metabolic rate and spend much of their time gathering food in waters as deep as 60 meters. The depth of an otter's dive appears to be physiologically constrained by the animal's dependence on oxygen stored in its lungs, in contrast to the greater dependence of seals on oxygen attached to hemoglobin in red blood cells or myoglobin in muscles (Lenfant et al. 1970).

The otters off Monterey, California, spend 63 percent of their time resting and 24 percent of their time gathering food and eating (Shimek and Monk 1977). In Alaska, otters often come ashore to rest. Resting on the shore is not common behavior of California otters, but a few individuals do routinely rest on shore (Vandevere 1971).

SEA OTTER

Rocks, used as tools or anvils, are held by an otter-on its stomach-and used to break clams and other shellfish by pounding them on the rock. An otter will often keep a particular rock through a series of food-gathering dives, usually by tucking it under the axilla (armpit). The axilla is also used to hold food collected during a dive. Although both forefeet are used to collect food, otters around Amchitka Island appear to use the left axilla exclusively for storing food, demonstrating a strong "right-handedness" (Kenyon 1975).

Food: Captive sea otters consume food equal to 20 to 25 percent of their body weight each day. In the wild, some individuals concentrate on a single species of prey; others eat a greater variety of foods, such as crustaceans, some fishes, mussels, clams, snails, and octopuses.

Sea urchins and clams comprise a major portion of the diet of sea otters in Alaska (Kenyon 1975). Although otters in California eat a wide variety of foods, they appear to exhibit some preference for prey. Mollusks, including abalone (*Haliotis* sp.), appear to be a favorite prey, when available; this has caused considerable political difficulty because of the commercial abalone fishery. Urchins, another popular otter prey, are also commercially harvested. In some areas, sea otters feed so extensively on kelp-eating sea urchins, it results in an increased abundance of kelp and associated changes in animal life. The presence of sea otters is therefore responsible to a large extent for the entire composition of the ecosystem of which they are a part. Kelp is not an obligatory part of their environment; otters in Alaska may be found in areas without kelp. Where kelp does occur, however, an otter will hold onto it to prevent itself from drifting while it sleeps.

Extensive stretches of sandy beach, such as those around Monterey Bay, were thought to prevent sea otters from extending their range north; however, many sea otters have crossed this bay and much larger distances are crossed in Alaska. Otters at the southern extent of their range, however, dive for pismo clams (*Tivela stultorum*) along the sandy shores south of San Luis Obispo, California, which indicates their ability to use sandy environments to some extent.

Sea otters in Monterey Bay have "discovered" a new habitat for octopus-the insides of beer cans, which the otters rip open with their teeth.

Reproduction: Unless otherwise stated, the following discussion is from Kenyon (1975). Females become sexually mature at 3 to 5 years of age, whereas males become mature when they weigh 25 to 27 kilograms.

Mating occurs throughout the year. Precopulatory behavior is usually initiated by the male and involves nuzzling and fondling with the forepaws while rolling and splashing at the surface. Females in estrus become more submissive. Just before mating, the female floats on her back with forepaws ridgedly extended. The male holds her from behind with his forepaws on her chest, grasping the sides of her head with his jaws. During copulation in this position, the male is frequently under water, and both animals roll from side to side, periodically lifting their noses above the surface to breath.

Females breed in alternate years and have a gestation period of 10 to 12 months. Although the young may be born throughout the year, most births occur during the summer. An individual may live more than 20 years and remain reproductively active throughout most of its life.

Economic status: The exploitation of the sea otter during the late 18th and the 19th century has been reviewed briefly under "population" because the value of their pelts was solely responsible for the radical changes in overall numbers and distribution of the species. Just before full protection for sea otters was given in 1908, one pelt was sold for $900.

The main economic factors associated with sea otters are: (1) the large, but unknown, amount of money spent by tourists to view them along the central California shorelines; and (2) the competition between otters and both commercial and sport fisheries for certain food species, such as abalone and clams.

Mortality and diseases: High populations of otters can overexploit their food resources, which leads to starvation and its associated diseases. Mortality, under such circumstances, is estimated at 8 to 11 percent. Enteritis, blindness, and tooth abscesses also contribute to mortality.

Predators of sea otters include the white shark (*Carcharadon carcharias*), killer whales, and bald eagles (*Haliaeetus leucocephalus*). In addition, for some time it was thought that recreational boaters were responsible for large numbers of dead otters, but reappraisal of the marks found on the otters suggested a higher percentage of shark predation than had been previously suspected (Morejohn et al. 1975).

An oil spill is an even greater threat than predation. The sea otter is probably the most vulnerable of all the marine mammals to problems from oil because of its dependence on a clean pelage for proper insulation and buoyancy.

Selected reference: Kenyon (1975).

Order Pinnipedia: True Seals and Eared Seals

Derivation: The ordinal name Pinnipedia is derived from the Greek word *pinna* (wing) and the Latin word *pedis* (foot). It refers to elongated, flat front and hind feet, in which the digits are bound together by webs of skin, forming flippers.

General description: Pinnipeds have streamlined, torpedo-shaped bodies, and all four limbs are modified into flippers. The limbs are deeply enclosed within the contours of the body as far as the elbows and knees. The head is flat and, with the exception of members of two genera, the face is short. The external ear flaps (pinnae) are reduced or absent and the nostrils are slitlike. Both ears and nostrils are closed when the animal is submerged. The eyes are embedded in deep, protective cushions of fat and adapted for underwater use. The corneas (transparent outer covering of eyes) are less convex than those of land mammals, and the pupils are capable of great enlargement. The mouth, jaws, and teeth are adapted for seizing and tearing rather than chewing. All teeth are similar in structure (homodont). Some are conical or "peglike" and others are remarkably complex, but they have no more than two roots. Carnassials are not developed. Pinnipeds have thick, muscular, flexible necks that can be bent upward because there are fewer interlocking processes of the vertebrae. The tails of pinnipeds are short and grow little after birth. Swimming thrust is generated by the hind flippers of phocids (earless seals) or by the front flippers of otariids (eared seals). Pinnipeds are usually hairy. Most have a thick oily layer of fat (blubber) between the tough outer skin and the body muscles. The blubber protects the animal from the cold of water and provides buoyancy, padding, and a reserve of energy. The genitalia and teats are usually retracted under the skin.

Measured from tip of nose to tip of tail, pinnipeds range in length from 140 to 650 centimeters. Adults weigh from 90 kilograms to about 3.5 metric tons.

Although pinnipeds are clumsy on land, they are skillful, graceful swimmers and divers. In swimming, they use not only flippers but also the entire sinuous trunk. Some can dive to depths of 600 meters and remain submerged longer than half an hour. Some species, such as the harbor seal, spend time on land throughout the year; others, such as the northern fur seal, spend most of the year at sea.

Even though food habits differ, pinnipeds are strictly carnivorous. Some are adept at securing food during the night; certain polar pinnipeds feed in total darkness for 4 months of the year.

Pinnipeds are much more gregarious than land carnivores. The size of breeding colony of pinnipeds may range from a few individuals to more than a million inhabiting an area with a radius of 50 kilometers. Pinnipeds select small, isolated areas for breeding grounds; some species are polygamous; others are monogamous. Pinnipeds mate once a year and give birth on land or ice. Gestation takes from 8 to 12 months. In many species, implantation of the fertilized egg is delayed, an evolution which may be an adaptation to allow births to occur at about the same time each year. Delayed implantation may also be advantageous to species that migrate long distances to their breeding ground and may ensure concentration of reproductively active individuals, Pinnipeds usually have only one young (pup) per year. Some are born with deciduous teeth that are shed early in life; others shed the teeth before birth. Although some newborn pups can swim, others have to be taught. The young of some species do not have enough blubber

to provide buoyancy or insulation until they are several weeks old. During the time pups are nursing, they are nourished by rich milk that contains approximately 50-percent fat and grow rapidly. Adult pelage is normally acquired toward the end of the first summer. Sexual maturity is reached at 2 to 7 years of age.

World distribution: Pinnipeds inhabit most of the coastlines and ice fronts of the colder seas of the world. Some species ascend rivers or live in landlocked waters, such as the Caspian Sea or Lake Baikal in Asia. Monk seals (*Monachus*) and one subspecies of California sea lion (*Zalophus*) are tropical members of the group; they occur in the Mediterranean, in Hawaiian waters, and near the Galapagos Islands.

Fossil record: The oldest known pinnipeds date to the Miocene in North America.

Number of species along the Oregon coast: Seven.

General references: Anderson and Jones (1967), Walker et al. (1966).

Key:

1a Has external ear pinnae (or flaps); walks on all four flippers on land (quadruped), with hind flippers rotated forward; swims principally with foreflip-pers; foreflippers long, more than one-fourth the length of the body; flippers naked or with little hair; digits with cartilaginous extensions beyond claws, three distinct claws on middle digits of hind flipper, with marginal digits rudimentary. Pelage colors usually uniform; whiskers smooth—*OTARIIDAE* (eared seals)... 2

Otarids have pinnae (external ear flaps) and can rotate their hind limbs forward to walk on all fours.

1b Lacks external ear pinnae; has large eyes, drags hind flippers on land and un-dulates like an inchworm; the hind flippers cannot be rotated forward under the body; swims principally by use of the hind flippers; foreflippers are short, have hair on all surfaces, are less than one-fourth the length of the body and are of uniform thickness with five well-developed claws; coloration of pelage diverse; whiskers often beaded—*PHOCIDAE* (true seals). 4

Phocidae do not have an external ear flap and cannot rotate their hind limbs forward. They move on land by undulating the body.

2a Conspicuous gap between the fourth and fifth postcanines in the upper jaw; pelage yellowish buff; adult males have a mane of longer, coarser hair; males may grow to 4 m in length and females to 2.8 m—*EUME-TOPIAS JUBATUS* (Steller or northern sea lion), page 448

2b No gap between fourth and fifth postcanines of upper jaw; pelage usually darker brown to black; males and females appear smaller than above. . 3

3a Pelage consists of light to dark brown hair with little underfur (black when wet); males grow to 2.7 m in length and 250 kg in weight and females to 1.9 m and 140 kg; adult males have a pronounced sagittal crest, muzzle not short; vocalizations are sharp barking-ZALOPHUS *CALIFORNIANUS* (California sea lion or circus seal), page 451
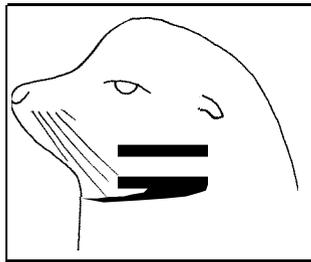
The external characteristic of a sagittal crest is a pronounced "forehead."

3b Pelage dark brown to black, consisting of a dense, soft underfur with overlying longer (guard) hair; males grow to 2.5 m in length and 300 kg in weight and females to 1.8 m and 65 kg; males lack a pronounced sagittal crest; muzzle short; vocalizations more of a roar or growl— *CALLORHINUS URSINUS* (northern fur seal), page 455

4a Pelage consists of a number of spots or mottling on either a dark or light background................................... 5

4b Pelage either a uniform light gray to brown or dark colored with light bands... 6

5a Adult coloration varies from off whits to dark brown or black, with highly variable spotting; males and females may grow to 1.6 m and 110 kg-PHOCA *VITULINA* (harbor seal, hair seal, spotted seal, or common seal), page 438

5b Adult coloration usually a light gray background with black spots, many of which may be surrounded by ring-shaped lighter areas; animals small, reaching only 1.25 m in length and 68 kg in weight-PHOCA *HISPIDA* (ringed seal), page 440

6a Coloration is usually a uniform light gray to a yellow or
   brown shade; males grow to 4.9 m in length and 1 800 to
   2 300 kg in weight and develop large noses as adults;
   females may be 3.3 m in length and 800 kg in weight—
   MIROUNGA ANGUSTIROSTRIS (northern elephant seal),
   page 443

6b Adult males are usually dark brown with wide white or
   yellowish white ribbonlike bands around the neck and the
   hind end of the body, and forming a circle around each
   flipper (females and young may be paler and the bands
   less distinct); average length for both sexes is 1.55 m and
   80 kg in weight-PHOCA *FASCIATA* (ribbon seal), page 442

Family   Phocidae:
True   Seals

Derivation: The familial name Phocidae is derived from the Greek word *phoke* (a
kind of mammal, a seal) combined with the Latin suffix, *idae* (family).

General description: Phocids (true seals or earless seals) may easily be distin-
guished from otariids (eared seals) by their lack of an external ear pinna and by
their means of locomotion. True or earless seals are unable to rotate the hind
limbs forward, making them useless for movement on land. They move by undula-
tion, alternating their weight between sternum and pelvis and moving along like an
inchworm. Some species drag their bodies forward with their foreflippers, but this
is more common of pups before their coordination to undulate is fully developed.

Swimming is accomplished by alternate side to side strokes of the hind flippers,
frequently accompanied by a similar motion of the rear portion of the body. The
necessary development of the muscles of the spine, hip, and hind limbs,
necessary for strong swimming motions, precludes the forward rotation of the
hind limbs for use on land.

The only visible arm elements of the foreflipper are the wrist and digits, which are
webbed and have hair on both surfaces. There are well-developed claws on each
digit. During fast swimming, the foreflippers are held close to the body but may be
used as ailerons (a control) for fast turning. In some species, foreflippers are im-
portant in maintaining space between individuals on land; this is accomplished by
waving the flippers with the claws exposed. Foreflippers are also used by elephant
seals to flip sand onto the body, possibly as an aid in controlling the body
temperature.

In many species, the skin is well pigmented. The outermost layer of phocid skin
has a cellular structure similar to mucous membrane-softer and more permanent
than the skin of terrestrial mammals which sloughs off or becomes calloused.
Such a layer prevents phocids from becoming "waterlogged."

The amount of hair on phocids varies greatly among species. Within a species,
pattern and coloration of pelage may vary greatly. Many large sebaceous glands
secrete an oily film over each hair. When seals molt, they lose the outermost layer
of skin and all their hair, in contrast to otariids which shed individual hairs without
losing skin. The hair of true seals has little insulation value, and the skin is only

one or two degrees warmer than the water in which they swim. They depend, therefore, on a layer of blubber for insulation, and there is some evidence to suggest seasonal changes in metabolic rate.

There are minor differences in the incisors of subfamilies Phocinae and Cysto-phorinae. The postcanine teeth of Pacific Northwest species usually have three or more distinct cusps (points or bumps on the top of the tooth), but the otariids normally have one prominent cusp, with one or two minor cusps.

The vertebrae of the lower back (lumbar) have large lateral projections, to which the important swimming muscles of the hind limbs are attached. These vertebrae also fit loosely together to allow considerable lateral and vertical movements. The head of a true seal appears to merge into its trunk with no discernible neck. Arching of the back when resting is typical for many species. Adult male elephant seals raise their heads and chests in upright postures during threat displays to one another to establish dominance.

The breeding strategies of true seals vary considerably. Harbor seals are thought to be monogynous (one male mates with one female), whereas elephant seals are polygynous (one males mates with several females). The more aggressive male elephant seals are recognized as more dominant by other males and are able to breed with more females by challenging less aggressive males on the rookery. Polygyny is a result of this dominance and there is therefore genetic selection for larger and more aggressive male elephant seals. As a result, males are larger and up to three times as heavy as females, whereas there is little difference in size between sexes in monogynous species, such as the harbor seal. The testes of phocids are internal. Females give birth to a single pup, and females of most species are thought to mate within 2 weeks after giving birth. True seals may be born in the water and are capable of swimming immediately. Pups are nursed at regular internals for up to 8 weeks before they are weaned.

World distribution: Phocid seals are found in all oceans of the world but are most concentrated in subpolar and temperate regions.

Fossil record: Phocids are thought to have originated in the north Atlantic, and the earliest fossil evidence is from the middle Miocene. North Pacific species are thought to have evolved from early phocids invading the Pacific from the north Atlantic via the Arctic from late Pliocene to Pleistocene.

Number of species along the Oregon coast: Four.

General references: King (1964), Scheffer (1958a).

Genus Phoca: Northern hemisphere hair seals

Derivation: The word Phoca comes from the Greek Phoca, meaning seal.

General description: These medium-size pinnipeds are found virtually throughout the northern hemisphere, and pelages tend to have either spotted or ribbonlike patterns. The genus has representatives in the thick pack ice of the Arctic, south to 28°N in the north Pacific and 35°N in the north Atlantic. Some species are

found exclusively in freshwater lakes, such as the Baikal seal (Phoca *siberica*); others are found in both near-shore estuaries and in freshwater systems. Members of this genus appear to be monogynous, without conspicuous dominance hierarchies or defense of territories during the breeding season. Males and females are generally similar in size and coloration. The genus Phoca now includes the old genus *Pusa.*

World distribution: The north Atlantic, north Pacific, portions of the several arctic oceans, Lake Baikal, and the Caspian Sea.

Number of species along the Oregon coast: One commonly and two rarely.

General references: None.

Species *Phoca vitulina:*
Harbor seal, hair seal, spotted seal, or common seal

Derivation: The specific name *vitulina* is derived from the Latin word *vitulus* (a calf, sea calf, or seal).

Specific description: Adult males may grow to 1.6 meters in length and 110 kilograms in weight. Except when pregnant, adult females are similar in size and weight to adult males. When ready to give birth, a female may weigh 150 kilo grams. Pups are 0.6 meter long and weigh 7 kilograms at birth. Harbor seals have short hair that may take on a variety of colors and patterns. Newborn pups may have a soft, off-white coat, but it is usually shed while the young are still in the uterus. Some young born early in the pupping season may retain this pelage for 2 weeks before shedding it. Coloration of adults varies from solid off white to solid dark shades or spotted patterns of brown and black. There may be a gradual geographic relationship to the proportion of light or dark colored harbor seals found from the Arctic to their southern limit in central Baja California.

Abundance and distribution: The harbor seal is found in the northern hemisphere from subtropical to subpolar seas. The eastern Pacific population is thought to be 300,000 individuals; the estimated populations in the central eastern Pacific are as follows: California 5,000, Oregon 4,000, Washington, 4,000, and British Columbia 35,000. In Oregon, over 1,500 are found seasonally in the Columbia River; 1,000 in the Umpqua River; 600 to 700 in the Coos Bay-Cape Arago area; 300 to 500 in Tillamook Bay and in the Rogue River (and its offshore reef); and 100 or more in Netarts Bay, in Siletz Bay, in Alsea Bay, and near Bandon. Numerous smaller populations are found along the entire coast. Although harbor seals are considered nonmigratory, individuals from adjacent populations mix to some extent, but their home range is not known. The animals are more gregarious during the pupping season (in late spring) and during the fall (which may coincide with the molting and breeding seasons).

Habits: Harbor seals are among the most common pinnipeds seen near shore and in bays and estuaries. They haul out (climb out of the water) only where water is constantly accessible. These areas include tidal sand bars, mudflats, small rocks, islands, and reefs. In areas where there is little harassment, these animals can be
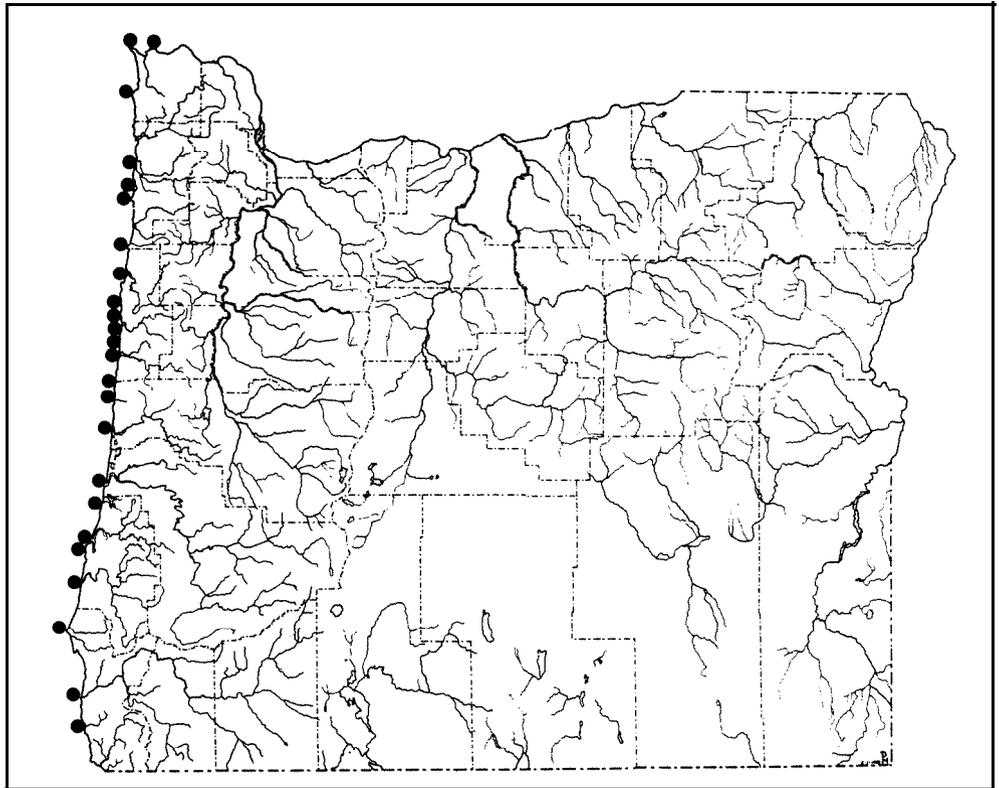
KNOWN DISTRIBUTION OF HARBOR SEAL IN OREGON
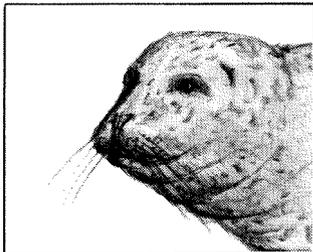
HARBOR SEAL

more easily approached, especially if sudden movements and loud noises are avoided. Harbor seals are wary, however, and are easily scared off their hauling grounds. Harassment, therefore, may be a factor in the choice of a hauling area or its abandonment.

Harbor seals frequently swim alone, although groups of animals adjacent to hauling areas or in rivers may also be seen. The physical size of a haul-out may limit the number of animals using it; for example, a small rock may only be large enough for a single seal. What was originally thought to be precopulatory behavior (two individuals rolling about in the water and biting each other around the head and muzzle) has also been observed between males. This activity occurs from April through September.

Food: The dietary habits of harbor seals in the ocean have been studied by Imler and Sarber (1947) in Alaska, Spalding (1964) in British Columbia, and Scheffer and Slipp (1944) in Washington State. Harbor seals seem to be opportunistic feeders near the shore; they take a variety of bottom fishes and rockfishes, small schooling fishes (such as herring), as well as some salmon and lamprey eels. In recent years, populations of harbor seals in estuaries have been the source of considerable controversy over their effects on anadromous fishes. Observations in rivers and bays indicate that large prey, such as adult salmon or lamprey eels, are brought to the surface but smaller prey are consumed whole underwater.

Reproduction: Harbor seals are thought to mature sexually at 3 to 4 years of age. Dominance or territoriality is not exhibited, and the species appears to be monogynous. This species does not assert dominance by combat, and males and females are about the same size.

Females give birth to a single pup and the time of pupping appears to vary geographically (Bigg 1969a); for example, births occur earlier in California and Oregon than in Washington.

Although most pups in the Northwest are born in April and May, live births as early as mid-February and as late as mid-June occur. Very early in the pupping season newborn animals may be orphaned or, because of their weak state, left along a mainland beach while the mother forages for food. Some of these animals are taken from the beach by well-meaning individuals. This is illegal and may prevent the mother and pup from reuniting.

Pups suckle from 6 to 8 weeks before they are weaned.

Mating has not been observed although active sperm have been found in males from March to November. The first developing embryos have been found during December and may have been implanted as early as mid-November (Bigg 1969b). Implantation of the fertilized egg to the uterine wall probably occurs 2 months after fertilization.

Animals have been maintained in captivity to 32 years of age.

Economic status: Harbor seals were once hunted for their hides. All Pacific States and the province of British Columbia have had control or eradication programs (including bounty systems, open seasons, and government-paid hunters). The species is now protected by the Marine Mammal Protection Act of 1972 in the United States but is still thought by many to have an adverse economic impact on fisheries. Many of these animals are used in zoos and oceanariums because they are small and relatively easy to maintain.

Mortality and diseases: Known predators of harbor seals include the killer whale and several species of sharks. Some fisheries in the Puget Sound area of Washington refer to harbor seals as "killer whale twinkies." In Siletz Bay, Oregon, in the spring of 1976, a female harbor seal had a 0.5-meter shark bite that had completely disemboweled it. In March of 1978, two incidences of seals being eaten by sharks were observed in the Coos Bay, Oregon, estuary.

Selected references: Bigg (1969b), Bishop (1968).

Species *Phoca hispida:* Ringed seal

Derivation: The specific name *hispida* is derived from the Latin word *hispidas* which means spiny, shaggy, or rough. The reference is to the coarse pelage of the adult ringed seal.

General description: The ringed seal is the smallest of the pinnipeds in the north-
ern hemisphere. There is no sexual dimorphism, and adults reach 1.25 meters in
length and 68 kilograms in weight. Females may occasionally weigh more than
this from midwinter to late winter, possibly because of pregnancy combined with
a buildup of a blubber reserve. Pups are 0.6 meter long and weigh 4 kilograms at
birth. They are born with white coats, whereas adults have a spotted or mottled
appearance of brown and black contrasting with a white to dark gray background.
The head of the ringed seal seems small in proportion to its body length when
compared with other phocids.

Abundance and distribution: These animals are commonly associated with land-
fast ice along the northern coast of Alaska. Surveys of this area indicate that the
number of ringed seals varies by region, ranging from 14 per square kilometer in
the Chukchi Sea to 2.3 per square kilometer in the Beaufort Sea. The population
level in the Bering and Chukchi Seas is thought to be high and probably stable.
Soviet estimates of the population in the Arctic Ocean, including the Chukchi Sea,
are 5 million to 6 million and up to 12,000 more in the adjacent oceans. U.S.
estimates of the population in the Bering and Chukchi Seas are about one-quarter
million.

Ringed seals tend to be solitary, although they may congregate around leads
(cracks) in land-fast ice. In open water they may congregate in certain areas for
feeding or during migrations. Ringed seals are widely distributed along the open
coast, especially areas that are not readily accessible to humans. Between 12,000
and 16,000 individuals are taken each year by U.S. or Soviet hunters; ringed seals
are also the most dependable source of food for many remote villages.

The discovery of a single individual off the southern California coast makes
sighting of this species possible for the Oregon coast.

Food: Feeding habits of ringed seals vary greatly by season and location. Major
foods in western Alaska are mysids, amphipods, shrimps, saffron, polar cod, and
sculpins.

Reproduction: Males become sexually mature between 6 and 8 years of age, and
females between 5 and 7 years. Females give birth to a single pup, from late
March through April, in birth lairs within ice pressure ridges or under drifted snow.
The pup is suckled 4 to 6 weeks, during which time it may triple its weight and
the mother stays close to the pup. Breeding is thought to be monogynous and oc-
curs annually. The gestation period is 10.5 months. Animals may live 35 years.

Economic status: These animals are a source of food and material (skins, teeth,
etc.) to Natives in the Arctic. They are not known to eat commercially valuable
fishes.

Mortality and diseases: Predation by sharks and killer whales is presumed.
Ringed seals appear to be an important food resource for polar bears who eat the
blubber. Little is known about the diseases of ringed seals. Some mortality of
adults may occur during fights in the breeding season; severely scarred animals
are frequently seen in the spring.

Selected references: None.

Species *Phoca fasciata*: Ribbon seal

Derivation: The specific name *fasciata* is derived from the Latin word *fascia* (a band) and refers to the bands on the species' pelage.

General description: Males and females average 1.55 meter in length and 80 kilograms in weight, although a large 23-year old female was measured at 1.8 meter in length and 148 kilograms in weight. Pelages of males and females are similar, with a distinctive dark band over the shoulders, along the sides, and over the rump. Pups are 0.8 meter long, weigh 10 kilograms, and have a white coat at birth.

Abundance and distribution: Individuals are solitary and may be found to the southern limit of the drifting pack ice in the Bering Sea, Sea of Okhotsk, and the Chukchi Sea. Two stocks have been identified, one in the Bering Sea and one in the Sea of Okhotsk. Aerial and shipboard surveys have resulted in an estimate of 200,000 to 250,000 individuals. There has been concern that this population may be relatively low and declining as a result of commercial hunting. Such concern has resulted in stricter regulation of the harvest. A single ribbon seal was recovered in southern California, so this species may appear along the Oregon coast.

Food: Ribbon seals feed mainly on pelagic and demersal fishes, although cephalopods may be important at times.

Reproduction: Females mature at 2 to 4 years of age, but males mature at 3 to 5 years. Pregnancy rates are unknown. The birth season is from late March to mid-April. The mating season is from late April to early May. Gestation is 10.5 to 11 months. An estimate of the 1st-year mortality rate is 44 percent and, thereafter, 11.2 percent per year. Individuals may live 26 years.

Economic status: Approximately 3,500 of these animals are taken in the Sea of Okhotsk and 3,060 in the Bering Sea, primarily by Soviet sealing operations. Eskimo and Aleut peoples harvest some for food and hides.

Mortality and diseases: Nothing is known of the natural diseases or predation of this   species.

Selected references: None.

Genus   Mirounga: Elephant   seals

Derivation: The generic name *Mirounga* is derived from the aboriginal Australian *miroung,* the name for the elephant seal.

General description: Elephant seals are the largest of the pinnipeds. Males may reach over 6.5 meters in length and weigh over 3 500 kilograms. The females are smaller, about 3.0 meters long and 1 000 kilograms in weight. The males are dark gray, fading to a grayish brown through the years. Females are a deeper brown and generally darker than the males. The snout of adult males is the most characteristic feature of this genus. At adulthood, the snout becomes enlarged, up to 38 centimeters, and the nostrils are directed toward the open mouth, acting as **a** resonating chamber. The roars or snorts are usually reserved for breeding periods.

ELEPHANT
SEAL

World distribution: A northern hemisphere species of *Mirounga* is distributed in the eastern Pacific from southeastern Alaska to mid-Baja California. A southern species has a circumpolar distribution on subantarctic islands.

Number of species along the Oregon coast: One.

General references: King (1964), Scheffer (1958a).

Species *Mirounga angustirostris:* Northern elephant seal

Derivation: The specific name *angustirostris* is derived from the Latin words *angustus* (narrow or small) and *rostrum* (a snout or beak).

General description: Males grow to 4.9 meters in length and 1 800 to 2 300 kilograms in weight; adult females, to 3.3 meters and 800 kilograms. Pups are 1.2 meter long and weigh 33 to 45 kilograms at birth. The hair of this species is short, stiff, and without underfur. During annual molting, the skin and hair are sloughed off in large patches. Newborn pups have black hair, but they molt at 1 month as they are weaned and become "silver" colored. The coloration of adults is uniform, except during the molt, varying from light gray to yellowish or brownish, although algal growth or copepods may be responsible for a greenish tinge on animals spending long times at sea. There is pronounced sexual dimorphism and adult males are characterized by a large nose or proboscis, from which they derive their common name, elephant seal. The proboscis starts to develop at about 5 years of age and is used during trumpeting vocalizations to establish and maintain dominance among males during the breeding season.

Abundance and distribution: The elephant seal was once near extinction in the late 19th century but has repopulated its previous range, following rapid population growth under complete protection during most of this century. Although the population may have numbered fewer than 100 at the turn of the century, it was likely between 40,000 and 60,000 individuals by 1980. The largest single population is on Isla Guadalupe, Mexico. As numbers have increased, the range of the elephant seal has extended to both the north and the south.

The breeding range is from Isla Natividad (27°N), off central Baja California, Mexico, to the Farallon Islands (37°N) off San Francisco, California. Animals calve and breed primarily on offshore islands, but there are a few rookeries on the mainland.

Although no patterns of migration have been documented, tagged animals from within the breeding range have principally moved north of their rookery during the nonbreeding season. Some of these have ranged as far as the Gulf of Alaska. Individuals may be totally pelagic during much of the year, as indicated by algal growths on the hair and a lack of sizable populations onshore, except during the breeding and molting seasons. Assessment of populations is difficult because all age and sex classes are not on shore at any one time. Counts during portions of the molting period, which peaks in April, are higher than counts during the breeding season. During the pupping period, pups frequently outnumber the adults.
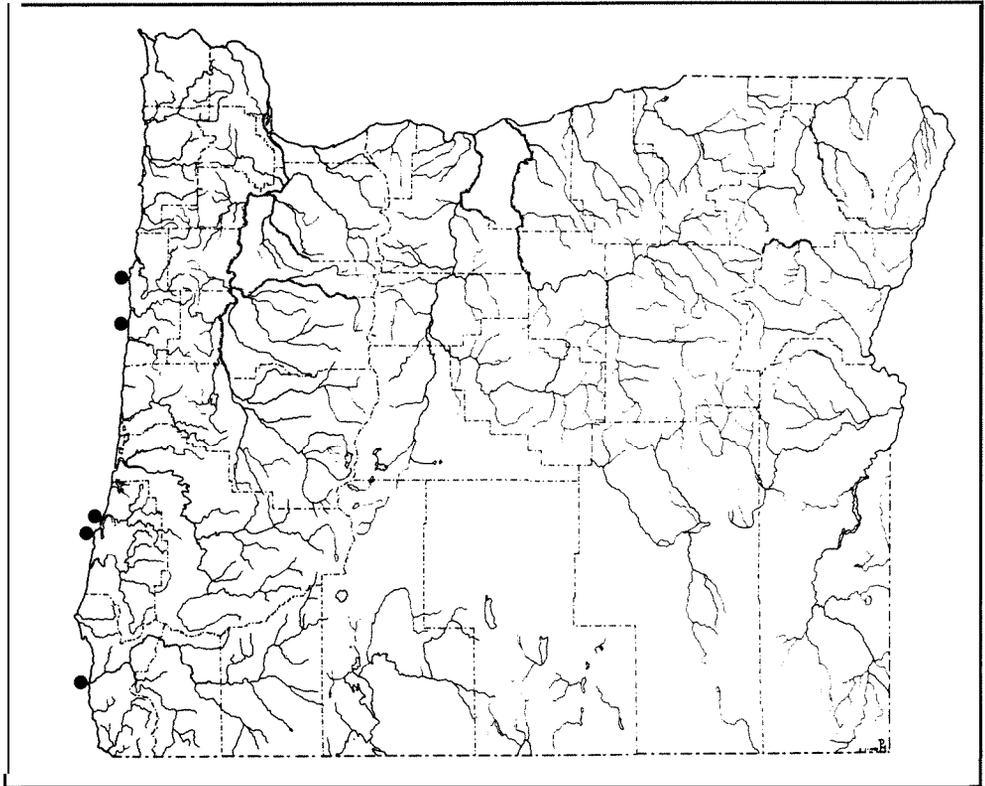
KNOWN DISTRIBUTION OF NORTHERN ELEPHANT SEAL IN OREGON

Habits: The elephant seal is easy to approach on land, and this led to its rapid exploitation during the 19th century by whalers seeking any source of oil.

Although unable to rotate their hind flippers forward as eared seals do, elephant seals can move rapidly by the typical phocid undulatory movement. During the breeding season, adult males will charge intruders-other male elephant seals and humans.

Elephant seals are gregarious during the breeding season and extremely tolerant of other species of pinnipeds. California sea lions frequently haul out adjacent to elephant seals during this season.

Northern elephant seals are the largest pinnipeds in the northern hemisphere. Their southern counterpart, the southern elephant seal, *Mirounga leonina,* is the largest pinniped in the world. Because of their large size, these seals yielded a large amount of oil. As a consequence of heavy exploitation, this species was so reduced that it was thought to be extinct even before it was scientifically described. The blubber layer may be 15 centimeters thick and account for 40 percent of an animal's weight.

The polygynous breeding behavior of these seals is the result of male-dominated hierarchies established before the pupping and breeding season, which is late December through February. Males fight with one another to establish relative dominance. Once established, these relationships are maintained primarily by vocalizations, although fighting does occur when a new male tries to enter the breeding area. The most dominant male is responsible for most of the breeding in his area of the rookery. This selection process of large and aggressive males succeeding to breed has resulted in conspicuous sexual dimorphism in the species. Males who have not achieved adequate dominance to participate in breeding may be found around the perimeter of the breeding rookeries, and some may be heard "practicing" their vocalizations in grottos and coves.

Females usually do not leave pups after birth until they are weaned; pups therefore have continuous access to their mothers' milk. They derive so much energy (40-percent fat content early in the season) that they appear to swell during the suckling period, weighing two to three times their birth weight. Most deaths of pups occur either from starvation as a result of the pup not being able to find its mother, from injury as a result of being inadvertently trampled on by adult seals, or frequently from bites by females other than their mothers while attempting to suckle. While on land, elephant seals prefer sandy areas and are frequently seen flipping sand over their backs with their flippers. It has been suggested that this shades their skin and may be useful in thermoregulation since evaporative cooling from the moist sand may provide some relief from the heat.

Food: Elephant seals apparently feed both in near-shore and offshore waters. Species consumed include bottom and midwater fishes, squid, small sharks, and skates.

Reproduction: Males are sexually mature at 5 to 6 years of age. Females may give birth at age 3, although 4 or 5 is more common. Sexual maturity in males occurs before they are physically and socially mature enough to compete for dominance during the breeding season. Most males probably never breed. Successful males may breed for 2 or 3 consecutive years.

Females give birth to a single pup during December or January and usually breed a week later. The gestation period is 11 ½ months. At Año Nuevo Island, California, 15 to 26 percent of all pups die within 3 months of birth (LeBoeuf 1974). Some elephant seals have lived more than 20 years.

Economic status: Once highly valued for oil, elephant seals have been protected by the Mexican government since 1922 and more recently by the United States. A few elephant seals are presently captured for zoos.

These animals are a source of considerable public interest, and many cruises from southern California visit islands where elephant seals breed during the winter. Tours of rookeries on land at Año Nuevo Point, California, are extremely popular.

Elephant seals have had little conflict with commercial or sport fisheries, despite their relatively high numbers.

Mortality and diseases: Mortality of pups is usually caused by starvation, injury associated with trampling by adult seals (usually males), or rejection by females other than their mother. Some adult mortality is the result of intraspecific competition, the most obvious being the fighting between males prior to the breeding season. Predators include killer whales and sharks, especially great white sharks.

Selected references: LeBoeuf (1971, 1974), Odell (1974, 1977).

Family Otariidae: Eared Seals

SEA LION

Derivation: The familial name *Otariidae* is derived from the Greek word *otaros* (large eared), combined with the Latin suffix *idae* (family).

General description: Eared seals include the animals commonly referred to as sea lions and fur seals. They are most easily separated from other pinnipeds by their ability to rotate the hind limbs forward and walk on land on all four limbs (quadrupedal). On close inspection, small external ear flaps (pinnae) can be seen.

During swimming, the foreflippers provide the principal means of locomotion, and the rear flippers, with their soles pressed together, act as rudders. The upper arm and upper portions of the forearm are within the main body contour. The lower forearm, wrist, and digits are the bone elements composing the external foreflippers which bend laterally to form a right angle at the wrist for upright postures on land. The digits of the foreflippers have extensions of cartilage that do not fold. Heavy webbing is found between these digits. The first digit forms the front edge of the flipper, is more robust, and is strengthened with subcutaneous fibrous tissue. The foreflippers are hairless and black and have reduced nails that appear at the junction of the bony digit and its cartilage extension.

The hind flippers are webbed with extensions of cartilage, forming an uneven margin of indentations between the digits. These cartilagenous extensions can be folded to expose the nails of the three central digits which can be used even for delicate scratching of the nose. The two outer digits also have small nails, although they may not be visible.

The vertebrae of the neck have strong projections to which the muscles of the neck attach, allowing more diverse movement of the neck and head than in true seals. The chest vertebrae are posterior to the neck and also have large projections for attachment of muscles important in movement of the foreflippers.

In eared seals, the saggital crest is well developed, and in some individuals it develops to such an extent that it becomes a conspicuous external feature (forming a high forehead or a bump on the top of the head).

The teeth of eared seals are relatively unspecialized; the teeth behind the canines are simple, laterally flat, and cone shaped to facilitate gripping prey.

Because of the seal's need to quickly move its head from side to side in the pursuit and capture of prey, the muscles of the elongated neck are well developed, as are those of the back and shoulders which are important in the swimming motions of the front flippers.

Conservation and dissipation of heat can be an important problem for these animals. While in the water, they must insulate themselves to prevent loss of body heat. On land they may encounter high enough temperatures that loss of body heat is equally important. Insulation is accomplished by the hair or fur and the buildup of body fat (blubber). Sea lions depend more on blubber, since they have primarily coarse hair with little insulative underfur. Sea lions in general have a more temperate distribution and are less tolerant of cold than are fur seals (the Steller sea lion is one exception).

Northern fur seals have 19 shorter, softer underfur hairs for each of their long, stiff guard hairs. Each hair grows from a separate follicle, and molting occurs one hair at a time without changes in the skin. Although the whiskers are hairlike, they are not thought to molt.

When eared seals are out of the water and overheat because of warm temperatures or heavy exertion, heat can be radiated from the body either by panting or by the selective opening of blood capillaries near the surface of the flippers. Heat is typically conserved in the area of the flipper by means of countercurrent systems in which warm blood moving from the central body to the limb passes blood returning from the limb and transfers its heat to the blood returning to the body. This allows blood reaching the extremities to have the least temperature difference with its environment.

Eared seals breed on land, although some males may hold semiaquatic territories. Testes are located in the scrotum. Pupping typically occurs just before mating, and an 11 %-month gestation period with delayed implantation assures year to year synchrony of these events. Suitable land (isolated mainland beaches and islands) for eared seals to breed on is limited. Competition occurs between males for breeding territories. Males usually establish territories by fighting, but they are maintained by stereotyped boundary displays (vocalizations and posturing) and other nonviolent behavior. Usually the largest and most aggressive males are successful in acquiring the best territories, which usually include direct access to water.

Females are attracted to the best territories and thus the larger, more aggressive males breed more often, and their genes are transmitted to the next generation, emphasizing these characteristics. This has resulted in a great difference between the sizes of males and females. One male breeds with many females, but he has nothing to do with rearing the pups.

Many males do not leave their territories throughout the breeding season, during which time their energy is derived from the stored body fat in the layer of blubber; as a result, many lose considerable weight. Females, after giving birth to a single pup, go to sea to feed between periods of nursing.

Weaning may take up to a year in some species, and occasionally a female Steller sea lion may be seen nursing a pup of the year as well as a yearling.

World distribution: Eared seals are found throughout the world in temperate and subpolar waters. Sea lions typically have a temperate distribution, whereas fur seals prefer colder waters. Exceptions to this include a subspecies of California sea lion at the Galapagos Islands (a tropical setting at 1 "S), the northern extension of the Steller sea lion in the subarctic, populations of northern fur seals at San Miguel Island off southern California (34°N), and Guadalupe fur seals at Guadalupe Island, Baja California, Mexico (30°N).

Fossil record: Eared seals are thought to have evolved in the north Pacific, and fossil evidence dating from the middle Miocene resembles modern forms. Most of the fossil material recently unearthed has come from the Pacific Northwest.

Number of species along the Oregon coast: Three.

General references: King (1964), Scheffer (1958a).

Genus Eumetopias:
Steller sea lion or northern sea lion

Derivation: The generic name Eumetopias is derived from the Greek prefix *eu,* meaning "good" or "true," and *metopias,* meaning "with a broad or high forehead."

General description: There is only one species in this genus. The generic description is under the species.

World distribution: Same as that under the species.

General references: Same as those under the species.

Species *Eumetopias jubatus:*
Steller sea lion or northern sea lion

Derivation: The specific name *jubatus* is the Latin word for "maned" or "having a mane."
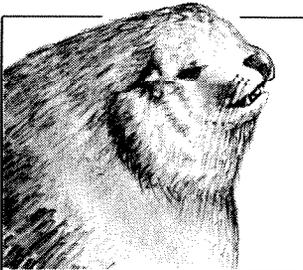
STELLER SEA LION

Specific description: Adult males grow to 4 meters in length and 950 kilograms in weight; females, 2.8 meters in length and 500 kilograms in weight. Pups are about 1 meter long and weigh 16 to 33 kilograms at birth. Mature animals are yellowish brown or tan, occasionally off white. When wet, this color may appear light brown, and in subadults may appear silver. Newborn pups are dark brown to black. Subadults have a light brown pelage. The species has moderately long, stiff hair, and males develop a mane of coarse hair around the neck. The neck and shoulder muscles are well developed in territorial males. The muzzle-to-forehead profile of females and subadults is flat, in contrast to the male's well-developed forehead. The tooth structure is typical of members of this family, but there is a space between the fourth and fifth postcanines'of the upper jaw.

Abundance and distribution: The Steller sea lion ranges from San Miguel Island (the most northerly of the California Channel Islands) along the west coast of North America, throughout the Aleutian Islands and as far north as St. Matthew Island. In the western Pacific, it ranges south from the Aleutian Islands to Hokkaido, Japan.
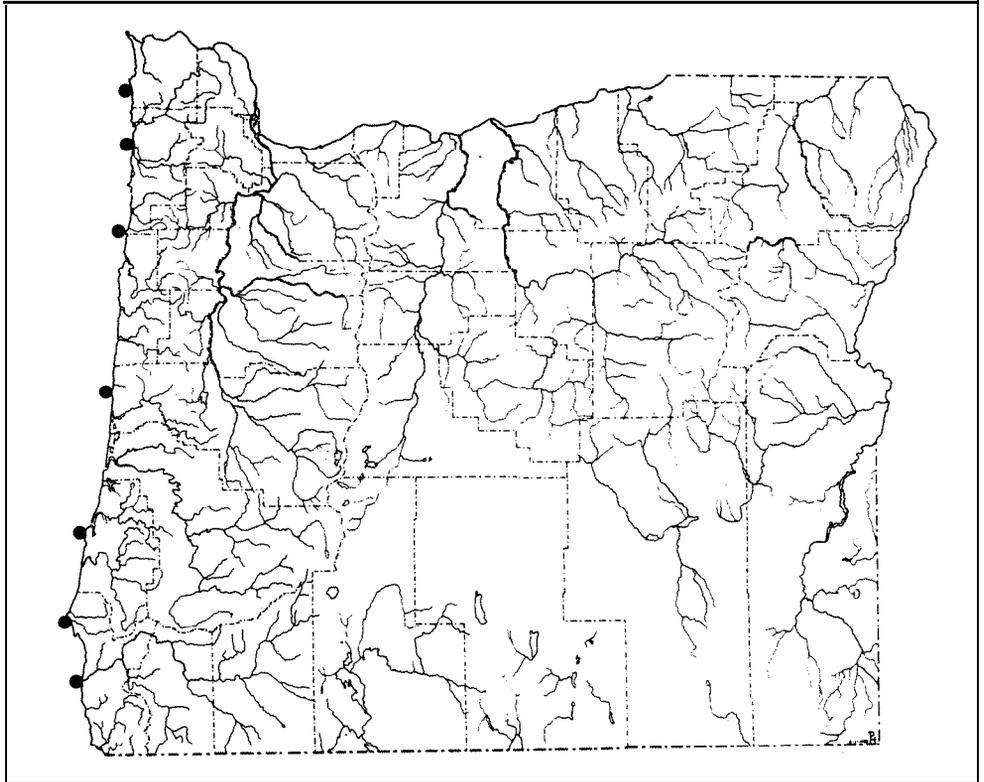
KNOWN DISTRIBUTION OF STELLER OR NORTHERN SEA LION IN OREGON

The only population estimate is an amalgamation of estimates made by various investigators at different times for specific geographical areas and years. The world population has thus been estimated to be between 250,000 and 300,000 individuals (Kenyon and Rice 1961).

At the end of the breeding season in mid-July, adult males in California, Oregon, and Washington move north into British Columbia and Alaska so that by the end of October, no adult males are found along the Oregon coast (Mate 1975). Females and pups, however, overwinter in these more southerly areas, but since their numbers decline during the winter, some females may also move north. Four thousand individuals breed in California, 3,000 in Oregon, and no more than a few hundred in Washington.

During the early part of this century, Steller sea lions were the most abundant pinniped in the California Channel Islands. By the 1950's, however, California sea lions were more abundant. Steller sea lions in that area presently are limited to rocks off San Miguel Island and number less than two dozen. The reason for the

reduction of this species in the southern extent of its range is unknown. A recent decline in the population at Año Nuevo Island (40 miles south of San Francisco) follows 50 years of relatively stable numbers. Declines are also suspected in some populations of the Aleutian Islands.

Habits: The Steller sea lion breeds almost exclusively on rocky areas of offshore islands. Few mainland rookery or hauling areas are known.

The animal's vocalization is a low growl. Distinctive vocalizations can be recognized for pups, females calling pups, and males performing territorial displays or challenging intruders.

Males fight one another for territorial rights before the breeding season, and they mate with estrous females found within their territory. Once territories are established and females start to fill the rookery, territorial displays between males on adjacent territories allow them to maintain the territories without much physical contact. The number of these displays is more frequent for males adjacent to new territory holders. Although males may become sexually mature at 4 years, they are not competitive enough to hold territories until about age 10. The importance of dominance to breeding success has given larger animals an advantage that has probably led to evolution of larger males than females.

Although considered a near-shore species, Steller sea lions have been observed 100 miles offshore. In many portions of their range, groups of animals are seen leaving an area together, and they may feed together.

Food: Stomach contents have included many types of near-shore fish and cephalopods. The species is considered an opportunistic feeder, and the stomach contents usually reflect the relative abundance of the prey in an area. Individual animals have been found with stomach contents of single species-such as squid, hake, or herring-but mixtures are more common. In some areas rockfish appear important.

Reproduction: Both males and females may become sexually mature as early as age 3, although 4 years is more common. Males are not large enough to hold territories and gain access to estrous females until about age 10.

Soon after arriving at a rookery, pregnant females each give birth to a single pup. Within 2 weeks they come into estrus and mate. The mating period is June through mid-July. There is delayed implantation. The gestation period is 11.5 months, resulting in a l-year reproductive cycle. Pregnancy rates of over 80 percent are common for sexually mature females. Individuals of this species may live more than 24 years.

Economic status: Once used by Indians and Eskimos as a source of food and material for the construction of clothes and cultural artifacts, the Steller sea lion now has little commercial value. Small numbers are still taken in the northern portion of its range for subsistence. Stellers have been implicated in various conflicts with the fishing industry, including consumption of fish caught by humans (such

as halibut and black cod from longlines), destruction of king crab pot buoys, and occasional damage of gillnets. On the other hand, Steller sea lions are a source of tourist revenue at places like Sea Lion Rock (San Francisco) and Sea Lion Caves (Florence, Oregon).

Mortality and diseases: Known predators of Steller sea lions include killer whales and sharks. Walrus occasionally eat Steller sea lion pups. Harvest of this species in the United States is for subsistence, although incidental kills occur in some fisheries. Information on naturally occurring diseases is minimal, although leptospirosis and sea lion virus have been confirmed and have been implicated in contributing to premature births.

General references: Gentry (1970), Mate (1975), Sandergren (1970).

Steller sea lion and California sea lion.

Genus Zalophus: California sea lion or circus seal

Derivation: The generic name Zalophus is derived from the Greek prefix za, an intensive meaning "very," and the Greek word *lophos* (the crest). The name refers to the development of the prominent bony (sagittal) crest along the top of the brain case in members of this genus.

General description: There is only one species in the genus. The generic description is under the species. .

World distribution: Same as that under the species.

General references: Same as those under the species.

Species *Zalophus californianus:*
California sea lion or circus seal

Derivation: The specific name *californianus* is a proper name. The species was named after the State of California, which is designated by the Latin suffix *anus* (belonging to). Therefore, *californianus* means "belonging to California."

Specific description: Adult males grow to 2.7 meters in length and 250 kilograms in weight, and adult females to 1.9 meter and 140 kilograms. Pups are 0.75 meter long and weigh 5 to 6 kilograms at birth. Adults are light to dark brown, and pups at birth are dark brown to black. When wet, animals may appear black. In the southern extent of the range, adults are lighter colored; females are lighter than males, approaching the tan or light tan of Steller sea lions-differences in size and the small area in which their populations overlap make confusion unlikely. A more difficult distinction is that of immature or female California sea lions with immature Steller sea lions because both may appear light brown and have a flat muzzle-to-forehead profile. Adult male California sea lions start to develop a pro- nounced sagittal crest by age 5, which easily distinguishes them from other species. The sagittal crest is quite apparent by the time males become territorial; in addition, the pelage over the sagittal crest may be lighter than over the rest of the body. Adult males may also have light eyebrows.

Abundance and distribution: One subspecies of the California sea lion (*Zalophus californianus californianus*) breeds principally from the California Channel Islands (although pups have been born as far north as the Farallon Islands) south to the southern tip of Baja California, Mexico, and throughout the Sea of Cortez. Two other subspecies have been described. *Zalophus californianus wollebaeki* inhabits the Galapagos Islands at latitude 1 "S, and *Zalophus californianus japonicus,* which used to inhabit Japanese waters, is thought to be extinct. The eastern
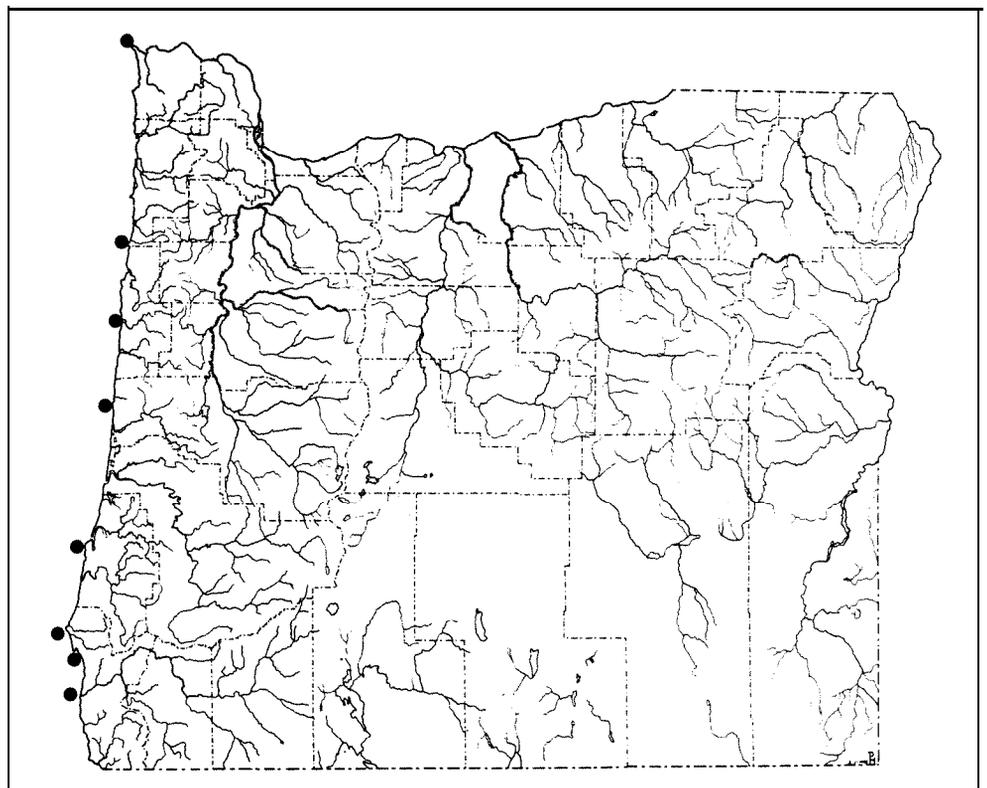
KNOWN DISTRIBUTION OF CALIFORNIA SEA LION IN OREGON

Pacific population is estimated to be more than 100,000 individuals. About 10,000 animals inhabit the Sea of Cortez (Gulf of California). After the breeding season, which ends in mid-July, some adult and subadult males move north of the breeding range and overwinter in British Columbia as far north as 50°N; thus, there are no breeding populations in the Northwest; but migrant maies are the predominant pinniped species during the winter.

During the last 50 years, this species has increased from low numbers to become the most abundant pinniped in the California Channel Islands. It is not known whether this increase represents an increase in the population or merely a redistribution. Populations in Oregon reach a seasonal peak in September and October of up to 3,600 individuals. Females have been observed as far north as the Farallon Islands, where they have given birth.

Habits: The California sea lion is the common "circus seal." Because of its small size, the ease with which it can be trained, and its mild disposition, this species has been chosen and is preferred by zoos and oceanariums.

The vocalization of this animal resembles a dog's bark and under favorable weather conditions can be heard up to 2 kilometers.

The California sea lion is commonly seen "body surfing" near shore. When traveling at high speed, an animal leaps clear of the water (termed "porpoising"). In recent years, the species has become a common sight in many bays and rivers. In fact, one individual was sighted in April 1977 at the top of Bonneville Dam (240 km from the ocean). The U.S. Navy has trained California sea lions to recover objects from the ocean floor. Individuals may dive to depths of 200 meters. A maximal diving time of 20 minutes is possible, although dives for feeding typically last 3 to 7 minutes. Groups of animals performing synchronous dives suggests that they feed together.

California sea lions breed on both rocky and sandy beaches (principally on islands).

Food: The California sea lion was long thought to be a squid and anchovy feeder, primarily because of stomach contents examined in southern California during months when squid and anchovy were abundant. It is now known, however, to be an opportunistic feeder, and it feeds extensively on hake-at least seasonally-in the Pacific Northwest.

During the winter of 1976 when herring were spawning in Yaquina Bay, two groups of California sea lions, up to 10 individuals each, made synchronous dives lasting up to 7 minutes. After surfacing, the group breathed heavily for about 3 minutes and then dove again in unison. Although no surface feeding was observed, one California sea lion was traumatically injured, subsequently euthanized, and its stomach examined; its stomach contained large numbers of herring and herring egg masses. Stomach contents also indicate that these animals feed on rockfish and sculpins.

During the Oregon winter, a portion of a California sea lion population leaves the hauling area in late afternoon and early evening, returning to the area and hauling out from sunrise to midday. Examination of stomachs of animals collected from sunrise to midday revealed fuller stomachs and less digested prey than those collected in the afternoon, indicating nocturnal feeding (Mate 1975).

Since the passage of the Marine Mammal Protection Act in 1972 (U.S. Department of Commerce 1978), reduced harassment around mouths of rivers has led to more extensive use of these areas by the sea lions. Observations of surface feeding show consumption of large salmonids and lamprey eels, but the stomachs contain smaller fishes that are apparently swallowed whole underwater. Prey brought to the surface apparently are limited to that which is difficult to kill or must be swallowed in several bites. Large fish are bitten in the belly, brought to the surface, and shaken violently, thereby ripping the stomach from the body. The fish may then be eaten at the surface; bites are torn off if the fish is too large to be swallowed whole.

Reproduction: Females are thought to be sexually mature by age 4, although some may mature at 3. Males are thought to become sexually mature at age 4 to 5, coinciding with the initial development of the sagittal crest. Males do not become breeders, however, until they are more physically mature, about age 9 or 10. Pregnancy rates may be as high as 90 percent for adult females. Females give birth to a single pup between the end of May and the end of June. The gestation period is 11.5 months, including a period of delayed implantation. Individuals may live more than 20 years.
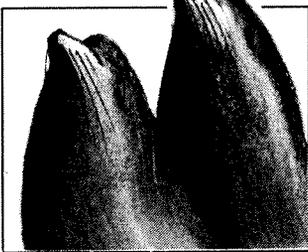
Economic status: There is high demand for live California sea lions for the various display industries (zoos, oceanariums, circuses). The cost of obtaining appropriate permits to capture these animals has risen, making each animal more valuable. The animals are considered a positive resource for tourism in several places along the coast and at the mouths of some rivers, such as the Monterey Bay, Breakwater, and Santa Cruz in California, and Sea Lion Caves in Oregon. Fishery interests, however, view them as competitors for mutually desirable species of fishes; considerable controversy exists over their presence in river systems.

CALIFORNIA SEA LION

Mortality and diseases: Sharks and killer whales are known predators of this species.

Odell (1971) reported increased numbers of premature births during 1970 at San Miguel Island off southern California. During the fall migration, after the pupping and breeding season, Mate (1975) reported the following symptoms in California sea lions: lethargy, the seeking of freshwater, and high blood urea nitrogen levels. The cause of the symptoms was later diagnosed as Leptospira, a bacterium (Vedros et al. 1971). Over 75 percent of the migrant population apparently was affected, and the following year less than 25 percent of the normal numbers participated in the migration to the Northwest.

Subsequent investigations of the natural diseases of California sea lions have led to numerous discoveries of other pathogens. The most recent and startling of these findings is the discovery of the San Miguel sea lion virus, which is

serologically and immunologically identical to Xanthema, a virus of swine (Smith et al. 1973). The disease first appeared in 1932 in southern California swine populations. Kept under control in a localized area, the disease did not surface again until 1952 when it became widespread in a short time and moved outside California. Afflicted animals were killed and incinerated *or* buried, and the disease was finally brought under control at a cost of $6 million. Both outbreaks were traced to the consumption by swine of garbage that may have included material from marine mammals. Marine mammals are thought to be the reservior of this virus which has periodically found its way into terrestrial species (Smith et al. 1977).

A die-off in 1970 and 1971 of sea lions stimulated numerous research projects to identify the problem, including studies of the heavy metal and chlorinated hydrocarbon content of the tissues of marine mammals (Buhler et al. 1975, Delong et al. 1973, LeBoeuf and Bonnell 1971). Many such toxicants were found in higher concentrations than in any animal previously examined. It is likely that the high concentrations of mercury in livers and cadmium in kidneys are from naturally occurring sources in the marine environment, although coastal effluents may be a factor in some areas. The highest levels of chlorinated hydrocarbons and polychlorinated biphenyls yet known for animals were also found concentrated in the blubber of pinnipeds. The levels of metals and persistent toxicants made by humans were higher in sick animals captured during a particular year than they were in healthy animals collected other years. It is not known, however, whether these high levels predisposed animals to contract this disease or whether the illness resulted in fasting, which reduced lipid (fat) content and resulted in an increased concentration of the fat soluble human-made compounds (Buhler et al. 1975).

Selected references: Mate (1975), Odell (1975), Peterson and Bartholomew (1967).

Genus *Callorhinus*: Fur seal

Derivation: The generic name *Callorhinus* is derived from the Greek words *kalos* (beautiful) and *rhinos* (a nose).

General description: There is only one species in the genus. The generic description is under the species.

World distribution: Same as that under the species.

General references: Same as those under the species.

Species *Callorhinus ursinus:* Northern fur seal

Derivation: The specific name *ursinus* is a Latin word that means "resembling a bear."

General description: Adult males grow to 2.5 meters in length and 300 kilograms in weight; adult females measure 1.8 meter and 65 kilograms. Pups are 0.7 meter long and may weigh from 4.5 to 9.0 kilograms at birth. Adult males are predominantly dark brown to black, but the color varies greatly and may appear dark

gray or reddish brown. Males beyond age 6 start to develop a thicker pelage around the shoulders and neck that may include some white hairs. Females and young males are dark gray dorsally and brownish gray ventrally. After a short period on breeding rookeries, however, they may appear yellowish brown from the stains of mud and excrement which do not fade until they molt. Pups are born with a coarse black pelage that molts and becomes dark gray after about 8 weeks. Typical of fur seals, the pelage is dense and soft (300,000 hairs per square inch). They have a short muzzle and long flippers.

Abundance and distribution: There are about 1.7 million northern fur seals distrib uted among five main breeding areas. The most important of these is the Pribilof Islands in the eastern Bering Sea which support 1.3 million animals, followed by the Commander Islands in the western Bering Sea with 265,009, Robben Island in the Sea of Okhotsk with 165,000, the Kurile Islands in the western north Pacific with 20,000, and San Miguel Island off southern California in the eastern north Pacific with just over 2,000.

Northern fur seals give birth on these islands during June and July. In the eastern Pacific, after the pupping-breeding season at the Pribilof Islands, adult females and subadults of both sexes migrate south as far as southern California. Many adult males remain in northern waters; all animals are pelagic at least 8 months of the year.

The Russian explorer, Vitus Bering, and his naturalist, George Wilhelm Steller, described fur seals during their 1741 voyages to the Bering Sea. The Pribilof Islands' population was discovered in 1786, and millions of pelts were taken dur- ing the next few decades. The populations were greatly depleted by 1834, and the Russians forbade the killing of females. The United States recognized the fur seal as an important resource, and this influenced its decision to purchase Alaska in 1867. From 1889 to 1909, over 600,000 fur seals were harvested by pelagic sealing (shooting fur seals from ships at sea without discriminating by age or sex). The peak of pelagic sealing occurred in 1894 when nearly 62,000 pelts were sold. For each pelt recovered, at least one other animal was wounded or unrecovered, which resulted in the herds being reduced from an estimated 2 million to about 300,000. Pelagic sealing was stopped by international agreement in 1911, and the population increased rapidly. By the late 1930's, Japan abrogated the fur seal treaty because of its concern over the predatory effects of the large seal herds on its commercial fisheries. The treaty was reinforced by a similar convention in 1957, however, and remains in force today.

Fur seals are rarely seen ashore on the Oregon coast.

Habits: Northern fur seals are pelagic most of the year and are usually seen from 16 to over 160 kilometers offshore, either as individuals or in groups. Frequently while resting at sea, they assume a "jug handle" posture (tips of hind flippers and one foreflipper touching above the water).

Food: Fur seals feed from evening to early morning and often sleep during the day. They dive to depths of 190 meters while foraging. The remains of 54 species of fishes and 9 species of squid have been identified from their stomachs. Fur seals appear to be opportunistic feeders, and prey include small schooling fishes-such as anchovy, capelin, and herring. Pollock is the principal prey in the Bering Sea. Squid is a common feature of the offshore diet. Off the Oregon coast, anchovy, hake, saury, and rockfish are the principal prey. Fur seals in captivity have maintained their weight on diets of 4 to 20 percent of their body weight per day. This wide range may depend on the seasonal caloric value of the fish they consume and on seasonal changes in their metabolic rate, based on activity.

Reproduction: Females become mature at 3 to 4 years, whereas males mature at 5 or 6. Males, however, may not breed until they are large enough to become competitive for territories. Once mature, the pregnancy rate of females is about 80 percent. Pups are born from mid-June to late July, and females breed within 2 weeks after giving birth. A delayed implantation of 3⅓ to 4 months occurs. The gestation period, including delayed implantation, is 11 months. Animals may live over 25 years.

Economic status: Aleuts derive most of their income from harvesting seals at the Pribilof Islands for the U.S. Government. The harvest is composed primarily of 3- and 4-year-old bachelor males. One of the islands, St. George Island, is no longer harvested, but an average of 30,000 fur seals are taken annually at St. Paul Island. Because of the polygynous breeding behavior of this species, the harvest of young males is thought not to reduce the reproductive potential of the population, although there is some question of whether this selective harvest technique may have some long-term genetic ramifications. The skins of fur seals taken by the United States are shared with Canada and Japan who, in return, agree not to resume pelagic sealing. The United States gives Canada and Japan 30 percent of the annual take, 15 percent to each country.

Mortality and diseases: Mortality of pups has been shown to be highly correlated with the density of animals on rookeries. Pups may inadvertently be killed by fighting or copulating males. Hookworm and dysentery are both early factors in mortality of pups. Starvation that occurs after weaning may account for considerable mortality. First-year mortality may account for 50 percent of the newborn pups. Mortality from birth to age 3 is about 70 percent and varies, depending on the weather at sea.

Fur seals are eaten by sharks and killer whales, and pups are occasionally eaten by Steller sea lions.

Known diseases include leptospirosis and a virus that induces premature birth in females.

Selected references: Scheffer (1970), U.S. Department of Commerce (1976).

NORTHERN FUR SEAL

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Fishes

Common name	Scientific name
Anchovy	*Engraulis mordax*
Arctic cod	*Boreogadus saida*
Blue lanternfish	*Tarletonbeania crenularis*
Bonito	*Sarda chiliensis*
Brown cat shark	*Apristurus brunneus*
Capelin	*Mallotus villosus*
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*Oncorhynchus keta*
Dogfish	*Squalus acanthias*
Herring	*Clupea harengus*
Jack mackerel	*Trachurus symmetricus*
Lamprey	*En tosphenus triden ta tus*
Ling cod	*Ophiodon elonga tus*
Mahi-mahi	*Coryphaena hippurus*
Pacific angel shark	*Squa tina californica*
Pacific cod	*Gadus macrocephalus*
Pacific sand lance	*Ammodytes hexapterus*
Pink salmon	*Oncorhynchus gorbuscha*
Pipefish	*Syngnathus* spp.
Rockfish	*Sebastes* spp.
Sablefish	*Anoplopoma fimbria*
Saffron cod	*Eleginus gracilis*
Sardine	*Sardinops sagax*
Saury	*Cololabis saira*
Walleye pollock	*Theragra chalcogramma*

Literature Cited

Adams, D. R., and D. A. Sutton.
1968. A description of the baculum and os clitoris of *Eutamias townsendii* ochrogenys. J. Mammal. 49:764-768.

Adams, G. I.
1896. Extinct Felidae of North America. Am. J. Sci. Ser. 4, 1:419-444.

Adams, L., and S. D. Davis.
1967. The internal anatomy of home range. J. Mammal. 48:529-536.

Adams, W. H., Jr.
1956. The nutria in coastal Louisiana. Proc. La. Acad. Sci. 19:28-41.

Albone, E. S., and M. W. Fox.
1971. Anal gland secretion of the red fox. Nature 233:569-570.

Albright, R.
1959. Bat banding at Oregon Caves. Murrelet 40:26-27.

Alcorn, P. A.
1958. A shrew-bee episode. Murrelet 39:40.

Aldous, S. E., and J. Manweiler.
1942. The winter food habits of the short-tailed weasel in northern Minnesota. J. Mammal. 23:250-255.

Aleksiuk, M.
1968a. Scent-mound communication, territoriality, and population regulation in beaver *(Castor canadensis* Kuhl). J. Mammal. 49:759-762.

Aleksiuk, M.
1968b. The metabolic adaptation of the beaver *(Castor canadensis* Kuhl) to the Arctic energy regime. Ph. D. thesis. Univ. B. C., Vancouver. 123 p.

Aleksiuk, M.
1970a. The function of the tail as a fat storage depot in the beaver *(Castor canadensis).* J. Mammal. 51:145-148.

Aleksiuk, M.
1970b. The seasonal food regime of arctic beavers. Ecology 51:264-270.

Aleksiuk, M., and I. McT. Cowan.
1969a. Aspects of seasonal energy expenditure in the beaver *(Castor canadensis* Kuhl) at the northern limit of its distribution. Can. J. Zool. 47:471-481.

Aleksiuk, M., and I. McT. Cowan.
1969b. The winter metabolic depression in arctic beavers *(Castor canadensis* Kuhl) with comparisons to California beavers. Can. J. Zool. 47:965-979.

Allan, P. F.
1947. Blue jay attacks red bats. J. Mammal. 28:180.

Allen, D. L.
1938. Notes on the killing technique of the New York weasel. J. Mammal. 19:225-229.

Allen, D. L.
1939a. Winter habits of Michigan skunks. J. Wildl. Manage. 3:212-228.

Allen, D. L., and W. W. Shapton.
1942. An ecological study of winter dens with special reference to the eastern striped skunk. Ecology 23:59-68.

Allen, G. M.
1939b. Bats. 368 p. Harvard Univ. Press, Cambridge, Mass.

Allen, K. R.
1980. Conservation and management of whales. 101 p. Wash. Sea Grant Publ., Univ. Wash. Press.

Allen, R.
1950. Notes on the Florida panther, *Felis concolor coryi.* J. Mammal. 31:279-280.

Altmann, M.
1952. Social behavior of elk, *Cervus canadensis nelsoni,* in the Jackson Hole area of Wyoming. Behavior 4:116-143.

Altmann, M.
1956. Patterns of herd behavior in free-ranging elk of Wyoming, *Cervus canadensis nelsoni.* Zoologica 41:65-71.

Altmann, M.
1960. The role of juvenile elk and moose in the social dynamics of their species. Zoologica 45:35-39.

Amyx, H. L., and D. L. Huxsoll.
1973. Red and gray foxes: Potential reservoir host for *Ehrlichia canis.* J. Wildl. Dis. 9:47-50.

Anderson, D. L.
1969. The persistent use of a floating blind by muskrats. Am. Midl. Nat. 81:601-602.

Anderson, S., and J. N. Jones, Jr., Eds.
1967. Recent mammals of the world, a synopsis of families. 453 p. Ronald Press Co., New York.

Andrews, R. D., G. L. Storm, R. L. Phillips, and R. A. Bishop.
1973. Survival and movements of transplanted and adopted red fox pups. J. Wildl. Manage. 37:69-72.

Anthony, H. E.
1916. Habits of Aplodontia. Am. Mus. Nat. Hist. Bull. 35:53-63.

Anthony, H. E.
1928. Field book of North American mammals. 625 p. G. P. Putnam's Sons, New York.

Asdell, S. A.
1964. Patterns of mammalian reproduction. 670 p. Cornell Univ. Press, Ithaca, N.Y.

Ashbrook, F. G., and K. B. Hanson.
1927. Breeding martens in captivity. J. Heredity 18:499-503.

Ashbrook, F. G., and K. B. Hanson.
1930. The normal breeding season and gestation period of martens. U.S. Dep. Agric. Circ. 107, 7 p.

Atwood, E. L.
1950. Life history studies of nutria, or coypu, in coastal Louisiana. J. Wildl. Manage. 14:249-265.

Aulerich, R. J., and D. R. Swindler.
1968a. Description of the permanent dentition of ranch mink. Mich. Agric. Exp. Stn. Q. Bull. 50:269-275.

Aulerich, R. J., and D. R. Swindler.
1968b. The dentition of the mink (*Mustela vison*). J. Mammal. 49:488-494.

Babero, B. B., and J. W. Lee.
1961. Studies on the helminths of nutria, *Myocastor* coypus (Molina), in Louisiana with checklist of other worm parasites from this host. J. Parasitol. 47:378-390.

Bailey, B.
1929. Mammals of Sherburne County, Minnesota. J. Mammal. 10:153-164.

Bailey, T. N.
1971. Biology of striped skunks on a southwestern Lake Erie marsh. Am. Midl. Nat. 85:196-207.

Bailey, T. N.
1972. The elusive bobcat. Nat. Hist. 81:43-49.

Bailey, V.
1905. Biological survey of Texas. North Am. Fauna 25,222 p.

Bailey, V.
1923. The combing claws of the beaver. J. Mammal. 4:77-79.

Bailey, V.
1926. How beavers build their houses. J. Mammal. 7:41-44.

Bailey, V.
1936. The mammals and life zones of Oregon. North Am. Fauna 55, 416 p.

Baird, S. F.
1857. Mammals of North America. Vol. 8. 757 p. Pac. R. R. Rep.

Baldwin, E. M.
1964. Geology of Oregon. 2d ed. 165 p. Univ. Oreg. Coop. Bookstore, Eugene.

Barber, D. L., and L. L. Lockard.
1973. Some helminths from mink in southwestern Montana, with a checklist of their internal parasites. Great Basin Nat. 33:53-60.

Barbour, R. W., and W. H. Davis.
1969. Bats of America. 286 p. Univ. Press Ky., Lexington.

Barnes, V. G., Jr.
1973. Pocket gophers and reforestation in the Pacific Northwest: A problem analysis. U.S. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. 155, 18 p.

Batchelor, R. F.
1965. The Roosevelt elk in Alaska. Alaska Dep. Fish and Game, V: Proj. W-6-R-5, Work Plan D, 37 p.

Bauer, R. D., J. T. Light, Jr., and W. R. Thornton.
1968. Determination of the winter range of a black-tailed deer herd in the north Coast Range of California. Calif. Fish and Game 54:27-32.

Beck, L. R., and R. G. Anthony.
1971. Metabolic and behavioral thermoregulation in the long-tailed vole, *Microtus longicaudus.* J. Mammal. 52:404-412.

Beer, J. R.
1955. Survival and movements of banded big brown bats. J. Mammal. 36:242-248.

Bemrick, W. J., and J. C. Schlotthauer.
1971. *Paragonimus kellicotti* (Ward 1908) in a Minnesota skunk (*Mephitis mephitis*). J. Wildl. Dis. 7:36.

CHICKAREE

Bennett, L. J., P. F. English, and
R. L. Watts.
1943. The food habits of the black
bear in Pennsylvania. J. Mammal.
24:25-31.

Bennitt, R.
1948. The coyote bounty system in
Missouri, 1936-1947. Trans. 13th
North Am. Wildl. Conf., p. 314322.

Benson, D. A.
1961. Prevention of damage to ply
wood by porcupines: A general
review. 12 p. Can. Wildl. Serv.

Benson, S. B., and A. E. Borell.
1931. Notes on the life history of
the red tree mouse, *Phenacomys
longicaudus*. J. Mammal.
12:226-233.

Berzin, A. A.
1971. [The sperm whale.] A. V.
Yablokov, ed. 394 p. [Translated by
Israel Program for Scientific Trans-
lations, Jerusalem, 1972. Available
from Natl. Tech. Inf. Serv.
TT 71-50152, Springfield, Va.]

Best, P. B.
1975. Review of world sperm whale
stocks. 35 p. Advis. Comm. Mar.
Resour. Res. Sci. Consult. Mar.
Mamm., Bergen, Norway, Aug. 31
to Sept. 9, 1976. Food and Agric.
Organ. U.N.

Bigg, M. A.
1969a. Clines in the pupping
season of the harbour seal, *Phoca
vitulina*. Fish. Res. Board Can. J.
26(2):449-455.

Bigg, M. A.
1969b. The harbour seal in British
Columbia. Fish. Res. Board Can.
Bull. 172:1-33.

Bigg, M. A., and A. A. Wolman.
1975. Live-capture killer whale (Or-
cinus orca) fishery, British Colum-
bia and Washington, 1962-73. Fish.
Res. Board Can. J. 32(7):1213-1221.

Bigler, W. J.
1971. Serologic evidence of
Venezuelan equine encephalitis
virus infections in raccoons of
south-central Florida. J. Wildl. Dis.
7:166-170.

Bigler, W. J., R. G. McLean, and
H. A. Trevino.
1973. Epizootiologic aspects of rac-
coon rabies in Florida. Am. J. Epi-
demiol. 98:326-335.

Birney, E. C., and E. D. Fleharty.
1966. Age and sex comparisons of
wild mink. Trans. Kans. Acad. Sci.
69:139-145.

Birney, E. C., and E. D. Fleharty.
1968. Comparative success in the
application of aging techniques to
a population of winter-trapped
mink. Southwest. Nat. 13:275-282.

Bishop, R. H.
1968. Reproduction, age determina-
tion, and behavior of the harbour
seal, *Phoca vitulina* L., in the Gulf
of Alaska. M.S. thesis. Univ.
Alaska, College [Fairbanks]. 121 p.

Bishop, S. C.
1923. Note on the nest and young
of the small brown weasel. J. Mam-
mal. 4:26-27.

Bishop, S. C.
1947. Curious behavior of a hoary
bat. J. Mammal. 28:293-294.

Bissonnette, T. H., and A. G. Csech.
1939. A third year of modified
breeding behavior with raccoons.
Ecology 20:156-162.

Blackman, M. W.
1911. The anal glands of Mephitis
mephitis. Anat. Rec. 5:491-504.

Blair, W. F.
1947. An analysis of certain genetic
variations in pelage color of the
Chihuahua deer-mouse
(Peromyscus maniculatus blandus).
Contrib. Lab. Vertebr. Biol. Univ.
Mich. 35, 18 p.

Blanchard, H.
1964. Weight of a large fisher. J.
Mammal. 45:487-488.

Boddicker, M. L., and D. R. Progulske.
1968. Helminth parasites of rac-
coon in South Dakota. Proc. S.D.
Acad. Sci. 47:161-166.

Bogan, M. A.
1972. Observations on parturition
and development in the hoary bat,
Lasiurus cinereus. J. Mammal.
53:611-614.

Bookhout, T. A.
1964. Prenatal development of
snowshoe hares. J. Wildl. Manage.
28:338-345.

Bookhout, T. A.
1965. Breeding biology of snow.
shoe hares in Michigan's upper
peninsula. J. Wildl. Manage.
29:296-303.

Borowski, S.
1964. Moult of shrews (*Sorex* L.)
under laboratory conditions. Acta
Theriol. 8:125-135.

Bowlsby, C. C., and R. C. Swanson.
1964. Soil survey of Tillamook, Ore-
gon. 75 p. and 39 maps. USDA Soil
Conserv. Serv. in cooperation with
Oreg. Agric. Exp. Stn.

Bradley, W. G., and R. A. Mauer.
1967. Ecological distribution and
population fluctuation of *Pero-
myscus maniculatus* in southern
Nevada. J. Ariz. Acad. Sci.
4:234-238.

Bradt, G. W.
1938. A study of beaver colonies in
Michigan. J. Mammal. 19:139-162.

Brander, R. B.
1971. Longevity of wild porcupines.
J. Mammal. 52:835.

Brander, R. B.
1973. Life-history notes on the por-
cupine in a hardwood-hemlock
forest in upper Michigan. Mich.
Acad. 5:425-433.

Brassard, J. A., and R. Bernard.
1939. Observations on breeding
and development of marten, *Martes
a. americana* (Kerr). Can. Field-Nat.
53:15-21.

Bray, O. E., and V. G. Barnes.
1967. A literature review on black
bear populations and activities.
Colo. Coop. Wildl. Fies. Unit, 34 p.
Colo. State Univ., Fort Collins.

Brenner, F. J.
1962. Foods consumed by beavers in Crawford County, Pennsylvania. J. Wildl. Manage. 26:104-107.

Brenner, F. J.
1964. Reproduction of the beaver in Crawford County, Pennsylvania. J. Wildl. Manage. 28:743-747.

Brenner, F. J.
1967. Spatial and energy require. ments of beavers. Ohio J. Sci. 67:242-246.

Brent, H. I., and E. L. Bowhay.
1956. Black bear food habits. Wash. Game Dep. Q. Prog. Rep. W-37-R-7, 7 p.

Broadbooks, H. E.
1939. Food habits of the vagrant shrew. Murrelet 20:62-66.

Brodie, E. D., Jr., and C. Maser.
1967. Analysis of great horned owl pellets from Deschutes County, Oregon. Murrelet 48:11-12.

Broughton, E., F. E. Graesser, L. N. Carbyn, and L. P. E. Choquette.
1970. Oral papillomatosis in the coyote in western Canada. J. Wildl. Dis. 6:180-181.

Brown, D. H., and K. S. Norris.
1956. Observations of captive and wild cetacean. J. Mammal. 37(3):31 l-326.

Brown, E. R.
1961. The black-tailed deer of west. ern Washington. Wash. State Game Dep. Bull. 13, 124 p.

Brownell, Robert L., and Chani-il Chun.
1976. Probable existence of the Korean stock of the gray whale (Eschrichtius robustus). J. Mammal. 58(2):238-239.

Brownell, R. L., R. R. Reeves, and C. Schonewald.
1978. Preliminary report on world catches of marine mammals 1966-1975. 353 p. Natl. Tech. Inf. Ser. Publ. PB290 713.

Browniee, R. G., R. M. Silverstein, D. Müller-Schwarze, and A. G. Singer.
1969. Isolation, identification, and function of the chief component of the male tarsal scent in black-tailed deer. Nature 221:284-285.

Bruce, J.
1925. The problem of mountain lion control in California. Calif. Fish and Game 11:1-17.

Buhler, D. R., R. R. Claeys, and B. R. Mate.
1975. Heavy metal and chlorinated hydrocarbon residues in California sea lions (Zalophus californianus californianus). Fish. Res. Board Can. J. 32(12):2391-2397.

Burkel, M. D., M. F. Andrews, and E. C. Meslow.
1970. Rabies detection in road-killed skunks (Mephitis mephitis). J. Wildl. Dis. 6:496-499.

Burt, W. H., and R. P. Grossenheider.
1964. A field guide to the mammals. 284 p. Houghton Mifflin Co., Boston.

Buzzard, C. R., and C. C. Bowlsby.
1970. Soil survey of Curry area, Oregon. 70 p. and 46 maps. USDA Soil Conserv. Serv. in cooperation with Oreg. Agric. Exp. Stn.

Cahalane, V. H.
1944. Meeting the mammals. 133 p. Macmillan Co., New York.

Cahalane, V. H.
1947. Mammals of North America. 628 p. Macmillan Co., New York.

Calhoun, J. B.
1962. The ecology and sociology of the Norway rat. U.S. Dep. Health, Educ., and Welfare, Publ. Health Serv. Rep. 1008,288 p.

Cameron, G. N.
1971. Niche overlap and competi-tion in woodrats. J. Mammal. 52:288-296.

Camp, C. L.
1918. Excavations of burrows of the rodent Aplodontia, with obser-vations on the habits of the animal. Univ. Calif. Publ. Zool. 17:517-536.

Campbell, D. L., and R. W. Bullard.
1972. A preference-testing system for evaluating repellents for black-tailed deer. Proc. Vertebr. Pest Conf. 5:56-63.

Cappucci, D., Jr.
1970. Rabies in a raccoon. J. Am. Vet. Med. Assoc. 157:1082-1083.

Cappucci, D. T., R. W. Emmons, D. A. Mullen, S. K. Dritz, and J. P. Garcia.
1972. Unusual laboratory exposure to a rabid skunk. J. Am. Vet. Med. Assoc. 161641642.

Cappucci, D. T., Jr., and W. M. Longhurst.
1972. Rabies in a deer. Calif. Fish and Game 58:141-144.

Carney, W. P., and P. D. Leiby.
1968. Echinococcus multilocularis in Peromyscus maniculatus and Vulpes vulpes from Minnesota. J. Parasitol. 54:714.

Carpenter, J. W., H. E. Jordan, and B. C. Ward.
1973. Neurologic disease in wapiti naturally infected with meningeal worms. J. Wildl. Dis. 9:148-153.

Carter, D. C.
1970. Chiropteran reproduction. In About bats, p. 233-246. B. H. Slaughter and D. W. Walton, eds. South. Methodist Univ. Press, Dallas, Texas.

Carter, T. D.
1955. Remarkable age attained by a bobcat. J. Mammal. 36:290.

Caughley, G.
1971. An investigation of hybridiza-tion between free-ranging wapiti and red deer in New Zealand. N. Z. J. Sci. 14:993-1008.

Chapman, D. G.
1974a. Status of antarctic rorqual stocks. In The whale problem: A status report, p. 218-238. W. E. Schevill, ed. Harvard Univ. Press, Cambridge, Mass.

Chapman, D. G.
1976. Summary of north Pacific sperm whale assessments. Sci. Comm. Int. Whaling Comm.

Chapman, J. A.
1971a. Orientation and homing of the brush rabbit (*Sylvilagus bachmani*). J. Mammal. 52686699.

Chapman, J. A.
1971 b. Organ weights and sexual dimorphism of the brush rabbit. J. Mammal. 52:453-455.

Chapman, J. A.
1974b. *Sylvilagus bachmani.* Mamm. Spec. 34:1-4.

Chapman, J.A., and A. L. Harman.
1972. The breeding biology of a brush rabbit population. J. Wildl. Manage. 36816823.

Chapman, J. A., and G. S. Lind.
1973. Latitude and litter size of the California ground squirrel, *Spermophilus beecheyi.* South. Calif. Acad. Sci. Bull. 72:101-105.

Chapman, J. A., and B. J. Verts.
1969. Interspecific aggressive behavior in rabbits. Murrelet 50:17-18.

Chitwood, B. G.
1932. Occurrence of *Uncinaria stenocephala* from the fisher. J. Parasitol. 18:307.

Christian, J. J.
1966. The natural history of a summer aggregation of the big brown bat, *Eptesicus fuscus fuscus.* Am. Midl. Nat. 55:66-95.

Clark, F. W.
1972. Influence of jackrabbit density on coyote population change. J. Wildl. Manage. 36:343-356.

Clark, K. A., R. M. Robinson, L. L. Weishuhn, T. J. Galvin, and K. Horvath.
1973. *Hepatozoon procyonis* infections in Texas. J. Wildl. Dis. 9:182-193.

Clothier, R. R.
1955. Contribution to the life history of *Sorex vagrans* in Montana. J. Mammal. 36:214-221.

Cockrum, E. L.
1956. Homing, movements, and longevity of bats. J. Mammal. 37:48-57.

Coerr, E., and W. E. Evans.
1980. Gigi, a baby whale borrowed for science and returned to the sea. 128 p. G. P. Putnams, New York.

Coman, B. J.
1973. The diet of red foxes, *Vulpes vulpes* L., in Victoria. Aust. J. Zool. 21:391-401.

Conley, R. H., and J. H. Jenkins.
1970. An evaluation of several techniques for determining the age of bobcats *(Lynx Rufus) [sic]* in the Southeast. Proc. Conf. Southeast. Assoc. Game and Fish Comm. 23:104-109.

Connell, J. H.
1954. Home range and mobility of brush rabbits in California chaparral. J. Mammal. 35:392-405.

Constantine, D. G.
1958. Ecological observations on lasiurine bats in Georgia. J. Mammal. 39:64-70.

Constantine, D. G.
1959. Ecological observations on lasiurine bats in the North Bay area of California. J. Mammal. 40:13-15.

Constantine, D. G.
1966. Ecological observations on lasiurine bats in Iowa. J. Mammal. 47:34-41.

Constantine, D. G.
1970. Bats in relation to the health, welfare, and economy of man. *In* Biology of bats, p. 320420. W. A. Wimsatt, ed. Acad. Press, New York.

Cook, D. B., and W. J. Hamilton, Jr.
1957. The forest, the fisher, and the porcupine. J. For. 55:719-722.

Cope, J. B., K. Koontz, and E. Churchwell.
1961. Notes on homing of two species of bats, *Myotis lucifugus* and *Eptesicus fuscus.* Proc. Indiana Acad. Sci. 70:270-274.

Corliss, J. F.
1973. Soil survey of Alsea area, Oregon. 82 p. and 43 maps. USDA Soil Conserv. Serv. and USDA For. Serv.; U.S. Dep. Inter. Bur. Land Manage.-in cooperation with Oreg. Board Nat. Resour. and Oreg. Agric. Exp. Stn.

Cosgrove, G. E., W. B. Lushbaugh, G. Humason, and M. G. Anderson.
1968. Synhimantus (Nematoda) associated with gastric squamous tumors in muskrats. Wildl. Dis. Assoc. Bull. 4:54-57.

Couch, L. K.
1925. Storing habits of Microtus townsendii. J. Mammal. 6:200-201.

Couch, L. K.
1932. Porcupines in Franklin County, Washington. Murrelet 13:55.

Coulter, M. W.
1960. The status and distribution of fisher in Maine. J. Mammal. 41:1-9.

Coulter, M. W.
1966. Ecology and management of fishers in Maine. Ph. D. thesis. Syracuse Univ., Syracuse, N.Y. 183 p.

Cowan, I. McT.
1936. Nesting habits of the flying squirrel, *Glaucomys sabrinus.* J. Mammal. 17:58-60.

FIREWEED

Cowan, I. McT.
1938. Geographic distribution of color phases of the red fox and black bear in the Pacific Northwest. J. Mammal. 19:202-206.

Cowan, I. McT.
1946. Parasites, diseases, injuries, and anomalies of the Columbian black-tailed deer (*Odocoileus he mionus columbianus*) (Richardson) in British Columbia. Can. J. Res. 24:71-103.

Cowan, I. McT.
1956. Life and times of the coast black-tailed deer. *In* The deer of North America, p. 523617. W. P. Taylor, ed. Stackpole Co., Harrisburg, Pa.

Cowan, I. McT., and M. G. Arsenault.
1954. Reproduction and growth of the creeping vole, *Microtus oregoni serpens* Merriam. Can. J. Zool. 32:198-208.

Cowan, I. McT., and V. Geist.
1961. Aggressive behavior in deer of the genus *Odocoileus.* J. Mammal. 42:522-526.

Cowan, I. McT., and C. J. Guiguet.
1965. The mammals of British Columbia. B. C. Prov. Mus. 11:1-141.

Cowan, I. McT., and C. W. Holloway.
1973. Threatened deer of the world: Conservation status. Biol. Conserv. 5:243-250.

Cowan, I. McT., and R. H. Mackay.
1950. Food habits of the marten (*Martes americana*) in the Rocky Mountain region of Canada. Can. Field-Nat. 64:100-104.

Crabb, W. D.
1941. Food habits of the prairie spotted skunk in southeastern Iowa. J. Mammal. 22:349-364.

Crabb, W. D.
1944. Growth, development, and seasonal weights of spotted skunks. J. Mammal. 25:213-221.

Crabb, W. D.
1948. The ecology and management of the prairie spotted skunk in Iowa. Ecol. Monogr. 18:203-232.

Craighead, J. J., G. Atwell, and B. W. O'Gara.
1972. Elk migrations in and near Yellowstone National Park. Wildl. Monogr. 29, 48 p.

Cramblet, H. M., and R. L. Ridenhour.
1956. Parturition in *Aplodontia.* J. Mammal. 37:87-90.

Criddle, N., and S. Criddle.
1925. The weasels of southern Manitoba. Can. Field-Nat. 39:142-148.

Crouch, G. L.
1966. Preferences of black-tailed deer for native forage and Douglas. fir seedlings. J. Wildl. Manage. 30:471-475.

Crouch, G. L.
1968a. Clipping of woody plants by mountain beaver. J. Mammal. 49:151-152.

Crouch, G. L.
1968b. Forage availability in relation to browsing of Douglas-fir seedlings by black-tailed deer. J. Wildl. Manage. 32:542-553.

Crouch, G. L.
1971. Susceptibility of ponderosa, Jeffrey, and lodgepole pines to pocket gophers. Northwest Sci. 45:252-256.

Crowe, D. M.
1975. Aspects of aging, growth, and reproduction of bobcats from Wyoming. J. Mammal. 56:177-198.

Dailey, M. D., and B. L. Brownell, Jr.
1972. A checklist of marine mammal parasites. *In* Mammals of the sea: Biology and medicine, p. 528589. S. H. Ridgway, ed. Charles C. Thomas, Springfield, Ill.

Dalquest, W. W.
1940a. Bats in the San Juan Islands, Washington. Murrelet 21:4-5.

Dalquest, W. W.
1940b. New meadow mouse from the San Juan Islands, Washington. Murrelet 21:7-8.

Dalquest, W. W.
1941. Ecologic relationships of four small mammals in western Washington. J. Mammal. 22:170-173.

Dalquest, W. W.
1942. Geographic variation in northwestern snowshoe hares. J. Mammal. 23:166-183.

Dalquest, W. W.
1943. Seasonal distribution of the hoary bat along the Pacific coast. Murrelet 24:20-24.

Dalquest, W. W.
1947a. Notes on the natural history of the bat, *Myotis yumanensis,* in California, with a description of a new race. Am. Midl. Nat. 38:224-247.

Dalquest, W. W.
1947b. Notes on the natural history of the bat *Corynorhinus rufinesquii* in California. J. Mammal. 28:17-30.

Dalquest, W. W.
1948. Mammals of Washington. Univ. Kans. Mus. Nat. Hist. Publ. 2:1-444.

Dalquest, W. W., and D. R. Orcutt.
1942. The biology of the least shrew-mole, Neurotrichus gibbsii minor. Am. Midl. Nat. 27:387-401.

Dalquest, W. W., and M. C. Ramage.
1946. Notes of the long-legged bat (*Myotis volans*) at Old Fort Tejon and vicinity, California. J. Mammal. 27:60-63.

Dalquest, W. W., and V. B. Scheffer.
1945. The systematic status of the races of the mountain beaver (*Aplodontia rufa*) in Washington. Murrelet 26:34-37.

Dana, R. H., Ed.
1970. Proceedings: 4th vertebrate pest conference. 204 p. (Meeting Mar. 3-5, 1970, sponsored by Calif. Vertebr. Pest Comm.)

Daniel, M. J.
1960. Porcupine quills in viscera of fisher. J. Mammal. 41:133.

Dasmann, R. F., and R. D. Taber.
1956. Behavior of Columbian black-tailed deer with reference to population ecology. J. Mammal. 37:143-164.

Daugherty, A. E.
1979. Marine mammals of California. 61 p. Calif. Dep. Fish and Game and Univ. Calif. Sea Grant Mar. Adv. Program.

Davis, J. R.
1955. Food habits of the bobcat in Alabama. M.S. thesis. Ala. Polytech. Inst., Auburn.

Davis, W. B.
1936. Young of the brush rabbit, Sylvilagus bachmani. Murrelet 17:36-40.

Davis, W. B.
1939. The recent mammals of Idaho. 400 p. Caxton Print., Ltd., Caldwell, Idaho.

Davis, W. B.
1966. The mammals of Texas. Tex. Parks and Wildl. Dep. Bull. 41:5-267.

Davis, W. H., R. W. Barbour, and M. D. Hassell.
1968. Colonial behavior of Eptesicus fuscus. J. Mammal. 49:44-50.

Davis, W. H., and J. W. Hardin.
1967. Homing in Lasionycteris noctivagans. J. Mammal. 48:323.

Davis, W. H., and H. B. Hitchcock.
1965. Biology and migration of the bat, Myotis lucifugus, in New England. J. Mammal. 46:296-313.

Davis, W. H., and 0. B. Reite.
1967. Responses of bats from temperate regions to changes in ambient temperature. Bioi. Bull. 132:320-328.

Dealy, J. E.
1971. Habitat characteristics of the Silver Lake mule deer range. USDA For. Serv. Res. Pap. PNW-125, 99 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

Dearborn, N.
1932. Foods of some predatory fur-bearing animals in Michigan. Univ. Mich. Sch. For. and Conserv. Bull. 1:1-52.

Delong, R. L., W. G. Gilmartin, and J. G. Simpson.
1973. Premature births in California sea lions: Association with high organochlorine pollutant residue levels. Science 181:1168-1169.

deVos, A.
1951a. Overflow and dispersal of marten and fisher from wildlife refuges. J. Wildl. Manage. 15:164-175.

deVos, A.
1951b. Recent finding in fisher and marten ecology and management. Trans. North Am. Wildl. Conf. 16:498-507.

deVos, A.
1952. Ecology and management of fisher and marten in Ontario. Ont. Dep. Lands and For. Tech. Bull. 9, 90 p.

deVos, A.
1957. Pregnancy and parasites of marten. J. Mammal. 38:412.

Dice, L. R.
1932. The songs of mice. J. Mammal. 13:187-196.

Dice, L. R.
1941. Variation of the deer-mouse (Peromyscus maniculatus) on the Sand Hill of Nebraska and adjacent areas. Contrib. Lab. Vertebr. Biol. Univ. Mich. 15, 19 p.

Dice, L. R.
1947. Effectiveness of selection by owls of deer-mice (Peromyscus maniculatus) which contrast in color with their background. Contrib. Lab. Vertebr. Biol. Univ. Mich. 34, 20 p.

Dice, L. R.
1949. Variations of Peromyscus maniculatus in parts of western Washington and adjacent Oregon. Contrib. Lab. Vertebr. Biol. Univ. Mich. 44, 33 p.

Dicker, S. E., and M. G. Eggleton.
1964. Renal function in the primitive mammal Aplodontia rufa, with some observations on squirrels. J. Physiol. 170:186-194.

Dieterich, R. A., and R. W. Van Pelt.
1972. Juvenile osteomalacia in a coyote. J. Wildl. Dis. 8:146-148.

Dixon, J.
1919. Notes on the natural history of the bushy-tailed woodrats of California. Univ. Calif. Publ. Zool. 21:49-74.

Dixon, J.
1934. A study of the life history and food habits of mule deer in California. Calif. Fish and Game 20:6-144.

Dixon, J. S.
1933. Red fox attacked by a golden eagle. J. Mammal. 14:257.

Dobie, J. F.
1949. The voice of the coyote. Little, Brown, and Co., Boston.

Dodge, W. E., and P. R. Canutt.
1969. A review of the status of the porcupine (Erethizon dorsatum epixanthum) in western Oregon. 25 p. U.S. Gov. Print. Off., Washington, DC.

Donat, F.
1933. Notes on the life history and behavior of Neotoma fuscipes. J. Mammal. 14:19-26.

Dorney, R. S.
1953. Some unusual juvenile raccoons weights. J. Mammal. 34:122-123.

Dorney, R. S.
1954. Ecology of marsh raccoons. J. Wildl. Manage. 18:217-225.

Dozier, H. L.
1950. Muskrat trapping on the Montezuma National Wildlife Refuge, New York, 1943-1948. J Wildl. Manage. 14:403-412.

Drickamer, L. C., and J. Bernstein.
1972. Growth in two subspecies of Peromyscus maniculatus. J. Mammal. 53:228-231.
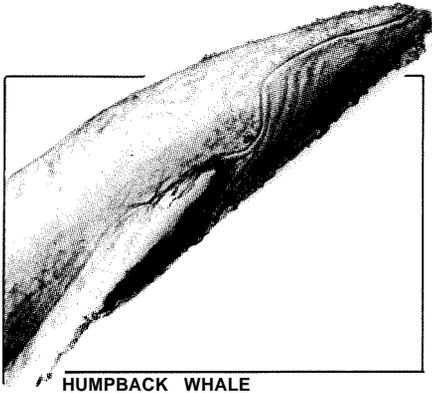
HUMPBACK WHALE

Duke, K. L.
1949. Some notes on the histology of the ovary of the bobcat (Lynx) with special reference to the corpora lutea. Anat. Rec. 103:111-132.

Duke, K. L.
1954. Reproduction in the bobcat (Lynx rufus). Anat. Rec. 120:816-817.

Dyer, W. G.
1969a. A checklist of the Protozoa and Helminths of the deer mouse, Peromyscus maniculatus, in North America. Am. Midl. Nat. 81:258-262.

Dyer, W. G.
19696. Helminths of the striped skunk, Mephitis mephitis, in North America. Am. Midl. Nat. 82:601-605.

Dyer, W. G.
1970. Helminths of the striped skunk, Mephitis mephitis Schreber, in North Dakota. Proc. Helminthol. Soc. Wash. 37:92-93.

Eadie, W. R.
1954. Skin gland activity and pelage descriptions in moles. J. Mammal. 35:186-196.

Eadie, W. R., and W. J. Hamilton, Jr.
1958. Reproduction in the fisher in New York. N.Y. Fish and Game J. 5:77-83.

Earle, S.
1979. Humpbacks: The gentle whales. Natl. Geogr. 155(1):2-17.

Easterla, D. A., and L. C. Watkins.
1970. Breeding of Lasionycteris noctivagans and Nycticeius humeralis in southwestern Iowa. Am. Midl. Nat. 84:254-255.

Eckroade, R. J., G. M. ZuRhein, and R. P. Hanson.
1973. Transmissible mink encephalopathy in carnivores: Clinical, light and electron microscopic studies in raccoons, skunks, and ferrets. J. Wildl. Dis. 9:229-240.

Edge, E. R.
1931. Seasonal activity and growth in the Douglas ground squirrel. J. Mammal. 12:194-200.

Edson, J. M.
1933. A visitation of weasels. Murrelet 14:76-77.

Egoscue, H. J.
1962. The bushy-tailed woodrat; a laboratory colony. J. Mammal. 43:328-337.

Eisenberg, J. F.
1964. Studies on the behavior of Sorex vagrans. Am. Midl. Nat. 72:417-425.

Elder, W. H.
1951. The baculum as an age criterion in mink. J. Mammal. 32:43-50.

Ellis, R. J.
1959. Food habits and control of coyotes in north-central Oklahoma. Okla. State Univ. Publ. 56:1-31.

Elton, C.
1942. Voles, mice, and lemmings: Problems in population dynamics. 496 p. Oxford Univ. Press, London.

Emson, H. E., M. A. Baltzan, and H. E. Wiens.
1972. Trichinosis in Saskatchewan, an outbreak due to infected bear meat. Can. Med. Assoc. J. 106:897-898.

Enders, R. K.
1952. Reproduction in the mink (Mustela vison). Proc. Am. Philos. Soc. 96:691-755.

Enders, R. K., and J. R. Leekley.
1941. Cyclic changes in the vulva of the marten (Martes americana). Anat. Rec. 79:1-5.

Enders, R. K., and O. P. Pearson.
1943. The blastocyst of the fisher. Anat. Rec. 85:285-287.

English, P. F.
1923. The dusky-footed woodrat (Neotoma fuscipes). J. Mammal. 4:1-9.

Englund, J.
1965a. Studies on food ecology of the red fox (Vulpes v.) in Sweden. Viltrevy (Swed. Wildl.) 3:377-485.

Englund, J.
1965b. The diet of foxes (Vulpes vulpes) on the Island of Gotland since myxomatosis. Viltrevy (Swed. Wildl.) 3:507-530.

Englund, J.
1969. The diet of fox cubs (Vulpes vulpes) in Sweden. Viltrevy (Swed. Wildl.) 6:1-39.

Englund, J.
1970. Some aspects of reproduction and mortality rates in Swedish foxes (Vulpes vulpes), 196163 and 196669. Viltrevy (Swed. Wildl.) 8:1-82.

Erickson, A. W.
1964. An analysis of black bear kill statistics for Michigan. Mich. State Univ. Res. Bull. 4:68-102.

Erickson, A. W.
1965. The black bear in Alaska. Alaska Dep. Fish and Game Fed. Aid Wildl. Restoration Proj. Rep. Proj. W-6-R-5, Work Plan F.

Erickson, A. W., and J. E. Nellor.
1964. Breeding biology of the black bear. Mich. State Univ. Res. Bull. 4:1-45.

Erickson, A. W., J. E. Nellor, and G. A. Petrides.
1964. The black bear in Michigan. Mich. State Univ. Res. Bull. 4, 102 p.

Erickson, A. W., and W. G. Youatt.
1961. Seasonal variations in the hematology and physiology of black bears. J. Mammal. 42: 198-203.

Erickson, J. A., A. E. Anderson, D. E. Medin, and D. C. Bowden.
1970. Estimating ages of mule deer-an evaluation of technique accuracy. J. Wildl. Manage. 34:523-531.

Erickson, J. A., and W. G. Seliger.
1969. Efficient sectioning of incisors for estimating ages of mule deer. J. Wildl. Manage. 33:384-388.

Erlinge, S.
1968. Food studies on captive otters Lutra lutra L. Oikos 19:259-270.

Ernst, C. H.
1965. Rutting activities of a captive striped skunk. J. Mammal. 46:702-703.

Ernst, J. V., B. Chobotar, and D. M. Hammond.
1971. The oocysts of Eimeria ver-miformis sp. n. and E. papillata sp. n. (Protozoa: Eimeriidae) from the mouse Mus musculus. J. Protozool. 18:221-223.

Errington, P. L.
1935. Food habits of mid-west foxes. J. Mammal. 16:192-200.

Errington, P. L.
1943. An analysis of mink predation upon muskrats in north-central United States. Iowa Agric. Exp. Stn. Res. Bull. 320:798-924.

Errington, P. L.
1954. The special responsiveness of minks to epizootics in muskrat populations. Ecol. Monogr. 24:377-393.

Errington, P. L.
1963. Muskrat populations. Iowa State Univ. Press, Ames.

Errington, P. L., F. Hammerstrom, and F. N. Hammerstrom, Jr.
1940. The great horned owl and its prey in north-central United States. Iowa Agric. Exp. Stn. Bull. 277:757-850.

Evans, J.
1970. About nutria and their control. U.S. Dep. Inter., Bur. Sport Fish. and Wildl. Resour. Publ. 86, 65 p.

Evans, J., and R. P. Matthews.
1972. Porcupine damage survey in western Washington, 1970-1971. 14 p. Wash. For. Prot. Assoc., Seattle.

Evans, W. E.
1976. Distribution and differentiation of stocks of Delphinus delphis Linnaeus, in the northeastern Pacific. Advis. Comm. Mar. Resour. Res. Sci. Consult. Mar. Mamm., Bergen, Norway, Aug. 30 to Sept. 9. Food and Agric. Organ. U.N.

Ewing, W. G., and E. H. Studier.
1973. A method for control of water vapor pressure and its effect on metabolism and body temperature in Mus musculus. Comp. Biochem. Physiol. 45:121-125.

Ewing, W. G., E. H. Studier, and M. J. O'Farrell.
1970. Autumn fat deposition and gross body composition in three species of Myotis. Comp. Biochem. Physiol. 36:119-129.

Farrell, R. K., R. W. Leader, and S. D. Johnston.
1973. Differentiation of salmon poisoning disease and elokomin fluke fever: Studies with the black bear (Ursus americanus). Am. J. Vet. Res. 34-919-922.

Ferrel, C. M., H. R. Leach, and D. F. Tillotson.
1953. Food habits of the coyote in California. Calif. Fish and Game 39:301-341.

Fichter, E., G. Schildman, and H. H. Sather.
1955. Some feeding patterns of coyotes in Nebraska. Ecol. Monogr. 25:1-37.

Field, R. J.
1970. Winter habits of the river otter (Lutra canadensis) in Michigan. Mich. Acad. 3:49-58.

Findley, J. S.
1956. Comments on the winter food of red foxes in eastern South Dakota. J. Wildl. Manage. 20:216-217.

Findley, J. S., and C. Jones.
1964. Seasonal distribution of the hoary bat. J. Mammal. 45:461-470.

Findley, J. S., E. H. Studier, and D. E. Wilson.
1972. Morphologic properties of bat wings. J. Mammal. 53:429-444.

Fisher, E. M.
1933. A note on Bassariscus. J. Mammal. 14:257.

Fisher, H. D., and R. J. Harrison.
1970. Reproduction in the common porpoise (Phocoena phocoena) of the north Atlantic. J. Zool. Lond. 161:471-486.

Fisler, G. F.
1965. A captive mountain beaver. J. Mammal. 46:707-709.

Fitch, H. S.
1948. Ecology of the California ground squirrel on grazing lands. Am. Midl. Nat. 39:513-596.

Flahaut, M. R.
1939. Unusual location of hibernating jumping mice. Murrelet 20:17-18.

Flook, D. R.
1970. A study of sex differential in the survival of wapiti. Can. Wildl. Serv. Rep. Ser. 11, 71 p.

Fog, M.
1969. Studies on the weasel (Mustela nivalis) and the stoat (Mustela erminea) in Denmark. Dan. Rev. Game Biol. 6:3-14.

Folk, G. E., Jr., K. B. Coady, and M. A. Folk.
1968. Physiological observations on raccoons in winter. Iowa Acad. Sci. 75:301-305.

Folk, G. E., Jr., R. C. Simmonds, and M. A. Folk.
1967. Physiological observations on subarctic bears under winter den conditions. In Mammalian hibernation, p. 75-85. K. Fisher and F. South, eds. Oliver and Boyd, Edinburgh, Scotland.

Forbes, R. B., and L. W. Turner. 1972. Notes on two litters of Townsend's chipmunks. J. Mammal. 53:355-359.

Forcum, D. L. 1966. Postpartum behavior and vocalizations of snowshoe hares. J. Mammal. 47:543.

Fordyce, R. E., Ed. 1980. A guide to recent literature on archaeocete cetaceans. Smithson. Inst., Washington, D.C.

Foresman, K. R., and R. A. Mead. 1973. Duration of post-implantation in a western subspecies of the spotted skunk *(Spilogale putorius).* J. Mammal. 54:521-523.

Forsman, E., and C. Maser. 1970. Saw-whet owl preys on red tree mice. Murrelet 51:10.

Forsman, E. D. 1976. A preliminary investigation of the spotted owl in Oregon. M.S. thesis. Oreg. State Univ., Corvallis. 127 p.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA For. Serv. Gen. Tech. Rep. PNW-8, 417 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

Franklin, W. L. 1968. Herd organization, territoriality, movements and home ranges in Roosevelt elk. M.S. thesis. Humboldt State Coll., Arcata, Calif. 89 p.

Franklin, W. L., A. S. Mossman, and M. Dole. 1975. Social organizations and home range of Roosevelt elk. J. Mammal. 56:102-1 18.

Friley, C. E., Jr. 1949. Age determination, by use of the baculum, in the river otter, *Lutra c. canadensis* Schreber. J. Mammal. 30:102-110.

Fry, J. F. 1961. Musculature and innervation of the pelvis and hind limb of the mountain beaver. J. Morphol. 109:173-198.

Frye, F. L., L. Z. McFarland, and J. B. Enright. 1964. Sacrococcygeal agenesis in Swiss mice. Cornell Vet. 50:487-495.

Gabrielson, I. N. 1923. Notes on Thomomys in Oregon. J. Mammal 4:189-190.

Gabrielson, I. N. 1928. Notes on the habits and behavior of the porcupine in Oregon. J. Mammal. 9:33-38.

Gambell, R. 1975. A review of population assessments of antarctic fin whales. Advis. Comm. Mar. Resour. Res. Sci. Consult. Mar. Mamm., Bergen, Norway, Aug. 31 to Sept. 9, 1976. Food and Agric. Organ. U.N.

Gander, F. F. 1929. Experiences with woodrats, Neotoma fuscipes macrotis. J. Mammal. 10:52-58.

Gashwiler, J. S. 1959. Small mammal study in west-central Oregon. J. Mammal. 40:128-139.

Gashwiler, J. S. 1960. Longevity of a wild deer mouse. Murrelet 41:27.

Gashwiler, J. S. 1965a. Longevity and home range of a Townsend chipmunk. J. Mammal. 46:693.

Gashwiler, J. S. 1965b. Tree seed abundance vs. deer mouse populations in Douglas-fir clearcuts. Proc. Soc. Am. For., Div. For.-Wildl. Manage., p. 219-222.
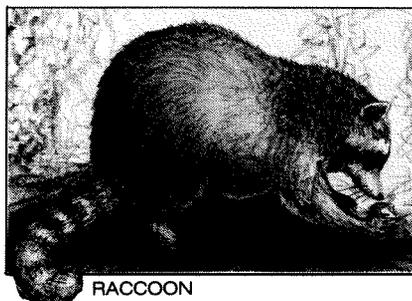
Gashwiler, J. S. 1969. Deer mouse repopulation of a poisoned Douglas-fir clearcut. J. For. 67:494-497.

Gashwiler, J. S. 1970. Plant and mammal changes on a clearcut in west-central Oregon. Ecology 51:1018-1026.

Gashwiler, J. S. 1971. Deer mouse movement in forest habitat. Northwest Sci. 45:163-170.

Gashwiler, J. S. 1972. Life history notes on the Oregon vole, *Microtus oregoni.* J. Mammal. 53:558-569.

Gashwiler, J. S., and W. L. Robinette. 1957. Accidental fatalities of the Utah cougar. J. Mammal. 38:123-126.

Gashwiler, J. S., W. L. Robinette, and O. W. Morris. 1960. Foods of bobcats in Utah and eastern Nevada. J. Wildl. Manage. 24:226-229.

Gashwiler, J. S., W. L. Robinette, and O. W. Morris. 1961. Breeding habits of bobcats in Utah. J. Mammal. 42:76-84.

Gaskin, D. G., and B. A. Blair. 1977. Age determination of harbor porpoise *(Phocoena phocoena* L.) in the western North Atlantic. Can. J. Zool. 55(1):18-30.

Gates, W. H. 1937. Spotted skunks and bobcat. J. Mammal. 18:240.

Genoways, H. H., and J. K. Jones, Jr. 1968. Notes on spotted skunks (genus *Spilogale)* from western Mexico. An. Inst. Biol. Univ. Nac. Auton. Mex. 39, Ser. Zool. 1:123-132.

Gentry, R. L. 1970. Social behavior of the Steller sea lion. Ph. D. thesis. Univ. Calif., Santa Cruz. 113 p.

RACCOON

Gerell, R.
1968. Food habits of the mink (*Mustela vison* Schreber) in Sweden. Viltrevy (Swed. Wildl.) 5:119-211.

Gerell, R.
1989. Activity patterns of the mink Mustela vison Schreber in southern Sweden. Olkos 20:451-460.

Gerell, R.
1970. Home ranges and movements of the mink *Mustela* vison Schreber in southern Sweden. Oikos 21:160-173.

Gerell, R.
1971. Population studies on mink, *Mustela vison* Schreber, in southern Sweden. Viltrevy (Swed. Wildl.) 8:83-109.

Gianini, C. A.
1927. An unusual habit of the mink. J. Mammal. 8:244.

Gier, H. T.
1968. Coyotes in Kansas. Rev. Kans. State Coll. Agric. Exp. Stn. Bull. 393,.118 p.

Giger, R. D.
1965. Surface activity of moles as indicated by remains in barn owl pellets. Murrelet 46:32-36.

Giger, R. D.
1973. Movements and homing in Townsend's mole near Tillamook, Oregon. J. Mammal. 54:648-659.

Gilbert, D. L.
1952. Bear studies. Colo. Game and Fish Dep., Fed. Aid Q. (Jan.), p. 26-31.

Gilbert, P. F., 0. C. Wallmo, and R. B. Gill.
1970. Effect of snow depth on mule deer in Middle Park, Colorado. J. Wildl. Manage. 34:15-23.

Giles, L. W.
1939. Fall food habits of the raccoon in central Iowa. J. Mammal. 20:68-70.

Giles, L W.
1940. Food habits of the raccoon in eastern Iowa. J. Wildl. Manage. 4:375-382.

Gill, D.
1970. The coyote and the sequential occupants of the Los Angeles Basin. Am. Anthropol. 72:821-826.

Gill, D.
1972. The evolution of a discrete beaver habitat in the Mackenzie River Delta, Northwest Territories. Can. Field-Nat. 86:233-239.

Gill, D., and L. D. Cordes.
1972. Winter habitat preference of porcupines in the southern Alberta foothills. Can. Field-Nat. 86:349-355.

Glover, F. A.
1943. A study of the winter activities of the New York weasel. Pa. Game News 14:8.

Goshring, H. H.
1971. Two rhino mice (Mus *musculus*) from Minnesota. J. Mammal. 52:834-835.

Goehring, H. H.
1972. Twenty-year study of *Eptesicus fuscus* in Minnesota. J. Mammal. 53:201-207.

Goertz, J. W.
1964. Habitats of three Oregon voles. Ecology 45:846-848.

Golley, F. B., G. A. Petrides, E. L. Rauber, and J. H. Jenkins.
1965. Food intake and assimilation by bobcats under laboratory conditions. J. Wildl. Manage. 29442447.

Goodpaster, W., and D. F. Hoffmeister.
1950. Bats as prey for mink in Kentucky cave. J. Mammal. 31:457.

Gorham, J. R., H. J. Griffiths, and R. K. Farrell.
1965. Minks. Diseases and parasites. U.S. Dep. Agric. Handb. 175, 38 p.

Goss, R. J.
1963. The deciduous nature of deer antlers. *In* Mechanisms of hard tissue destruction, p. 339369. R. Sognnaes, ed. AAAS Publ. 75. Washington, DC.

Goss, R. J.
1968. Inhibition of growth and shedding of antlers by sex hormones. Nature 220:83-85.

Goss, R. J.
1969a. Photoperiodic control of antler cycles in deer. I. Phase shift and frequency changes. J. Exp. Zool. 170:31 I-324.

Goss, R. J.
1969b. Photoperiodic control of antler cycles in deer. II. Alterations in amplitude. J. Exp. Zool. 171:223-234.

Gould, E.
1955. The feeding efficiency of insectivorous bats. J. Mammal. 36:399-407.

Gould, E.
1971. Studies of maternal-infant communications and development of vocalizations in the bats *Myotis* and *Eptesicus.* Commun. Behav. Biol. 5:263-313.

Graf, W.
1955. The Roosevelt elk. 105 p. Port Angeles Evening News, Port Angeles, Wash.

Graf, W.
1956. Territorialism in deer. J. Mammal. 37:165-170.

Graham, R. E.
1966. Observations on the roosting habits of the big-eared bat, *Plecotus townsendi,* in California limestone caves. Cave Notes 8:17-22.

Grange, W. B.
1932a. Observations on the snowshoe hare, Lepus americanus phaeonotus Allen. J. Mammal. 13:1-19.

Grange, W. B.
1932b. The pelages and color changes of the snowshoe hare, Lepus americanus phaeonotus Allen. J. Mammal. 13:99-116.

Grange, W. B.
1953. Those of the forest. 314 p. Flambeau Publ. Co., Babcock, Wis.

Grau, G. A., G. C. Sanderson, and J. P. Rogers.
1970. Age determination of raccoons. J. Wildl. Manage. 34:364-372.

Green, R. G., and C. A. Evans.
1940b. Studies on the population cycle of snowshoe hares on the Lake Alexander area. II. Mortality according to age groups and seasons. J. Wildl. Manage. 4:267-278.

Green, R. G., and C. A. Evans.
1940c. Studies on the population cycle of snowshoe hares on the Lake Alexander area. III. Effect of reproduction and mortality of young hares on the cycle. J. Wildl. Manage. 4:347-358.

Green, R. G., and C. L. Larson.
1938. A description of shock disease in the snowshoe hare. Am. J. Hyg. 28:190-212.

Green, R. G., C. L. Larson, and J. F. Bell.
1939. Shock disease as the cause of the periodic decimation of the snowshoe hare. Am. J. Hyg. 30:83-102.

Green, R. G., C. L. Larson, and D. W. Mather.
1938. The natural occurrence of shock disease in hares. Trans. North Am. Wildl. Conf. 3:887-888.

Greenhall, A. M., and J. L. Paradiso.
1968. Bats and bat banding. U.S. Dep. Inter., Bur. Sport Fish. and Wildl. Resour. Publ. 72, 48 p.

Greensides, R. D., and R. A. Mead.
1973. Ovulation in the spotted skunk (Spilogale putorius latifrons). Biol. Reprod. 8:576-584.

Greer, K. R.
1955. Yearly food habits of the river otter in the Thompson Lakes region, northwestern Montana, as indicated by scat analyses. Am. Midl. Nat. 54:299-313.

Greer, K. R.
1957. Some osteological characters of known-age ranch minks. J. Mammal. 38:319-330.

Grinnell, J., J. S. Dixon, and J. M. Linsdale.
1937. Fur-bearing mammals of California: Their natural history, systematic status, and relations to man. Vol. 1. 375 p. Univ. Calif. Press, Berkeley.

Grundmann, A. W., and Y. H. Tsai.
1967. Some parasites of the muskrat, Ondatra zibethicus osoyoosensis (Lord 1863) Miller, 1912 from the Salt Lake Valley, Utah. Trans. Am. Microsc. Soc. 86:139-144.

Gruneberg, H.
1943. The genetics of the mouse. 412 p. Univ. Press, Cambridge, Engl.

Guenther, S. E.
1950. Nutria. Wash. State Game Dep., Game Bull. 2:5.

Guiguet, C. J.
1954. A record of Baird's dolphin (Delphius bairdii Dall) in British Columbia. Can. Field-Nat. 68(3):136.

Guilday, J. E.
1949. Winter food of Pennsylvania mink. Pa. Game News 20:12, 32.

Gulland, J. A.
1974. Distribution and abundance of whales in relation to basic productivity. In The whale problem: A status report, p. 27-52. William E. Schevill, ed. Harvard Univ. Press, Cambridge.

Gulland, J. A.
1976. A note on the abundance of antarctic blue whales from the southern hemisphere. Advis. Comm. Mar. Resour. Res. Sci. Consult. Mar. Mamm., Bergen, Norway, Aug. 31 to Sept. 9, 1976. Food and Agric. Organ. U.N.

Guthrie, D. A.
1969. The carotid circulation in Aplodontia. J. Mammal. 50:1-7.

Hagmeier, E. M.
1956. Distribution of marten and fisher in North America. Can. Field-Nat. 70:149-168.

Hagmeier, E. M.
1959. A reexamination of the subspecies of fisher. Can. Field-Nat. 73:185-197.

Hair, J. D., and J. L. Mahrt.
1970. Eimeria albertensis n. sp. and E. borealis n. sp. (Sporozoa: Eimeriidae) in black bears Ursus americanus from Alberta. J. Protozool. 17:663-664.

Haley, D.
1978. Marine mammals of eastern north Pacific and Arctic waters. 256 p. Pac. Search Press, Seattle.

Hall, E. R.
1942. Gestation period in the fisher with recommendations for the animal's protection in California. Calif. Fish and Game 28:143-147.

Hall, E. R.
1945. Four new ermines from the Pacific Northwest. J. Mammal. 26:75-85.

Hall, E. R.
1946. Mammals of Nevada. 710 p. Univ. Calif. Press, Berkeley.

Hall, E. R.
1951. American weasels. Univ. Kans. Mus. Nat. Hist. Publ. 4:1-446.

Hall, E. R., and K. R. Kelson.
1959. The mammals of North America. 1,083 p. Ronald Press Co., New York.

Hamilton, W. J., Jr.
1929. The winter food of the eastern skunk. Am. Fur Breeder 2:4.

Hamilton, W. J., Jr.
1931. Skunks as grasshopper destroyers. J. Econ. Entomol. 24:918.

Hamilton, W. J., Jr.
1933a. The insect food of the big
brown bat. J. Mammal. 14:155-156.

Hamilton, W. J., Jr.
1933b. The weasels of New York.
Am. Midl. Nat. 14:289-344.

Hamilton, W. J., Jr.
1935. The fur-bearers of New York
in their relation to agriculture. Cor-
nell Univ. Ext. Bull. 319%25.

Hamilton, W. J., Jr.
1936a. The food and breeding
habits of the raccoon. Ohio J. Sci.
36:131-140.

Hamilton, W. J., Jr.
1936b. Food habits of the mink in
New York. J. Mammal. 17:169.

Hamilton, W. J., Jr.
1936c. Seasonal food of skunks in
New York. J. Mammal. 17:240-246.

Hamilton, W. J., Jr.
1937. Winter activity of the skunk.
Ecology 18:326-327.

Hamilton, W. J., Jr.
1940. The summer food of mink
and raccoons on the Montezuma
Marsh, New York. J. Wildl. Manage.
4:80-84.

Hamilton, W. J., Jr.
1943. The mammals of Eastern
United States. 432 p. Comstock
Publ. Assoc., Ithaca, N.Y.

Hamilton, W. J., Jr.
1951. Warm weather foods of the
raccoon in New York State. J.
Mammal. 32:341-344.

Hamilton, W. J., Jr.
1961. Late fall, winter and early
spring foods of 141 otters from
New York. N.Y. Fish and Game J.
8:106-109.

Hamilton, W. J., Jr., and A. H. Cook.
1955. The biology and management
of the fisher in New York. N.Y. Fish
and Game J. 2:13-35.

Hamilton, W. J., Jr., and W. R. Eadie.
1964. Reproduction in the otter,
Lutra canadensis. J. Mammal.
45:242-252.

Hamilton, W. J., III.
1962. Reproductive adaptations of
the red tree mouse. J. Mammal.
43:486-504.

Hamlett, G. W. D.
1938. The reproduction cycle of the
coyote. U.S. Dep. Agric. Tech. Bull.
616, 11 p.

Hammer, E. W., and C. Maser.
1973. Distribution of the dusky-
footed woodrat, Neotoma fuscipes
Baird, in Klamath and Lake Coun-
ties, Oregon. Northwest Sci.
47:123-127.

Handley, C. 0.
1966. A synopsis of the genus
Kogia (pygmy sperm whales). In
Whales, dolphins, and porpoises.
p. 62-69. K. S. Norris, ed. Univ.
Calif. Press, Berkeley.

Handley, C. O., Jr.
1959. A revision of American bats
of the genera Euderma and Pleco-
tus. Proc. U.S. Natl. Mus.
110:95-246.

Hansen, E. L.
1965. Muskrat distribution in south-
central Oregon. J. Mammal.
46:669-671.

Hansen, R. M.
1952. Notes on behavior of long
tailed weasel in Utah. J. Mammal.
33:492.

Hansen, A. M., and J. T. Flinders.
1969. Food habits of North Ameri-
can hares. Colo. State Univ. Range
Sci. Dep., Sci. Ser. 1, 18 p.

Harger, E. M.
1967. Homing behavior of black
bears. Mich. Dep. Conserv., Res.
and Dev. Rep. 118, 13 p.

Harley, J. P.
1972. A survey of the helminths of
the muskrat, Ondatra z. zibethica
Miller, 1912, in Madison County,
Kentucky. Trans. Ky. Acad. Sci.
33:13-15.

Harling, J., and M. McClaren.
1970. The occurrence of Endogone
macrocarpa in stomachs of Pero-
myscus maniculatus. Syesis
3:155-159.
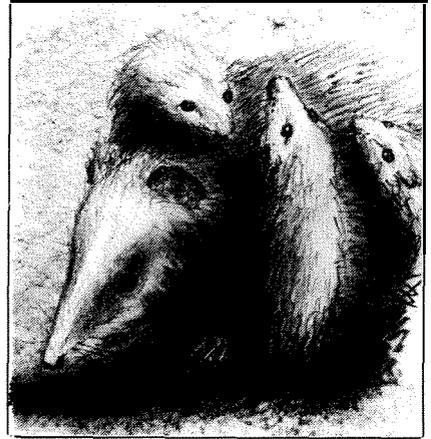
OPOSSUMS

Harper, J. A.
1964. Movement and associated
behavior of Roosevelt elk in south-
western Oregon. Proc. West.
Assoc. State Game and Fish
Comm. 44:139-141.

Harper, J. A.
1971. Ecology of Roosevelt elk.
44 p. Oreg. State Game Comm.,
Portland.

Harper, J. A., J. H. Harn, W. W.
Bentley, and C. F. Yocom.
1967. The status and ecology of
the Roosevelt elk in California.
Wildl. Monogr. 16, 49 p.

Harris, C. J.
1968. Otters: A study of the recent
Lutrinae. 397 p. London, Weiden-
feld, and Nicolson.

Harris, V. T.
1952. An experimental study of
habitat selection by prairie and
forest races of the deer mouse,
Peromyscus maniculatus. Contrib.
Lab. Vertebr. Biol. Univ. Mich. 56,
53 p.

Harris, V. T.
1954. Experimental evidence of
reproductive isolation between two
subspecies of Peromyscus
maniculatus. Contrib. Lab. Vertebr.
Biol. Univ. Mich. 70, 13 p.

Harrison, R. J.
1972. Functional anatomy of
marine mammals. Vol. 1. Acad.
Press, London and New York.

Hartman', C. G.
  1952. Possums. 174 p. Univ. Tex., Austin.

Hatler, D. F.
  1967. Some aspects in the ecology of the black bear *(Ursus americanus)* in interior Alaska. M.S. thesis. Univ. Alaska, College [Fairbanks]. 111 p.

Hattwick, M. A. W., F. H. Hochberg, P. J. Landrigan, and M. B. Gregg.
  1972. Skunk-associated human rabies. J. Am. Med. Assoc. 222:44-47.

Haugen, 0. L.
  1954. Longevity of the raccoon in the wild. J. Mammal. 35439.

Hawley, V. D.
  1955. The ecology of the marten in Glacier National Park. M.S. thesis. Mont. State Univ., Missoula. 131 p.

Hawley, V. D., and F. E. Newby.
  1957. Marten home ranges and population fluctuations. J. Mammal. 38:174-184.

Hawthorne, V. M.
  1971. Coyote movements in Sage hen Creek Basin, northeastern California. Calif. Fish and Game 57:154-161.

Hawthorne, V. M.
  1972. Coyote food habits in Sagehen Creek Basin, northeastern California. Calif. Fish and Game 58:4-12.

Hedge, R. S., G. E. Folk, Jr., and M. C. Brewer.
  1965. Studies on winter lethargy of black and grizzly bears. Proc. 16th Alaskan Sci. Conf. (AAAS) 16:31-32.

Heidt, G. A., and J. Hargraves.
  1974. Blood chemistry and hematology of the spotted skunk, *Spilogale putorius.* J. Mammal. 55:206-208.

Hendricks, S. L., and V. A. Seaton.
  1969. Rabies in wild animals trapped for pelts. Wildl. Dis. Assoc. Bull. 5:231-234.

Henson, 0. W., Jr.
  1970. The ear and audition. In Biology of bats. Vol. 2. p. 181-256. W. A. Wimsatt, ed. Acad. Press, New York.

Herman, C. M., and D. L. Price.
  1965. Epizootiologic studies on filarioids of the raccoon. J. Wildl. Manage. 29z694-699.

Hibben, R. C.
  1937. A preliminary study of the mountain lion, *Felis oregoneffsis.* Univ. N.M. Biol. Ser. 5(3), 59 p.

Hillaby, J.
  1968. Ancestors of the tabby. New Sci. 38:404-405.

Hillbricht, A., and L. Ryszkowski.
  1961. Investigations of the utilization and destruction of its habitat by a population of coypu, *Myocastor coypus* Molina, bred in semi-captivity. Ekol. Pol. Ser. A, 9:505-524.

Hines, W. W.
  1973. Black-tailed deer populations and Douglas-fir reforestation in the Tillamook Burn, Oregon. Oreg. State Game Comm. Res. Rep. 3, 59 p.

Hitchcock, H. B.
  1965. Twenty-three years of bat banding in Ontario and Quebec. Can. Field-Nat. 79:4-14.

Hnatiuk, J. M.
  1969. Occurrence of *Echinococcus multilocularis* Leuckart, 1863 in *Vulpes fulva* in Saskatchewan. Can. J. Zool. 47:264.

Hodgdon, H. E., and J. S. Larson.
  1973. Some sexual differences in behavior within a colony of marked beavers *(Castor canadensis).* Anim. Behav. 21:147-152.

Hodgson, R. G.
  1937. Fisher farming. 104 p. Fur Trade J. Can., Toronto.

Hollister, N.
  1911. A systematic synopsis of the muskrats. North Am. Fauna 32, 47 p.

Hollister, N.
  1913. A synopsis of the American minks. Proc. U.S. Natl. Mus. 44:471-480.

Hooper, E. T.
  1938. Geographical variation in woodrats of the species Neotoma fuscipes. Univ. Calif. Publ. Zool. 42:213-246.

Hooper, E. T., and B. T. Ostenson.
  1949. Age groups in Michigan otter. Univ. Mich. Mus. Zool. Occas. Pap. 518:1-22.

Hooven, E. F.
  1955. A field test of tetramine treated Douglas-fir seed. Oreg. State Board For. Res. Note 21, 17 p.

Hooven, E. F.
  1956. Field test of tretramine treated Douglas-fir seed. Oreg. State Board For. Res. Note 29, 11 p.

Hooven, E. F.
  1958. Deer mouse and reforestation in the Tillamook Burn. Oreg. State Board For. Res. Note 37, 31 p.

Hooven, E. F.
  1959. Dusky-footed woodrat in young Douglas-fir. Oreg. For. Res. Cent. Res. Note 41, 23 p.

Hooven, E. F.
  1966. A test of thiram on two rabbit-infested areas of Oregon. Tree Plant. Notes 79:1-3.

Hoover-r, E. F.
  1971a. Pocket gopher damage on ponderosa pine plantations in southwestern Oregon. J. Wildl. Manage. 35:346-353.

Hooven, E. F.
  1971b. The porcupine in Oregon: Its life history and control. Sch. For. Res. Pap. 10, 22 p. Oreg. State Univ., Corvallis.

Hooven, E. F., R. F. Hoyer, and R. M. Storm.
1975. Notes on the vagrant shrew, *Sorex vagrans*, in the Willamette Valley of western Oregon. Northwest Sci. 49:163-173.

Horner, B. E.
1954. Arboreal adaptations of Peromyscus, with special reference to use of the tail. Contrib. Lab. Vertebr. Biol. Univ. Mich. 61, 84 p.

Hornocker, M. G.
1969. Winter territoriality in mountain lions. J. Wildl. Manage. 33:457-464.

Hornocker, M. G.
1970. An analysis of mountain lion predation upon mule deer and elk in the Idaho Primitive Area. Wildl. Monogr. 21, 39 p.

Hornocker, M. G.
1971. Suggestions for the management of mountain lions as trophy species in the Intermountain Region. 51st Annu. Proc. West. Assoc. State Game and Fish Comm. 1971:399-402.

Hornocker, M. G., J. J. Craighead, and E. W. Pfeiffer.
1965. Immobilizing mountain lions with succinylcholine chloride and pentobarbital sodium. J. Wildl. Manage. 29880883.

Hornocker, M. G., and W. V. Wiles.
1972. Immobilizing pumas (*Felis concolor*) with phencyclidine hydrochloride. Int. Zoo Yearb. 12:220-223.

Horvath, 0.
1966. Observation of parturition and maternal care of the bushytailed woodrat (Neotoma *cinerea occidentalis* Baird). Murrelet 47:6-8.

Houseknecht, C. R., and R. A. Huempfner.
1970. A red fox-striped skunk encounter. Am. Midl. Nat. 83:304-306.

Howard, W. E., and R. E. Cole.
1967. Olfaction in seed detection by deer mice. J. Mammal. 48:147-150.

Howard, W. E., R. E. Marsh, and R. E. Cole.
1968. Food detection by deer mice using olfactory rather than visual cues. Anim. Behav. 16:13-17.

Howell, A. B.
1919. Microtus townsendi in the Cascade Mountains of Oregon. J. Mammal. 1:141-142.

Howell, A. B.
1923. Description of a new microtine rodent from Oregon, with remarks on some contiguous forms. J. Mammal. 4:33-37.

Howell, A. B.
1926. Voles of the genus *Phenacomys*. North Am. Fauna 48, 66 p.

Howell, A. B.
1928. The food and habitat preferences of *Phenacomys albipes*. J. Mammal. 9:153-154.

Howell, A. H.
1906. Revision of the skunks of the genus Spilogale. North Am. Fauna 26, 37 p.

Howell, A. H.
1918. Revision of the American flying squirrels. North Am. Fauna 44, 64 p.

Hubbs, C. L.
1951. Eastern Pacific records and general distribution of the pygmy sperm whale. J. Mammal. 32(4):403-410.

Hughes, S. E.
1968. Temperature of the bat, *Plecotus townsendii,* during arousal. J. Mammal. 49:140-142.

Hutchinson, G. E.
1950. Survey of contemporary knowledge of biogeochemistry. 3. The biogeochemistry of vertebrate excretion. Am. Mus. Nat. Hist. Bull. 96:1-554.

Imler, R. H., and H. R. Sarber.
1947. Harbor seals and sea lions in Alaska. U.S. Fish and Wildl. Serv. Spec. Sci. Rep. 28.

Inabnit, R., B. Chobotar, and J. V. Ernst.
1972. *Eimeria procyonis* sp. n., an *Isospora* sp., and a redescription of *E. nutalli* Yakimoff and Matikaschwili, 1932 (Protozoa: Eimeriidae) from the American raccoon *(Procyon lotor)*. J. Protozool. 19:244-247.

Ingles, L. G.
1942. Observations on the shorttailed weasel in California. J. Mammal. 23:446-448.

Ingles L. G.
1959. A quantitative study of mountain beaver activity. Am. Midl. Nat. 61:419-423.

Ingles, L. G.
1960. Tree climbing by mountain beavers. J. Mammal. 41:120-121.

Ingles, L. G.
1961a. Home range and habitats of the wandering shrew. J. Mammal. 42:455-462.

Ingles, L. G.
1961b. Reingestion in the mountain beaver. J. Mammal. 42:411-412.

Ingles, L. G.
1965. Mammals of the Pacific States. 506 p. Stanford Univ. Press, Stanford, Calif.

Ingram, R.
1973. Wolverine, fisher, and marten in central Oregon. Oreg. State Game Comm. Adm. Rep. 73-2, 41 p.

International Whaling Commission.
1976. Twenty-sixth report of the commission. 447 p. London.

International Whaling Commission.
1977. Twenty-seventh report of the commission. 522 p. London.

Ireland, P. H., and H. A. Hays.
1969. A new method for determining the home range of woodrats. J. Mammal. 50:378-379.

Jackson, H. H. T.
1931. The muskrat, a trapper's treasure trove. Home Geogr. Mon. 1:44-48.

Jackson, H. H. T.
1961. Mammals of Wisconsin. 504 p. Univ. Wis. Press, Madison.

Jacobsen, W. C.
1923. Rate of reproduction in Cite//us *beecheyi*. J. Mammal. 4:58.

Jacobson, J. O., E. C. Meslow, and M. F. Andrews.
1970. An improved technique for handling striped skunks in disease investigations. J. Wildl. Dis. 6:510-512.

Jaczewski, Z.
1954. The effect of changes in length of daylight on the growth of antlers in the deer (Cervus elaphus L.). Folia Biol. 2:133-143.

Jakowski, R. M., and D. S. Wyand.
1971. Listeriosis associated with canine distemper in a gray fox. J. Am. Vet. Med. Assoc. 159:626-628.

Jameson, E. W.
1955. Observations on the biology of *Sorex trowbridgii* in the Sierra Nevada, California. J. Mammal. 36:340-345.

Jameson, E. W., Jr.
1952. Food of deer mice, *Peromyscus maniculatus* and *P. boylei*, in the northern Sierra Nevada, California. J. Mammal. 44:418-419.

Jameson, R.
1974. An evaluation of attempts to reestablish the sea otter in Oregon. Master's thesis. Oreg. State Univ., Corvallis. 66 p.
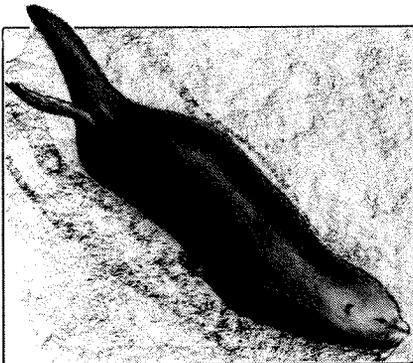
Jellison, W. L.
1970. Tularemia in Montana. Mont. Wildl. Mont. Anim. Ser. 2, p. 6-25.

Jennings, W. L., N. J. Schneider, A. L. Lewis, and J. E. Scatterday.
1960. Fox rabies in Florida. J. Wildl. Manage. 24:171-179.

Jepsen, G. L.
1970. Bat origins and evolution. *In* Biology of bats. Vol. 1. p. I-62. W. A. Wimsatt, ed. Acad. Press, New York.

Jewett, S. G., and H. W. Dobyns.
1929. The Virginia opossum in Oregon. J. Mammal. 10:351.

Jewett, S. G., Jr.
1930. Hoary bat secured in Portland, Oregon. Murrelet 1 1:75.

Johnson, A. S.
1970a. Biology of the raccoon (*Procyon lotor varius*) Nelson and Goldman in Alabama. Auburn Univ. Agric. Exp. Stn. Bull. 402, 148 p.

Johnson, C. E.
1921. The "hand-stand" habit of the spotted skunk. J. Mammal. 2:87-89.

Johnson, C. E.
1925. The muskrat in New York: Its natural history and economics. Roosevelt Wildl. Bull. 3:190-320.

Johnson, C. E.
1927. The beaver in the Adirondacks: Its economics and natural history. Roosevelt Wildl. Bull. 4:499-641.

Johnson, D. E.
1951. Biology of the elk calf, *Cervus canadensis nelsoni*. J. Wildl. Manage. 15:396-410.

Johnson, H. N.
1959. The role of the spotted skunk in rabies. 63d Annu. Proc. U.S. Livest. Sanit. Assoc., 8 p.

Johnson, M. L.
1943. Early medical men in the Northwest who were naturalists. West. J. Surg., Obstet., and Gynecol. 51:210-221.

Johnson, M. L.
1968. Application of blood protein electrophoretic studies to problems in mammalian taxonomy. Syst. Zool. 17:23-30.

Johnson, M. L.
1973. Characters of the heather vole, *Phenacomys,* and the red tree vole, *Arborimus.* J. Mammal. 54:239-244.

Johnson, M. L., and S. B. Benson.
1960. Relationship of the pocket gophers of the Thomomys mazamatalpoides complex in the Pacific Northwest. Murrelet 41:17-22.

Johnson, M. L., and L. K. Couch.
1954. Determination of the abundance of cougar. J. Mammal. 35:255-256.

Johnson, M. L. and C. Maser.
[In press.] Generic relationship of *Phenacomys albipes.* Northwest Sci.

Johnson, M. L., and B. T. Ostenson.
1959. Comments on the nomenclature of some mammals of the Pacific Northwest. J. Mammal. 40:571-577.

Johnson, W. J.
1970b. Food habits of the red fox in Isle Royale National Park, Lake Superior. Am. Midl. Nat. 84568572.

Johnston, R. F., and R. L. Rudd.
1957. Breeding of the salt marsh shrew. J. Mammal. 38:157-163.

Jones, C.
1965. Ecological distribution and activity periods of bats of the Mogollon Mountains area of New Mexico and adjacent Arizona. Tulane Stud. Zool. 12:93-100.

Jonkel, C. J.
1959. Ecological and physiological study of the pine marten. MS. thesis. Mont. State Univ., Bozeman. 81 p.

Jonkel, C. J., and I. McT. Cowan.
1971. The black bear in the spruce-fir forest. Wildl. Monogr. 27, 57 p.

SEA OTTER

Jonkel, C. J., and F. L. Miller.
1970. Recent records of black bears (*Ursus americanus*) on the barren grounds of Canada. J. Mammal. 51:826-828.

Jonkel, C. J., and R. P. Weckwerth.
1963. Sexual maturity and implantation of blastocysts in the wild pine marten. J. Wildl. Manage. 27:93-98.

Jorgensen, S. E., and L. D. Mech, Eds.
1971. Proceedings of a symposium on the native cats of North America: Their status and management. 139 p. U.S. Dep. Inter. Fish and Wildl. Serv., Bur. Sport Fish. and Wildl., Fort Snelling, Twin Cities, Minn.

Judd, W. W.
1970. Invertebrates from an abandoned muskrat house at London, Ontario. Can. J. Zool. 48:402-403.

Kangur, R.
1954. Shrews as tree seed eaters in the Douglas-fir region. Oreg. State Board For. Res. Note 17, 23 p.

Kappus, K. D., W. J. Bigler, R. G. McLean, H. A. Trevino.
1970. The raccoon an emerging rabies host. J. Wildl. Dis. 6:507-509.

Karstad, L., and J. Budd.
1964. Distemper in raccoons characterized by giant-cell pneumonitis. Can. Vet. J. 5:326-330.

Karstad, L., P. Lusis, and D. Wright
1971. Tyuer's disease in muskrats. J. Wildl. Dis. 7:96-99.

Kasuya, T.
1972. Growth and reproduction of *Stenella coeruleoalba* based on the age determination by means of dentinal growth layers. Sci. Rep. Whales Res. Inst. 24:57-79.

Kavanau, J. L., J. Ramos, and C. R. Peters.
1972. Light preferences of young foxes (*Urocyon cinereoargenteus*). Z. Tierpsychol. 31:404-409.

Kawakami, T.
1976. Squids found in the stomach of sperm whales in the northwestern Pacific. Sci. Rep. Whales Res. Inst. 28(Oct.): 145152.

Kawamura, A.
1974. Food and feeding ecology in the southern sei whale. Sci. Rep. Whales Res. Inst. 26:25-144.

Kebbe, C. E.
1955. Muskrat migration from Klamath Marsh. Murrelet 36:26.

Kebbe, C. E.
1959. The nutria in Oregon. Oreg. State Game Comm. Bull. 14:8.

Kebbe, C. E.
1961. Return of the fisher. Oreg. State Game Comm. Bull. 16:2, 6-7.

Keith, L. B.
1963. Wildlife's ten-year cycle. 201 p. Univ. Wis. Press, Madison.

Keith, L. B., and D. C. Surrendi.
1971. Effects of fire on a snowshoe hare population. J. Wildl. Manage. 35:16-26.

Kelker, G. H.
1937. Insect food of skunks. J. Mammal. 18:164-170.

Kellogg, R., and V. B. Scheffer.
1947. Occurrence of *Stenella euphorsyne* off Oregon coast. Murrelet 30(3):267-268.

Kelsall, J. P.
1970. Interaction between barren-ground caribou and muskrats. Can. J. Zool. 48:605.

Kenyon, K. W.
1975. The sea otter in the eastern Pacific Ocean. 352 p. Dover, New York.

Kenyon, K. W., and D. W. Rice.
1961. Abundance and distribution of the Steller sea lion. J. Mammal. 42:223-234.

Kight, J.
1962. An ecological study of the bobcat, *Lynx rufus* (Schreber), in west-central South Carolina. M.S. thesis. Univ. Ga., Athens.

Kindschy, R. R., Jr., and E. J. Larrison.
1961. Observations on a captive mountain beaver. Murrelet 42:1-3.

King, J., Ed.
1968. Biology of *Peromyscus* (Rodentia). Am. Soc. Mamm. Spec. Publ. 2, 593 p.

King, J. E.
1958. Development of a stand of coniferous reproduction and interplanted Douglas-fir. Northwest Sci. 32:1-8.

King, J. E.
1964. Seals of the world. 154 p. Br. Mus. (Nat. Hist.), Trustees.

King, J. M., H. C. Black, and 0. H. Hewitt.
1960. Pathology, parasitology, and hematology of the black bear in New York. N.Y. Fish and Game J. 7:99-111.

Kingston, N., and J. Morton.
1973. Trypanosomes from elk (*Cervus canadensis*) in Wyoming. J. Parasitol. 59:1132-1133.

Kinsel, G. V.
1958. The theory and practice of nutria raising. 231 p. Fur Trade J. Can., Toronto.

Kistner, T. P., and J. F. Bone.
1973. Diseases of game animals and birds and their relationship to humans. Oreg. State Game Comm. Bull. 28:3-10, 12.

Klingener, D.
1970. Superficial facial musculature of *Aplodontia*. J. Mammal. 51:35-41.

Klumov, S. K.
1963. [Feeding and helminth fauna of whalebone whales (Mysticeti) in the main whaling grounds of the world ocean.] Tr. Inst. Okeanol. 71:94-194. [In Russ.]

Knable, A. E.
1970. Food habits of the red fox (*Vulpes fulva*) in Union County, Illinois. Ill. Acad. Sci. 63:359-365.

Knight, I. M.
1951. Diseases and parasites of the muskrat (*Ondatra zibethicus osoyoosensis*) in British Columbia. Can. J. Zool. 29:188-214.

Knight, R. R.
1970. The Sun River elk herd. Wildl. Monogr. 23, 66 p.

Knowlton, F. F.
1972. Preliminary interpretations of coyote population mechanics with some management implications. J. Wildl. Manage. 36:369-382.

Knudsen, G. J., and J. B. Hale.
1968. Food habits of otters in the Great Lakes region. J. Wildl. Manage. 32:89-93.

Korfhage, R. C.
1974. Summer food habits of elk in the Blue Mountains of northeastern Oregon based on fecal analysis. M.S. thesis. Wash. State Univ., Pullman. 117 p.

Korschgen, L. J.
1957. Food habits of the coyote in Missouri. J. Wildl. Manage. 21:424-435.

Korschgen, L. J.
1958. December food habits of mink in Missouri. J. Mammal. 39:521-527.

Korschgen, L. J.
1959. Food habits of the red fox in Missouri. J. Wildl. Manage. 23:168-176.

Kramer, T. T., J. G. Nagy, and T. A. Barber.
1971. Diarrhea in captive mule deer fawns attributed to *Escherichia co/i*. J. Wildl. Manage. 35:205-209.

Krefting, L. W., J. H. Stoeckler, B. J. Bradle, and W. D. Fitzwater.
1962. Porcupine-timber relationships in the Lake States. J. For. 60:325-330.

Kritzman, E. B.
1972. A captive shrew-mole and her litter. Murrelet 53:47-49.

Krutzsch, P. H.
1954a. Notes on the habits of the bat, *Myotis californicus*. J. Mammal. 35:539-545.

Krutzsch, P. H.
1954b. North American jumping mice (genus *Zapus*). Univ. Kans. Mus. Nat. Hist. Publ. 7:349-472.

Kufeld, R. C., O. C. Wallmo, and C. Feddema.
1973. Foods of the Rocky Mountain mule deer. USDA For. Serv. Res. Pap. RM-111, 31 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Kugler, R. C.
1976. The historical records of American sperm whaling: What they tell us and what they don't. 5 p. Advis. Comm. Mar. Resour. Res. Sci. Consult. Mar. Mamm., Bergen, Norway, Aug. 31 to Sept. 9, 1976. Food and Agric. Organ. U.N.

Kuhn, L. W., W. Q. Wick, and R. J. Pedersen.
1966. Breeding nests of Townsend's mole in Oregon. J. Mammal. 47:239-249.

Kulp, J. L.
1961. The geologic time scale. Science 133:1105-1114.

Kunz, T. H.
1973. Resource utilization: Temporal and spatial components of bat activity in central Iowa. J. Mammal. 54:14-32.

Lagler, K. F., and B. T. Ostenson.
1942. Early spring food of the otter in Michigan. J. Wildl. Manage. 6:244-254.

Lankester, M. W., and V. J. Crichton.
1972. *Skrjabingylus lutrae* n. sp. (Nematoda: Metastrongyloidea) from otter (*Lutra canadensis*). Can. J. Zool. 50:337-340.

Lantz, D. E.
1923. Economic value of North American skunks. Farmer's Bull. 587:1-22.

Larrison, E. J.
1943. Feral coypus in the Pacific Northwest. Murrelet 24:3-9.

Latham, R. M.
1952. The fox as a factor in the control of weasel populations. J. Wildl. Manage. 16:516-517.

Laurie, E. M. O.
1946. The reproduction of the house mouse (Mus musculus) living in different environments. Proc. R. Soc. Lond., Ser. B, Biol. Sci. 133:248-281.

Lawlor, T. E.
1973. Aerodynamic characteristics of some neotropical bats. J. Mammal. 54:71-78.

Lawrence, G., and H. Biswell.
1972. Effect of forest manipulation on deer habitat in giant sequoia. J. Wildl. Manage. 36:595-605.

Lawrence, W. H., N. B. Kverno, and H. D. Hartwell.
1961. Guide to wildlife feeding injuries on conifers in the Pacific Northwest. 44 p. West. For. and Conserv. Assoc., Portland, Oreg.

Lawrence, W. H., and C. A. Sherman.
1963. An electronic traffic counter for recording burrow activity of the mountain beaver. J. Mammal. 44:399-405.

Laycock, G.
1966. The alien animals: The story of imported wildlife. 246 p. Ballantine Book, New York.

Layne, J. N., and L. M. Ehrhart.
1970. Digging behavior of four species of deer mice (Peromyscus). Am. Mus. Novit. 2429:1-16.

Layne, J. N., and W. H. McKeon.
1956a. Some aspects of red fox and gray fox reproduction in New York. N.Y. Fish and Game J. 3:44-74.

Layne, J. N., and W. H. McKeon.
1956b. Notes on the development of the red fox fetus. N.Y. Fish and Game J. 3:120-128.

Layne, J. N., and C. E. Winegamer. 1971. Occurrence of *Capillaria hepatica* (Nematoda: Trichuridae) in the spotted skunk in Florida. J. Wildl. Dis. 7:256-257.

Leatherwood, J. S., and R. R. Reeves. 1981. Whales, dolphins, and porpoises of the eastern north Pacific: A guide to their identification. NOAA Tech. Rep. NMFS Circ.

Leatherwood, J. S., and W. A. Walker. 1978. The northern right whale dolphin, *Lissodelphis borealis* in the eastern north Pacific. In Behavior of marine mammals. Vol. 3, Natural history of whales. Plenum, New York.

LeBoeuf, B. J. 1971. The aggression of the breeding bulls. Nat. Hist. 80:83-94.

LeBoeuf, B. J. 1974. Male-male competition and reproductive success in elephant seals. Am. Zool. 14:163-176.

LeBoeuf, B. J., and M. L. Bonnell. 1971. DDT in California sea lions. Nature 234:108-110.

Lechleitner, R. R. 1954. Age criteria in mink, *Mustela vison*. J. Mammal. 35:496-503.

Lee, A. K. 1963. The adaptations to arid environments in woodrats of the genus Neotoma. Univ. Calif. Publ. Zool. 64:57-96.

Leege, T. A. 1968. Natural movements of beavers in southeastern Idaho. J. Wildl. Manage. 32:973-976.

Lenfant, C., K. Johansen, and J. D. Torrance. 1970. Gas transport and oxygen storage capacity in some pinnipeds and the sea otter. Respir. Physiol. 9:277-286.

Lensink, C. J., R. V. Skoog, and J. L. Buckley. 1955. Food habits of marten in interior Alaska and their significance. J. Wildl. Manage. 19:364-368.

Leopold, A. S., T. Riney, R. McCain, and L. Tevis, Jr. 1951. The Jawbone deer herd. Calif. Div. Fish and Game, Game Bull. 4, 139 p.

Lewis, J. B. 1927. A mink fight. J. Mammal. 8:308.

Lewis, T. H. 1949. The morphology of the pectoral girdle and anterior limb in *Aplodontia*. J. Morphol. 85:533-558.

Licht, P., and P. Leitner. 1967. Behavioral responses to high temperatures in three species of California bats. J. Mammal. 48:52-61.

Liers, E. E. 1951. Notes on the river otter (*Lutra canadensis*). J. Mammal. 32:1-9.

Lincoln, R. C., and R. C. Anderson. 1973. The relationship of *Physaloptera maxillaris* (Nematoda: Physalopteroidea) to skunk (*Mephitis mephitis*). Can. J. Zool. 51:437-441.

Linhart, S. B., H. H. Brusman, and D. S. Basler. 1968. Field evaluation of an antifertility agent, stilbestrol, for inhibiting coyote reproduction. Trans. 33d North Am. Wildl. and Nat. Resour. Conf., p. 316-327.

Linsdale, J. M. 1946. The California ground squirrel. 475 p. Univ. Calif. Press, Berkeley and Los Angeles.

Linsdale, J. M., and L. P. Tevis. 1951. The dusky-footed woodrat. 664 p. Univ. Calif. Press, Berkeley.

Lindsdale, J., and Q. P. Tomich. 1953. A herd of mule deer. 567 p. Univ. Calif. Press, Berkeley.

Little, J. W., J. P. Smith, F. F. Knowlton, and R. R. Bell. 1971. Incidence and geographic distribution of some nematodes in Texas bobcats. Tex. J. Sci. 22:403-407.

Livezey, Ft., and F. Evenden, Jr. 1943. Notes on the western red fox. J. Mammal. 24:500-501.

Llewellyn, L. M. 1953. Growth rate of the raccoon fetus. J. Wildl. Manage. 17:320-321.

Lockyer, C. 1976. Growth and energy budgets of large baleen whales from the southern hemisphere. 179 p. Advis. Comm. Mar. Resour. Res. Sci. Consult. Mar. Mamm., Bergen, Norway, Aug. 31 to Sept. 9, 1976. Food and Agric. Organ. U.N.

Long, C. A., and R. G. Severson. 1969. Geographical variation in the big brown bat in the north-central United States. J. Mammal. 50:621-624.

Lum, S. K. 1878. The sewellel or showtl. Am. Nat. 12:10-13.

McCabe, R. A. 1949. The scream of the mountain lion. J. Mammal. 30:305-306.

McCann, C. 1975. A study on the genus *Berardius* Duvernoy. Sci. Rep. Whales Res. Inst. 26:111-137.

McGrew, P. 0. 1941. The Aplodontoidea. Field Mus. Nat. Hist. Geol. Ser. 9:1-30.

McKeever, S. 1960. Food of the northern flying squirrel in northeastern California. J. Mammal. 41:270-271.
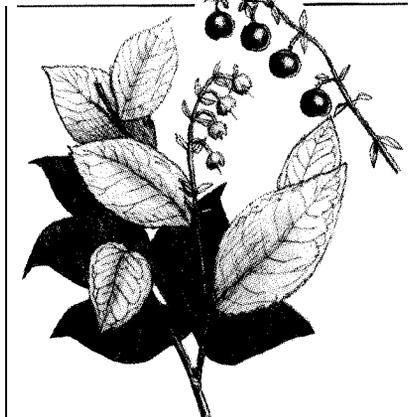
ALAL

McKeever, S., J. H. Schubert, M. D. Moody, G. W. Gorman, and J. F. Chapman.
1958. Natural occurrence of tularemia in marsupials, carnivores, lagomorphs, and large rodents in southwestern Georgia and northwestern Florida. J. Infect. Dis. 103:120-126.

MacLennan, R. R., and E. D. Bailey.
1972. Role of sexual experience in breeding behavior of male ranch mink. J. Mammal. 53:380-382.

MacLulich, D. A.
1937. Fluctuations in the numbers of the varying hare (*Lepus americanus*). Univ. Toronto Stud. Biol. Ser. 43:1-136.

McManus, J. J.
1970. Behavior of captive opossums, Didelphis marsupialis virginiana. Am. Midl. Nat. 84:144-169.

Mace, R. U.
1974. The bobcat is in trouble! Oreg. Wildl. 29:3-4.

Mackintosh, N. A.
1965. The stocks of whales. 232 p. Fish. News (Books) Ltd., London.

Macnab, J. A., and J. C. Dirks.
1941. The California red-backed mouse in the Oregon Coast Range. J. Mammal. 22:174-180.

Magnolia, L. R.
1977. Whales, whaling, and whale research: A selected bibliography. Whaling Mus. Publ. WM-1, 91 p.

Mann, W. M.
1930. Wild animals in and out of the zoo. Smithson. Sci. Ser. 6, 374 p.

Markley, M. H., and C. F. Bassett.
1942. Habits of captive marten. Am. Midl. Nat. 28:604-616.

Marsh, R. E., and W. E. Howard.
1968. Breeding ground squirrels, Spermophilus beecheyi, in captivity. J. Mammal. 49:781-783.

Marsh, R. E., and W. E. Howard.
1971. Care of ground squirrels (*Spermophilus* spp.) in captivity. Lab. Anim. Sci. 21:367-371.

Marsh, R. E., W. E. Howard, and H. Bongardt.
1969. Some serum transferrins in California ground squirrels (*Spermophilus*). J. Mammal. 50:649-652.

Marshall, A. D., and J. H. Jenkins.
1966. Movements and home ranges of bobcats as determined by radio-tracking in the upper coastal plain of west-central South Carolina. Proc. Conf. Southeast. Assoc. Game and Fish Comm. 20:206-214.

Marshall, W. H.
1936. A study of the winter activities of the mink. J. Mammal. 17:382-392.

Marshall, W. H.
1946. Winter food habits of pine marten in Montana. J. Mammal. 27:83-84.

Marshall, W. H.
1951a. Pine marten as a forest product. J. For. 49:899-905.

Marshall, W. H.
1951b. An age determination method for the pine marten. J. Wildl. Manage. 15:276-283.

Marshall, W. H., and R. K. Enders.
1942. The blastocyst of the marten (*Mantes*). Anat. Rec. 84:307-310.

Marston, M. A.
1942. Winter relations of bobcats to white-tailed deer in Maine. J. Wildl. Manage. 6:328-337.

Martin, P.
1971. Movements and activities of the mountain beaver (*Aplodontia rufa*). J. Mammal. 52:717-723.

Martin, R. A.
1969. Taxonomy of the giant Pleistocene beaver Castoroides from Florida. J. Paleontol. 43:1033-1041.

Martin, R. J.
1973. Growth curves for bushy tailed woodrats based upon animals raised in the wild. J. Mammal. 54:517-518.

Martinka, C. J.
1969. Population ecology of summer resident elk in Jackson Hole, Wyoming. J. Wildl. Manage. 33:465-481.

Maser, C.
1965a. Nest of bushy-tailed woodrat fifty feet above the ground. Murrelet 46:46.

Maser, C.
1965b. Life histories and ecology of Phenacomys albipes, Phenacomys longicaudus, Phenacomys silvicola. MS. thesis. Oreg. State Univ., Corvallis. 221 p.

Maser, C.
1966a. Notes on a captive *Sorex vagrans*. Murrelet 47:51-53.

Maser, C.
1966b. A second *Neotoma cinerea* nest fifty feet above the ground. Murrelet 47:72.

Maser, C.
1967. Black bear damage to Douglas-fir in Oregon. Murrelet 48:34-38.

Maser, C., and E. D. Brodie, Jr.
1966. A study of owl pellet contents from Linn, Benton, and Polk Counties, Oregon. Murrelet 47:9-14.

Maser, C., and J. F. Franklin.
1974. Checklist of vertebrate animals of the Cascade Head Experimental Forest. USDA For. Serv. Resour. Bull. PNW-51, 32 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

Maser, C., E. W. Hammer, and S. H. Anderson.
1970. Comparative food habits of three owl species in central Oregon. Murrelet 51:29-33.

Maser, C., and E. F. Hooven.
1974. Notes on the behavior and food habits of captive Pacific shrews, Sorex pacificus pacificus. Northwest Sci. 48:81-95.

Maser, C., and M. L. Johnson. 1967. Notes on the white-footed vole (*Phenacomys albipes*). Murrelet 48:24-27.

Maser, C., and R. M. Storm. 1970. A key to microtinae of the Pacific Northwest (Oregon, Washington, Idaho). 162 p. Oreg. State Univ. Book Stores Inc., Corvallis.

Maser, C., J. M. Trappe, and R. A. Nussbaum. 1978. Fungal-small mammal interrelationships with emphasis on Oregon coniferous forests. Ecology 59(4):799-809.

Mate, B. R. 1975. Annual migrations of the sea lions *Eumetopias jubatus* and *Zalophus californianus* along the Oregon coast. *In* Biology of the seal. K. Ronald and A. W. Mansfield, eds. Int. Counc. Explor. Sea, (ICES), Rapp. and P.-V. Reun. 169:455-461.

Mathwig, H. J. 1973. Food and population characteristics of Iowa coyotes. Iowa State J. Res. 47:167-189.

Matteson, F. S. 1877. Mountain boomer. Am. Nat. 11:434-435.

Matthew, W. D. 1910. The phylogeny of the Felidae. Am. Mus. Nat. Hist. Bull. 28:289-316.

Mead, R. A. 1967. Age determination in the spotted skunk. J. Mammal. 48:606-616.

Mead, R. A. 1968a. Reproduction in western forms of the spotted skunk (genus *Spilogale*). J. Mammal. 49:373-390.

Mead, R. A. 1968b. Reproduction in eastern forms of the spotted skunk (genus *Spilogale*). J. Zool. Lond. 156:119-136.

Mead, R. A., and K. B. Eik-Nes. 1969. Seasonal variations in plasma levels of progesterone in western forms of the spotted skunk. J. Reprod. Fert. Suppl. 6:397-403.

Mech, L. D., D. M. Burns, and J. R. Tester. 1968. Seasonal weight changes, mortality, and population structure of raccoons in Minnesota. J. Mammal. 49:63-73.

Mech, L. D., J. R. Tester, and D. W. Warner. 1966. Fall daytime resting habits of raccoons as determined by telemetry. J. Mammal. 47:450-466.

Meredith, D. H. 1972. Subalpine cover associations of Eutamias amoenus and Eutamias townsendii in the Washington Cascades. Am. Midl. Nat. 88:348-357.

Meslow, E. C., and L. B. Keith. 1968. Demographic parameters of a snowshoe hare population. J. Wildl. Manage. 32:812-834.

Metzgar, L. H. 1973. Exploratory and feeding home ranges in *Peromyscus*. J. Mammal. 54:760-763.

Meyer, M., and B. G. Chitwood. 1951. Helminths from fisher (*Martes p. pennanti*) in Maine. J. Parasitol. 37:320-321.

Miller, F. L. 1965. Behavior associated with parturition in black-tailed deer. J. Wildl. Manage. 29:629-631.

Miller, F. L. 1968. Observed use of forage and plant communities of black-tailed deer. J. Wildl. Manage. 32:142-148.

Miller, F. L. 1970a. Distribution patterns of black-tailed deer (*Odocoileus hemionus columbianus*) in relation to environment. J. Mammal. 51:248-260.

Miller, F. L. 1970b. Accidents of parturient black-tailed deer. Am. Midl. Nat. 83:303-304.

Miller, F. L. 1971a. Mutual grooming by black-tailed deer in northwestern Oregon. Can. Field-Nat. 85295301.

Miller, F. L. 1971b. Behavior of maternal black-tailed deer (*Odocoileus hemionus columbianus*) associated with the death of fawns. Z. Tierpsychol. 28:527-533.

Miller, F. W. 1930. The spring moult of Mustela longicauda. J. Mammal. 11:471-473.

Miller, F. W. 1931a. A feeding habit of the long-tailed weasel. J. Mammal. 12:164.

Miller, F. W. 1931b. The fall moult of Mustela longicauda. J. Mammal. 12:150-152.

Miller, R. C., R. W. Ritcey, and R. Y. Edwards. 1955. Live-trapping marten in British Columbia. Murrelet 36:1-8.

Mitchell, E. 1973. Preliminary report on Newfoundland fishery for minke whales (*Balaenoptus acutorostrata*). Int. Comm. Whaling, 24th Rep., p. 159-176. Int. Whaling Comm., London.

Mitchell, E. 1974. Present status of northwest fin and other whale stocks. *In* The whale problem, p. 108-169. W. Schevill, ed. Harvard Univ. Press, Cambridge.

Mitchell, E. 1975. Report of the meeting on smaller cetaceans. Montreal, April 1-11, 1974. Fish. Res. Board Can. J. 32(7):889-983.

Mitchell, E., and V. M. Kozicki. 1975. Supplementary information on minke whale (*Balaenoptera acutorostrata*) from Newfoundland fishery. Fish. Res. Board Can. J. 32(7):985-994.

Mitchell, E. D.
1966. Studies on the origin and diversification of marine mammalian orders. Fish. Res. Board Can., Arct. Biol. Stn. Annu. Rep., Invest. Summ. 16, 196566.

Mitchell, J. L.
1961. Mink movements and populations on a Montana river. J. Wildl. Manage. 25:48-54.

Miyazaki, N., T. Kusaka, and M. Nishiwaki.
1973. Food of Stenella coeruleoalba. Sci. Rep. Whales Res. Inst. 25(1973):265-275.

Mohr, C. E.
1948. Texas bat caves served in three ways. Natl. Speleol. Soc. Bull. 10:89-96.

Monson, R. A., W. B. Stone, and E. Parks.
1973. Aging red foxes (Vulpes fulva) by counting the annular cementum rings of their teeth. N.Y. Fish and Game J. 20:54-61.

Montgomery, G. G.
1968. Pelage development of young raccoons. J. Mammal. 49:142-145.

Montgomery, G. G.
1969a. Weaning of captive raccoons. J. Wildl. Manage. 33: 154-I 59.

Montgomery, G. G.
1969b. Tooth emergence and raccoon weaning. Am. Midl. Nat. 82:285-287.

Moore, A. W.
1933. Food habits of Townsend and coast moles. J. Mammal. 14:36-40.

Moore, A. W.
1942. Shrews as a check on Douglas-fir regeneration. J. Mammal. 23:37-41.

Moore, J. C.
1945. Life history notes on the Florida weasel. Proc. Fla. Acad. Sci. 7:247-263.

Moore, J. C.
1963. Recognizing certain species of beaked whales of the Pacific Ocean. Am. Midl. Nat. 70:396-428.

Moore, J. C.
1966. Diagnoses and distributions of beaked whales of the genus Mesoplodon known from North American waters. In Whales, dolphins, and porpoises, p. 32-61. K. S. Norris, ed. Univ. Calif. Press, Berkeley.

Moore, R. E.
1965. Olfactory discrimination as an isolating mechanism between Peromyscus maniculatus and Peromyscus polionotus. Am. Midl. Nat. 73:85-100.

Morejohn, G. V.
1969. Evidence of river otter feeding on freshwater mussels and range extension. Calif. Fish and Game 558385.

Morejohn, G. V., Jack A. Ames, and David B. Lewis.
1975. Post mortem studies of sea otters, Enhydra lutris L., in California. Mar. Resour. Tech. Rep. 30, 82 p. Calif. Dep. Fish and Game.

Morris, R. D.
1967. A note on the homing behavior of Peromyscus maniculatus osgoodi. Can. Field-Nat. 81:225-226.

Mossman, A. S.
1955. Reproduction of the brush rabbit in California. J. Wildl. Manage. 19:177-184.

Muller-Schwarze, D.
1969. Pheromone function of deer urine. Am. Zool. 9:21.

Müller-Schwarze, D.
1972. Social significance of forehead rubbing in black-tailed deer (Odocoileus hemionus columbianus). Anim. Behav. 20:788-797.

Mumford, R. E.
1958. Population turnover in wintering bats in Indiana. J. Mammal. 39:253-261.
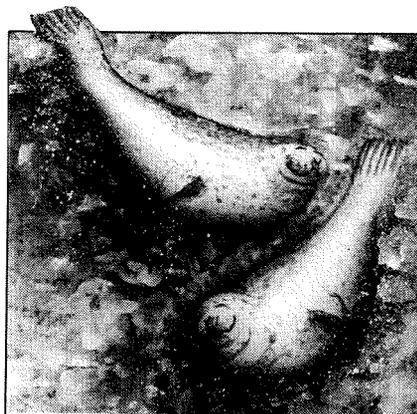
HARBOR SEALS

Mumford, R. E.
1969. Long-tailed weasel preys on big brown bats. J. Mammal. 50:360.

Murie, A.
1936. Following fox trails. Univ. Mich. Mus. Zool. Misc. Publ. 32:1-45.

Murie, A.
1940. Ecology of the coyote in the Yellowstone. Fauna Ser. 4, 206 p. U.S. Gov. Print. Off., Washington, D.C.

Murie, A.
1961. Some food habits of the marten. J. Mammal. 42:516-521

Murie, O. J.
1951. The elk of North America. 376 p. Stackpole Co., Harrisburg, Pa.

Murray, J. O., and D. O. Trainer.
1970. Bluetongue virus in North American elk. J. Wildl. Dis. 6:144-148.

Murray, K. F., and A. M. Barnes.
1969. Distribution and habitat of the woodrat, Neotoma fuscipes, in northeastern California. J. Mammal. 50:43-48.

Musgrave, M. E.
1926. Some habits of mountain lions in Arizona. J. Mammal. 7:282-285.

Muul, I.
1969. Mating behavior, gestation period, and development of Glaucomys sabrinus. J. Mammal. 50:121.

Nellis, C. H., and R. L. Ross. 1969. Changes in mule deer food habits associated with herd reduction. J. Wildl. Manage. 33:191-195.

Nelson, A. L., and C. 0. Handley. 1938. Behavior of gray foxes in raiding quail nests. J. Wildl. Manage. 2:73-78.

Nelson, E. W., and E. A. Goldman. 1930. Six new raccoons of the Procyon lotor group. J. Mammal. 11:453-459.

Newby, F. E. 1951. Ecology of marten in Twin Lakes area, Chelan County, Washington. MS. thesis. State Coll. Wash. 38 p.

Nichols, D. G., and J. T. Nichols. 1935. Notes on the New York weasel (Mustela noveboracensis). J. Mammal. 16:296-299.

Nishiwaki, M. 1972. General biology. In Mammals of the sea: Biology and medicine, p. 3-204. S. H. Ridgway, ed. Springfield, Ill.

Nishiwaki, M., and C. Handa. 1958. Killer whales caught in the coastal waters of Japan for recent 10 years. Sci. Rep. Whales Res. Inst. 13(1958):85-96.

Norris, K. S. 1966. Whales, dolphins, and porpoises. 789 p. Univ. Calif. Press, Berkeley.

Norris, K. S., and J. H. Prescott. 1961. Observations on Pacific cetaceans of California and Mexican waters. Univ. Calif. Publ. Zool. 63(4):29 l-402.

Northcott, T. H. 1971. Feeding habits of beaver in Newfoundland. Oikos 22:407-410.

Northcott, T. H. 1972. Water lilies as beaver food. Oikos 23:408-409.

Northcott, T. H., N. F. Payne, and E. Mercer. 1974. Dispersal of mink in insular Newfoundland. J. Mammal. 55:243-248.

Novakowski, N. S. 1969. The influence of vocalization on the behavior of beaver, Castor canadensis Kuhl. Am. Midl. Nat. 81:198-204.

Nussbaum, R. A., and C. Maser. 1975. Food habits of the bobcat, Lynx rufus, in the Coast and Cascade Ranges of western Oregon in relation to present management policies. Northwest Sci. 49:261-266.

Odell, D. K. 1971. Censuses of pinnipeds breeding on the California Channel Islands. J. Mammal. 52:187-190.

Odell, D. K. 1974. Seasonal occurrence of the northern elephant seal, Miroonga angustirostris, on San Nicolas Island, California. J. Mammal. 55:81-95.

Odell, D. K. 1975. Breeding biology of the California sea lion, Zalophus californianus. In Biology of the seal. K. Ronald and A. W. Mansfield, eds. Int. Counc. Explor. Sea (ICES), Rapp. and P.-V. Reun. 169:374-378.

Odell, D. K. 1977. Structure of the northern elephant seal population breeding on San Nicolas Island, California in 1971. Anim. Behav. 25(1):208-214.

O'Farrell, T. P. 1965. Home range and ecology of snowshoe hares in interior Alaska. J. Mammal. 46:406-418.

Ogle, T. F. 1971. Predator-prey relationships between coyotes and white-tailed deer. Northwest Sci. 45:213-218.

Ogle, T. F., and A. L. Farris. 1973. Aspects of cold adaptation in the coyote. Northwest Sci. 47:70-74.

Olsen, P. F. 1970. Sylvatic (wild rodent) plague. In Infectious diseases of wild mammals, p. 200-213. J. W. Davis, L. H. Karstad, and D. 0. Trainer, eds. Iowa State Univ. Press, Ames.

Olterman, J. H., and B. J. Verts. 1972. Endangered plants and animals of Oregon. IV. Mammals. Agric. Exp. Stn. Spec. Rep. 364, 47 p. Oreg. State Univ., Cowallis.

Ommundsen, P., and I. McT. Cowan. 1970. Development of the Columbian black-tailed deer (Odocoileus hemionus columbianus) during the fetal period. Can. J. Zool. 48:123-132.

Oregon State Game Commission. 1962. Exotic animals threaten Oregon wildlife, game crops. Oreg. State Game Comm. Bull. 17:7.

Oregon State Game Commission. 1972. Annual report: Game division. 180 p. Portland, Oreg.

Oregon Wildlife Commission. 1974a. Annual report: Wildlife division. 168 p. Portland, Oreg.

Oregon Wildlife Commission. 1974b. 1973-1974 biennial report. 38 p. Portland, Oreg.

Orr, H. D. 195758. Some factors affecting the utilization of space by mice of the genus Peromyscus. Proc. Minn. Acad. Sci. 25-26:204-210.

Orr, R. T. 1933. Aquatic habits of Peromyscus maniculatus. J. Mammal. 14:160-161.

Orr, R. T. 1940. The rabbits of California. Calif. Acad. Sci. Occas. Pap. 19:1-227.

Orr, R. T. 1942. Observations on the growth of young brush rabbits. J. Mammal. 23:299-302.

Orr, R. T. 1944. Communal nests of the house mouse (Mus musculus Linnaeus). Wasmann Collect. 6:15-17.

Orr, R. T. 1950. Unusual behavior and occurrence of a hoary bat. J. Mammal. 31:456-457.

Orr, R. T.
1970. Development: Prenatal and postnatal. *In* Biology of bats. Vol. 1. p. 217-230. W. A. Wimsatt, ed. Acad. Press, New York.

Orr, R. T.
1972. Marine mammals of California. 64 p. Univ. Calif. Press, Berkeley.

Osborne, T. O., and W. A. Sheppe.
1971. Food habits of *Peromyscus maniculatus* on a California beach. J. Mammal. 52:844-845.

Osgood, F. L.
1936. Earthworms as a supplementary food for weasels. J. Mammal. 17:64.

Pank, L. F., and G. H. Matschke.
1972. Decline and reinvasion of deer mouse populations after baiting Douglas-fir clearcuts with 6-aminonicotinamide. J. For. 70:678-680.

Pattie, D. L.
1969. Behavior of captive marsh shrews (*Sorex bendirii*). Murrelet 50:27-32.

Paul, J. R., L. E. Hanson, P. R. Schnurrenberger, and R. J. Martin.
1972. *Leptospira interrogans* serotypes *Ballum* and *Grippotyphosa* isolated from the muskrat. J. Wildl. Dis. 8:54-56.

Payne, R.
1979. Humpbacks: Their mysterious songs. Natl. Geogr. 155(1):18-25.

Payne, R. J., and S. McVay.
1971. Songs of humpback whales. Science 173(3997):585-597.

Pearce, J.
1937. A captive New York weasel. J. Mammal. 18:483-488.

Pearson, 0. P., and R. K. Enders.
1943. Ovulation, maturation and fertilization in the fox. Anat. Rec. 85:69-83.

Pearson, 0. P., M. R. Koford, and A. K. Pearson.
1952. Reproduction of the lump-nosed bat *(Corynorhinus rafinesquii)* in California. J. Mammal. 33:273-320.

Pelikan, J., J. Sovoboda, and J. Kvet.
1970. On some relations between the production of Typha latifolia and a muskrat population. Zool. Listy 19:303-320.

Pellett, F. C.
1913. Food habits of the skunk. Proc. Iowa Acad. Sci. 20:307-309.

Perrin, W. F.
1975a. Distribution and differentiation of populations of dolphins of the genus *Stenella* in the eastern tropical Pacific. J. Fish. Res. Board Can. 32(7):1059-1067.

Perrin, W. F.
1975b. Variation of spotted and spinner porpoise (genus *Stenella*) in the eastern Pacific and Hawaii. Scripps Inst. Ocean. Bull., Vol. 21, *206* p.

Perrin, W. F.
1980. Report of the sub-committee on small cetaceans. Rep. Int. Whaling Comm. 30:111-128.

Peterson, A. W.
1950. Backward swimming of the muskrat. J. Mammal. 31:453.

Peterson, K. J., T. P. Kistner, and H. E. Davis.
1973. Epizootiologic studies of anaplasmosis in Oregon mule deer. J. Wildl. Dis. 9:314-319.

Peterson, R. S., and G. A. Bartholomew.
1967. The natural history and behavior of the California sea lion. Am. Soc. Mamm., Spec. Publ. 1, 79 p.

Pfeiffer, E. W.
1953. Hormonally induced "mammary hairs" on a primitive rodent, *Aplodontia rufa.* Anat. Rec. 122:241-256.

Pfeiffer, E. W.
1958. The reproductive cycle of the female mountain beaver. J. Mammal. 39:223-235.

Pfeiffer, E. W., W. C. Nungesser, and J. F. Wallerius.
1960. The renal anatomy of the primitive rodent, *Aplodontia rufa,* and a consideration of its functional significance. Anat. Rec. 137:227-235.

Phillips, R. L.
1970. Age ratios of Iowa foxes. J. Wildl. Manage. 34:52-56.

Phillips, R. L., R. D. Andrews, G. L. Storm, and R. A. Bishop.
1972. Dispersal and mortality of red foxes. J. Wildl. Manage. 36:237-348.

Pike, G. C.
1956. Guide to the whales, porpoises, and dolphins of the northeast Pacific and Arctic waters of Canada and Alaska. Fish. Res. Board Can. Circ. 32, 14 p.

Pike, G. C., and L. B. MacAskie.
1969. Marine mammals of British Columbia. Fish. Res. Board Can. Bull. 171, 54 p.

Pilleri, G.
1960. Zentralnervensystem, Korperorgane und stammesgeschichtliche Verwandtschaft der *Aplodontia rufa* Rafinesque (Rodentia, Aplodontoidea). Acta. Anat. Suppl. 40 (to vol. 42):5-35.

Pils, C. M., and M. A. Martin.
1978. Population dynamics, predator-prey relationships and management of the red fox in Wisconsin. Dep. Nat. Resour. Tech. Bull. 105, 56 p. Madison, Wis.

Pimentel, R. A.
1949. Black rat and roof rat taken in the central Oregon coast strip. Murrelet 30:52.

Po-Chedley, D. S., and A. R. Shadle.
1955. Pelage of the porcupine, *Erethizon dorsa turn dorsa turn.* J. Mammal. 36:84-95.

Poelker, R. J., and H. D. Hartwell.
1973. Black bear of Washington.
Wash. State Game Dep. Biol. Bull.
14, 180 p.

Polderboer, E. B., L. W. Kuhn, and G.
0. Hendrickson.
1941. Winter and spring habits of
weasels in central Iowa. J. Wildl.
Manage. 5:115-119.

Pollack, E. M.
1949. The ecology of the bobcat
(Lynx *rufus rufus,* Schreber) in the
New England States. M.S. thesis.
Univ. Mass., Amherst.

Pollack, E. M.
1950. Breeding habits of the bobcat
in Northeastern United States. J.
Mammal. 31:327-330.

Preble, E. A.
1899. Revision of the jumping mice
of the genus *Zapus.* North Am.
Fauna 15, 43 p.

Presidente, P. J. A., S. E. Knapp, and
R. E. Dean.
1973. Treatment and control of *Dic-
tyocaulus viviparus* in captive
black-tailed deer. J. Wildl. Dis.
9:34-40.

Price, W. W.
1894. Notes on a collection of
mammals from the Sierra Nevada
Mountains. Zoe 4:315-332.

Progulske, D. R.
1952. The bobcat and its relations
to prey species in Virginia. M.S.
thesis. Va. Polytech. Inst., Blacks-
burg, Va.

Progulske, D. R.
1955. Game animals utilized as
food by the bobcat in the southern
Appalachians. J. Wildl. Manage.
19:249-253.

Provost, E. E., and C. M. Kirkpatrick.
1952. Observations on the hoary
bat in Indiana and Illinois. J. Mam-
mal. 33:110-1 13.

Pruitt, W. O., Jr.
1957. A high altitude weasel. Mur-
relet 38:36.

Quay, W. B.
1970. Integument and derivatives.
In Biology of bats. Vol 2. p. 248. W.
A. Wimsatt, ed. Acad. Press, New
York.

Quay, W. B., and D. Müller-Schwarze.
1970. Functional histology of in-
tegumentary glandular regions in
black-tailed deer (*Odocoileus he
mionus columbianus*). J. Mammal.
51:675-694.

Quick, H. F.
1944. Habits and economics of the
New York weasel in Michigan. J.
Wildl. Manage. 8:71-78.

Quick, H. F.
1953a. Wolverine, fisher, and
marten studies in a wilderness
region. Trans. North Am. Wildl.
Conf. 18:513-532.

Quick, H. F.
1953b. Occurrence of porcupine
quills in carnivorous mammals. J.
Mammal. 34:256-259.

Quick, H. F.
1955. Food habits of marten in
northern British Columbia. Can.
Field-Nat. 69:144-147.

Quimby, D. C., and J. E. Gaab.
1957. Mandibular dentition as an
age indicator in Rocky Mountain
elk. J. Wildl. Manage. 21:435-451.

Rabb, G. B.
1959. Reproductive and vocal
behavior in captive pumas. J. Mam-
mal. 40:616-617.

Radwan, M. A., and D. L. Campbell.
1967. Snowshoe hare preference
for spotted catsear flowers in west-
ern Washington. J. Wildl. Manage.
32:104-108.

Rand, A. L.
1944. The status of the fisher,
Martes pennanti (Erxleben), in
Canada. Can. Field-Nat. 58:77-81.

Rasmussen, D. I.
1964. Blood group polymorphism
and inbreeding in natural popula-
tions of deer mice *Peromyscus
maniculatus.* Evolution 18:219-229.

Rausch, R. L.
1961. Notes on the black bear, *Ur-
sus americanus* Pallas, in Alaska,
with particular reference to denti-
tion and growth. Z. Saugetierk. Bd.
26. H. 2:65-128.

Rausch, R. L., and S. H. Richards.
1971. Observations on parasite-
host relationships of *fchinococcus
multiilocularis* Leuckart, 1863, in
North Dakota. Can. J. Zool.
49:1317-1330.

Regnery, D. C., and J. H. Miller.
1972. A myxoma virus epizootic in
a brush rabbit population. J. Wildl.
Dis. 8:327-331.

Reichert, D. W.
1972. Rearing and training deer for
food habits studies. USDA For.
Serv. Res. Note RM-208, 7 p. Rocky
Mt. For. and Range Exp. Stn., Fort
Collins, Colo.

Reilly, S. B.
1978. Pilot whale. *In* Marine mam-
mals of western north Pacific and
Arctic waters, p. 113-119. D. Haley,
ed. Pac. Search Press, Seattle.

Remington, J. D.
1952. Food habits, growth, and
behavior of two captive pine
martens. J. Mammal. 33:66-70.

Reynolds, H. G.
1957. Porcupine behavior in the
desert-shrub type of Arizona. J.
Mammal. 38:412-419.

Reynolds, R. T.
1970. Nest observations of the
long-eared owl (*Asio otus*) in Ben-
ton County, Oregon, with notes on
their food habits. Murrelet 51:8-9.

Rice, D. W.
1974. Whales and whale research
in the eastern north Pacific. *In* The
whale problem: A status report, p.
170-194. W. G. Scheville, ed. Har-
vard Univ. Press, Cambridge.

Rice, D. W.
1975. Status of the eastern Pacific
(California) stock of the gray whale.
9 p. Advis. Comm. Mar. Resour.
Res. Sci. Consult. Mar. Mamm.,
Bergen, Norway, Aug. 31 to Sept. 9,
1976. Food and Agric. Organ. U.N.

Rice, D. W.
1978. Sperm whales. *In* Marine mammals, p. 8287. Delphine Haley, ed. Pac. Search Press, Seattle.

Rice, D. W., and A. A. Wolman.
1971. The life history and ecology of the gray whale (*Eschrichtius* robustus). Am. Soc. Mammal. Spec. Publ. 3, 142 p.

Richards, S. H., and R. L. Hine.
1953. Wisconsin fox populations. Wis. Conserv. Dep. Tech. Wildl. Bull. 6:1-78.

Richardson, W. B.
1942. Ring-tailed cats (*Bassariscus* astutus): Their growth and development. J. Mammal. 23:17-26.

Richens, V. B.
1967. Characteristics of mule deer herds and their range in northeastern Utah. J. Wildl. Manage. 31:651-666.

Ridgeway, S. H., Ed.
1972. Mammals of the sea: Biology and medicine. 812 p. Charles C. Thomas, Springfield.

Robinette, W. L., C. H. Baer, R. E. Pillmore, and C. E. Knittle.
1973. Effects of nutritional change on captive mule deer. J. Wildl. Manage. 37:312-326.

Robinette, W. L., J. S. Gashwiler, and 0. W. Morris.
1959. Food habits of the cougar in Utah and Nevada. J. Wildl. Manage. 23:261-273.

Robinette, W. L., J. S. Gashwiler, and 0. W. Morris.
1961. Notes on cougar productivity and life history. J. Mammal. 42:204-217.

Roest, A. I.
1951. Mammals of the Oregon Caves area, Josephine County. J. Mammal. 32:345-351.

Roest, A. I., R. M. Storm, and P. C. Dumas.
1953. Cuvier's beaked whale (*Ziphius cavirostris*) from Oregon. J. Mammal. 34(2):251-252.

Rogers, L. L.
1974. Shedding of foot pads by black bears during denning. J. Mammal. 55672674.

Rollings, C. T.
1945. Habits, foods and parasites of the bobcat in Minnesota. J. Wildl. Manage. 9:131-145.

Ronald, K., L. M. Hanly, D. J. Healey, and L. J. Selley.
1976. An annotated bibliography on the Pinnipedia. 785 p. Charlottenlund Int. Counc. Explor. Sea, Denmark.

Rongstad, 0. J., and J. R. Tester.
1971. Behavior and maternal relations of young snowshoe hares. J. Wildl. Manage. 35:338-346.

Rørvik, C. J., and A. Jonsgärd.
1975. Review of balaenopterids in the north Atlantic Ocean. 20 p. Advis. Comm. Mar. Resour. Res. Sci. Consult. Mar. Mamm., Bergen, Norway, Aug. 30 to Sept. 9, 1976. Food and Agric. Organ. U.N.

Ross, A.
1967. Ecological aspects of the food habits of insectivorous bats. Proc. West. Found. Vertebr. Zool. 1:205-263.

Rouse, R. A.
1957. Elk food habits, range use and movements, Gravelly Mountains, Montana. M.S. thesis. Mont. State Coll., Bozeman. 29 p.

Rowan, W., and L. B. Keith.
1956. Reproductive potential and sex ratios of snowshoe hares in northern Alberta. Can. J. Zool. 34:273-281.

Rudd, R. L.
1955. Age, sex, and weight comparisons in three species of shrews. J. Mammal. 36:323-339.

Russell, C. P.
1932. Seasonal migration of mule deer. Ecol. Monogr. 2:1-46.

Ryder, R. A.
1955. Fish predation by the otter in Michigan. J. Wildl. Manage. 19:497-498.

Rysgaard, G. N.
1941. Bats killed by severe storm. J. Mammal. 22:452-453.

Sackett, L. W.
1913. The Canada porcupine: A study of the learning process. Behav. Monogr. 2, Ser. 7, 84 p.

Sadleir, R. M. F. S.
1965. The relationship between agonistic behavior and population changes in the deer mouse (*Peromyscus maniculatus*). J. Anim. Ecol. 34:331-352.

Sandergren, F. E.
1970. Breeding and maternal behavior of the Steller sea lion (*Eumetopias jubata*) in Alaska. M.S. thesis. Univ. Alaska.

Sanderson, G. C.
1949. Growth and behavior of a litter of captive long-tailed weasels. J. Mammal. 30:412-415.

Sanderson, G. C.
1961a. The reproductive cycle and related phenomena in the raccoon. Ph. D. thesis. Univ. Ill., Urbana. 165 p.

Sanderson, G. C.
1961 b. Techniques for determining age of raccoons. Ill. Nat. Hist. Surv., Biol. Notes 45, 16 p.

Sargeant, A. B.
1972. Red fox spatial characteristics in relation to waterfowl predation. J. Wildl. Manage. 36:225-236.

Sargeant, A. B., G. A. Swanson, and H. A. Doty.
1973. Selective predation by mink, Mustela vison, on waterfowl. Am. Midl. Nat. 89:208-214.

Sather, J. H.
1958. Biology of the Great Plains muskrat in Nebraska. Wildl. Monogr. 2, 35 p.

Saunders, A. A.
1932. The voice of the porcupine. J. Mammal. 13:167-168.

Scammon, C. M.
1968. The marine mammals of the northwestern coast of North America. 319 p. Dover Publ. Inc., New York.

Scheffer, T. H.
1929. Mountain beavers in the Pacific Northwest; their habits, economic status, and control. U.S. Dep. Agric. Farmer's Bull. 1958:1-18.

Scheffer, T. H.
1930. Bat matters. Murrelet 11:11-13.

Scheffer, T. H.
1932. Weasels and snakes in gopher burrows. Murrelet 13:54-55.

Scheffer, T. H.
1933. Breeding of the Washington varying hare. Murrelet 14:77-78.

Scheffer. T. H.
1938a. Breeding records of Pacific coast pocket gophers. J. Mammal. 19:220-224.

Scheffer, V. B.
1938b. Notes on the wolverine and fisher in the State of Washington. Murrelet 19:8-10.

Scheffer, V. B.
1950. Notes on the raccoon in southwestern Washington. J. Mammal. 31:444-448.

Scheffer, V. B.
1953. Measurements and stomach contents of eleven delphinids from the northeast Pacific. Murrelet 34(2):27-30.

Scheffer, V. B.
1958a. Seals, sea lions, and walruses, A review of the Pinnipedia. 179 p. Stanford Univ. Press, Stanford, Calif.

Scheffer, V. B.
1958b. Long life of a river otter, J. Mammal. 39:591.

Scheffer, V. B.
1961. Encounter between Townsend moles. Murrelet 42:10.

Scheffer, V. B.
1970. The year of the seal. 205 p. Charles Scribners Sons, New York.

Scheffer, V. B., and J. W. Slipp.
1944. The harbor seal in Washington State. Am. Midl. Nat. 32:373-416.

Scheffer, V. B., and J. B. Slipp.
1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. Am Midl. Nat. 39(2):251-337.

Schevill, W. E., Ed.
1974. The whale problem: A status report. 419 p. Harvard Univ. Press, Cambridge, Mass.

Schitoskey, F., Jr.
1971. Anomalies and pathological conditions in the skulls of nutria from southern Louisiana. Mammalia 35:31 l-314.

Schitoskey, F., Jr.
1972. Bacular variation in nutria from southern Louisiana. Southwest. Nat. 16:431-459.

Schmidt, K. P.
1936. Dehairing of caterpillars by skunks. J. Mammal. 17:287.

Schneider, D. G., L. D. Mech, and J. R. Tester.
1971. Movements of female raccoons and their young as determined by radio-tracking. Anim. Behav. Monogr. 4:3-43.

Schnell, J. H.
1969-70. Rest site selection by radio-tagged raccoons. J. Minn. Acad. Sci. 36:83-88.

Schnurrenberger, P. R., R. J. Martin, and J. M. Koch.
1970. Rabies in Illinois skunks. J. Am. Vet. Med. Assoc. 157:1336-1 342.

Schofield, R. D.
1958. Litter size and age ratios of Michigan red foxes. J. Wildl. Manage. 22:313-315.

Schwarz, E., and H. K. Schwarz.
1943. The wild and commensal stocks of the house mouse, Mus musculus Linnaeus. J. Mammal. 24:59-72.

Scott, Th. G.
1947. Some food coactions of the northern plains red fox. Ecol. Monogr. 13:427-479.

Sealander, J. A.
1943. Winter food habits of mink in southern Michigan. J. Wildl. Manage. 7:41 l-417.

Sealander, J. A., and P. S. Gipson.
1972. Range extension of ringtail cat in Arkansas. Southwest. Nat. 16:458-459.

Seidensticker, J. C., IV, M. G. Hornocker, R. R. Knight, and S. L. Judd.
1970. Equipment and techniques for radiotracking mountain lions and elk. Univ. Idaho, For., Wildl., and Range Exp. Stn. Bull. 6, 20 p.

Seidensticker, J. C., IV, M. G. Hornocker, W. V. Wiles, and J. P. Messick.
1973. Mountain lion social organization in the Idaho Primitive Area. Wildl. Monogr. 35, 60 p.

Sekerak, A. D.
1969. Alaria taxideae Swanson and Erickson 1946 in pine marten from central Alaska (Trematoda: Diplostomatidae). Can. J. Zool. 47:266.

BIGLEAF MAPLE

Sergeant, D. E.
1963. Minke whale, *Balaenoptoera acutorosfrata* Lacepede, of the western north Atlantic. Fish. Res. Board Can. J. 20(6):1489-1504.

Sergeant, D. E.
1969. Feeding rates of cetacea. Fiskeridir., Skr. Ser. Havunders., Norway 15(3):246-258.

Seton, E. T.
1928. Lives of game animals. 4 vols. Doubleday, Doran and Company, Inc., Garden City, N.Y.

Seton, E. T.
1932. The song of the porcupine (Erethizon epixanthum). J. Mammal. 13:168-169.

Severaid, J. H.
1942. The snowshoe hare: Its life history and artificial propagation. Maine Dep. Inland Fish. and Game., 95 p.

Shadle, A. R.
1944. The play of American porcupines (Erethizon d. dorsatum and E. epizanthum). J. Comp. Psychol. 37:145-150.

Shadle, A. R.
1946. Copulation in the porcupine. J. Wildl. Manage. 10:159-162.

Shadle, A. R.
1947. Porcupine spine penetration. J. Mammal. 28:180-181.

Shadle, A. R.
1948. Gestation period in the porcupine, *Erethizon dorsatum dorsatum*. J. Mammal. 29:162-164.

Shadle, A. R.
1950a. The north American porcupine up-to-date. Ward's Nat. Sci. Bull. 24:5-6.

Shadle, A. R.
195Ob. Feeding, care, and handling of captive porcupines *(Erethizon).* J. Mammal. 31:411-416.

Shadle, A. R.
1951. Laboratory copulations and gestations of porcupine, *Erethizon dorsafum.* J. Mammal. 32:219-221.

Shadle, A. R.
1952. Sexual maturity and first recorded copulation of a 16-month male porcupine, *Erethizon dorsatum dorsatum.* J. Mammal. 33:239-241.

Shadle, A. R., and W. R. Ploss.
1943. An unusual porcupine parturition and development of the young. J. Mammal. 24:492-496.

Shadle, A. R., and D. Po-Chedley.
1949. Rate of penetration of porcupine spine. J. Mammal. 30:172-173.

Shadle, A. R., M. Smelzer, and M. Metz.
1946. The sex reactions of porcupines (Erethizon d. dorsatum) before and after copulation. J. Mammal. 27:116-121.

Shapiro, J.
1949. Ecological and life history notes on the porcupine in the Adirondacks. J. Mammal. 30:247-257.

Shaw, W. T.
1921. The nest of the Washington weasel (Mustela Washington). J. Mammal. 2:167-168.

Shaw, W. T.
1928. The spring and summer activities of the dusky skunk in captivity. N.Y State Mus. Handb. 4, 92 p.

Shaw, W. T.
1944. Brood nests and young of two western chipmunks in the Olympic Mountains of Washington. J. Mammal. 25:274-284.

Sheldon, W. G., and W. G. Toll.
1964. Feeding habits of the river otter in a reservoir in central Massachusetts. J. Mammal. 45:449-455.

Sheppe, W.
1966. Periodontal disease and supernumerary teeth in a population of *Mus musculus.* J. Mammal. 47:519-520.

Sheppe, W.
1967. Habitat restriction by competitive exclusion in the mice *Peromyscus* and *Mus.* Can. Field-Nat. 81:81-98.

Sherrell, P. E.
1970. An annotated checklist of the land mammals of Curry County, Oregon. M.S. thesis. Cent. Wash. State Coll., Ellensburg. 150 p.

Shields, P. W.
1960. Movement patterns of brush rabbits in northwestern California. J. Wildl. Manage. 24:381-386.

Shimek, S. J., and A. Monk.
1977. Daily activity of sea otter off the Monterey Peninsula, California. J. Wildl. Manage. 41(2):277-283.

Shotwell, J. A.
1955. Review of the Pliocene beaver *Dipoides.* J. Paleontol. 29:129-144.

Shotwell, J. A.
1958. Evolution and biogeography of the aplodontid and mylagaulid rodents. Evolution 12:451-484.

Silver, J.
1928. Pilot black-snake feeding on the big brown bat. J. Mammal. 9:149.

Simpson, G. G.
1941. Large Pleistocene felines in North America. Am. Mus. Novit. 1136:1-27.

Slijper, E. J.
1931. Ueber verletzungen und Erkran-kungen der Wirbel-saule und Ribben bei den Cetacean. Anat. Anz. 71(7/9):156-185.

Small, G. L.
1971. The blue whale. Columbia Univ. Press, New York.

Smith, A. W., T. W. Akers, S. H. Madin, and N. A. Vedros.
1973. San Miguel sea lion virus isolation, preliminary characterization and relationship to vesicular exanthema of swine virus. Nature 244(5411):108-110.

Smith, A. W., C. M. Prato, and D. E. Skilling.
1977. Characterization of two new serotypes of San Miguel sea lion virus. Intervirology **8**:30-36.

Smith, C. C.
1968. The adaptive nature of social organization in the genus of tree squirrels *Tamiasciurus.* Ecol. Monogr. **38**:31-63.

Smith, C. C.
1970. The coevolution of pine squirrels *(Tamiasciurus)* and conifers. Ecol. Monogr. **40**:349-371.

Smith, M. H., and J. T. McGinnis.
1968. Relationships of latitude, altitude, and body size to litter size and mean annual reproduction of offspring in *Peromyscus. Res. Popul. Ecol.* **10**:115-126.

Snell, G. D., Ed.
1943. Biology of the laboratory mouse. 2d ed. 497 p. Blackiston Co., Philadelphia, Pa.

Soest, R. W. M. van, and P. J. H. van Bree.
1969. On the moult in the stoat (Mustela *erminea* Linnaeus, 1758) from the Netherlands. Bijdr. Dierk. **39**:63-68.

Soest, R. W. M. van, and P. J. H. van Bree.
1970. Sex and age composition of a stoat population *(Mustela er-minea* Linnaeus, 1758) from a coastal dune region of the Netherlands. Beaufortia **17**:51-77.

Soest, R. W. M. van, J. van der Land, and P. J. H. van Bree.
1972. Skrjabingylus nasicola (Nematoda) in skulls of *Mustela er-minea* and *Mustela nivalis* (Mammalia) from the Netherlands. Beaufortia **20**:85-97.

Soper, J. D.
1919. Notes on Canadian weasels. Can. Field-Nat. **33**:43-47.

Southwest Fisheries Center.
1976. Report of the workshop on stock assessment of porpoises involved in the eastern Pacific yellowfin tuna industry. A. R. Rep. LJ-76-29, 54 p.

Spalding, D. J.
1964. Comparative feeding habits of the fur seal, sea lion, and harbour seal on the British Columbia coast. Fish. Res. Board Can. Bull. 146, 52 p.

Spalding, D. J., and J. Lesowski.
1971. Winter food of the cougar in south-central British Columbia. J. Wildl. Manage. **35**:378-381.

Spencer, H. E., Jr.
1955. The black bear and its status in Maine. Maine Dep. Inland Fish. Game Bull. **4**:1-55.

Sperry, C. C.
1933. Opossum and skunk eat bats. J. Mammal. **14**:152-153.

Sperry, C. C.
1941. Food habits of the coyote. U.S. Dep. Inter., Wildl. Res. Bull. 4, 70 p.

Stains, H. J.
1956. The raccoon in Kansas— natural history, management, and economic importance. Univ. Kans. Mus. Nat. Hist. and State Biol. Surv. Misc. Publ. 10, 76 p.

Stanley, W. C.
1963. Habits of the red fox in northeastern Kansas. Univ. Kans. Mus. Nat. Hist. Misc. Publ. 34, 31 p. Lawrence.

Stebbins, L. L.
1971. Seasonal variations in Circadian rhythms of deer mice, in northwestern Canada. Arctic **24**:124-131.

Stegemen, L. C.
1937. Notes on young skunks in captivity. J. Mammal. **18**:194-202.

Stegemen, L. C.
1939. Some parasites and pathological conditions of the skunk (Mephitis mephitis nigra) in central New York. J. Mammal. **20**:493-496.

Stelfox, J. G.
1964. Elk in northwest Alberta. Land, For., Wildl. **6**:14-23.

Stephenson, A. B.
1969. Temperatures within a beaver lodge in winter. J. Mammal. **50**:134-136.

Stevens, D. R.
1966. Range relationships of elk and livestock, Crow Creek drainage, Montana. J. Wildl. Manage. **30**:349-363.

Stickel, L. F., and R. T. Mitchell.
1944. Food habits study of Maryland raccoons. Md. Conserv. **21**:26-28.

Stockdale, P. H. G.
1970. The development, route of migration, and pathogenesis of *Perostrongylus pridhami* in mink. J. Parasitol. **56**:559-566.

Stolk, A.
1954. Some inflammation in whales, II. Proc. K. Ned. Akad. Wet. (Biol. and Med. Sci.) **57**(3):254.

Stollberg, B. P., and R. L. Hine.
1952. Food habits studies of ruffed grouse, pheasant, quail, and mink in Wisconsin. Wis. Conserv. Dep. Tech. Wildl. Bull. **4**:1-22.

Stone, W. B., E. Parks, and H. Parish.
1971. A dwarf, brachycephalic gray fox. N.Y. Fish and Game J. **18**:139-141.

Stones, R. C., and J. E. Weibers.
1965. Seasonal changes in food consumption of little brown bats held in captivity at a "neutral" temperature of 92°F. J. Mammal. 46: 18-22.

Storer, T. I.
1930. Summer and autumn breeding of the California ground squirrel. J. Mammal. **11**:235-237.

Storer, T. I., and G. H. Vansell.
1935. Bee-eating proclivities of the striped skunk. J. Mammal. **16**:118-121.

Storm, G. L., and C. H. Halvorson.
1967. Effect of injury by porcupines on radial growth of ponderosa pine. J. For. **65**:740-743.

Storm, G. L., and B. J. Verts.
1966. Movements of a striped skunk infected with rabies. J. Mammal. 47:705-708.

Strecker, R. L., and J. T. Emlen, Jr.
1953. Regulatory mechanisms in house-mouse populations: The effect of limited food supply on a confined population. Ecology 34:375-385.

Streeter, R. G., and C. E. Braun.
1968. Occurrence of pine marten, *Martes* americana, (Carnivora: Mustelidae) in Colorado alpine areas. Southwest. Nat. 13:449-451.

Stroud, R. K.
1968. Risso dolphin in Washington State. J. Mammal. 49(2):347-348.

Struthers, P. H.
1928. Breeding habits of the Canadian porcupine (Erethizon dorsatum). J. Mammal. 9:300-308.

Studier, E. H.
1972. Some physical properties of the wing membranes of bats. J. Mammal. 53:623-625.

Stuewer, F. W.
1943a. Raccoons: Their habits and management in Michigan. Ecol. Monogr. 13:203-257.

Stuewer, F. W.
1943b. Reproduction of raccoons in Michigan. J. Wildl. Manage. 7:60-73.

Stuht, J. N., and W. G. Youatt.
7972. Heartworms and lung flukes from red foxes in Michigan. J. Wildl. Manage. 36:166-170.

Sturges, F. W.
1955. Weasel preys on larval salamander. J. Mammal. 36567568.

Suthers, R. A.
1970. Vision, olfaction, taste. In Biology of bats, p. 265304. Vol. 2. W. A. Wimsatt, ed. Acad. Press, New York.

Sutton, D. A., and C. F. Nadler.
1969. Chromosomes of the North American chipmunk genus *Eutamias*. J. Mammal. 50:524-535.

NORTH AMERICAN ELK

Sutton, D. A., and C. F. Nadler.
1974. Systematic revision of three Townsend chipmunks (*Eutamias townsendii*). Southwest. Nat. 19:199-211.

Svihla, A.
1931. Habits of the New York weasel in captivity. J. Mammal. 12:67-68.

Svihla, A.
1941. The relation of water to dormancy in mammals. Murrelet 22:15-18.

Svihla, A., and R. D. Svihla.
1931a. The Louisiana muskrat. J. Mammal. 12:12-28.

Svihla, A., and R. D. Svihla.
1931b. Mink feeding on clams. Murrelet 12:22.

Svihla, A., and R. D. Svihla.
1933. Notes on the jumping mouse *Zapus* trinotatus trinotatus Rhoads. J. Mammal. 14:131-134.

Tabel, H.
1970. Local production of antibodies to *Leptospira pomona* in kidneys of chronically infected skunks (Mephitis mephitis). J. Wildl. Dis. 6:299-304.

Tabor, J. E.
1974. Productivity, survival, and population status of river otter in western Oregon. M.S. thesis. Oreg. State Univ., Corvallis. 62 p.

Tarasoff, F. J., A. Bisaillon, J. Pierard, and A. P. Whitt.
1972. Locomotory patterns and external morphology of river otter, sea otter, and harp seal (Mammalia). Can. J. Zool. 50:915-929.

Taylor, W. P.
1915. Description of a new subgenus (*Arborimus*) of *Phenacomys,* with a contribution to knowledge of the habits and distribution of Phenacomys *longicaudus*, True. Proc. Calif. Acad. Sci., Ser. 4, 5:111-161.

Taylor, W. P.
1918. Revision of the rodent genus *Aplodontia*. Univ. Calif. Publ. Zool. 17:435-504.

Taylor, W. P.
1919. A new meadow mouse from the Cascade Mountains of Washington. J. Mammal. 1:180-182.

Taylor, W. P.
1920. The woodrat as a collector. J. Mammal. 1:91-92.

Taylor, W. P.
1935. Ecology and life history of the porcupine (*Erethizon epixanthum*) as related to the forests of Arizona and the Southwestern United States. Univ. Ariz. Biol. Bull. 6, 177 p.

Taylor, W. P.
1956. The deer of North America. 668 p. Stackpole, Harrisburg, Pa.

Taylor, W. P., and W. T. Shaw.
1927. Mammals and birds of Mount Rainier National Park. 249 p. U.S. Gov. Print. Off., Washington, D.C.

Terman, C. R., and J. F. Sassaman.
1967. Sex ratio in deer mouse populations. J. Mammal. 48:589-597.

Tester, J. R.
1953. Fall food habits of the raccoon in the South Platte Valley of northeastern Colorado. J. Mammal. 34500502.

Tevis, L., Jr.
1952. Autumn foods of chipmunks and golden-mantled ground squirrels in the northern Sierra Nevada. J. Mammal. 33:198-205.

Thomas, B.
1972. The phallus and its bearing upon the classification of the insular Peromyscus of British Columbia. Syesis 5:179-186.

Thomas, B.
1973. Evolutionary implications of karyotypic variation in some insular Peromyscus from British Columbia, Canada. Cytologia 38:485-495.

Thomas, D. C., and P. J. Bandy.
1973. Age determination of wild black-tailed deer from dental annulations. J. Wildl. Manage. 37:232-235.

Tillman, M. F.
1975. Assessment of north Pacific stocks of whales. Mar. Fish. Rev. 37(10):1-4.

Tomich, P. Q.
1962. The annual cycle of the California ground squirrel. Univ. Calif. Publ. Zool. 65:213-281.

Tomilin, A. G.
1967. [Mammals of the USSR and adjacent countries (1957).] [Translated by Israel Program for Scientific Translations, Jerusalem 9:1-717. Available from Smithsonian Inst., TT 65-50086.]

Toweill, D. E.
1974. Winter food habits of river otters in western Oregon. J. Wildl. Manage. 38:107-111.

Townsend, J. K.
1839. Narrative of a journey across the Rocky Mountains, to the Columbia River. . . . Reprinted in Early western travels, 1748-1846 (edited by R. G. Thwaits) 21:107-369. A. H. Clark Co., Cleveland.

Trainer, C. E.
1971. The relationship of physical condition and fertility of female Roosevelt elk (Cervus canadensis roosevelti) in Oregon. M.S. thesis. Oreg. State Univ., Corvallis. 93 p.

Trainer, D. O., and J. B. Hale.
1969. Sarcoptic mange in red foxes and coyotes in Wisconsin. Wildl. Dis. Assoc. Bull. 5:387-391.

Trainer, D. O., F. F. Knowlton, and L. Karstad.
1968. Oral papillomatosis in the coyote. Wildl. Dis. Assoc. Bull. 4:52-54.

Trapp, G. R.
1972. Some anatomical and behavioral adaptations of ringtails, Bassariscus astutus. J. Mammal. 53:549-557.

Trapp, R., and C. Trapp.
1965. Another vocal sound made by snowshoe hares. J. Mammal. 46:705.

Truitt, D.
1974. Dolphins and porpoises: A comprehensive, annotated bibliography of the smaller Cetacea. 582 p. Gale Res., Detroit.

Twente, J. W., Jr.
1955. Some aspects of habitat selection and other behavior of cavern-dwelling bats. Ecology 36:706-732.

Tyson, E. L.
1950. Summer food habits of the raccoon in southwestern Washington. J. Mammal. 31:448-449.

U.S. Department of Commerce.
1976. The story of the Pribilof fur seals. 34 p.

U.S. Department of Commerce.
1978. The Marine Mammal Protection Act of 1972. Annual Rep. 183 p.

U.S. Department of State.
1928. Preservation and protection of fur seals. Treaty Ser. 564, 7 p.

Urban, D.
1970. Raccoon populations, movement patterns, and predation on a managed waterfowl marsh. J. Wildl. Manage. 34:372-382.

Vandevere, J. E.
1971. Fecal analysis of the southern sea otter. Proc. 8th Annu. Conf. Biol. Sonar and Diving Mamm., p. 97-103. Stanford Res. Inst., Fremont. Calif.

Van Gelder, R. G.
1959. A taxonomic revision of the spotted skunks (genus Spilogale). Am. Mus. Nat. Hist. Bull. 117:229-392.

Van Zyll De Jong, C. G.
1972. A systematic review of the Nearctic and Neotropical river otters (Genus Lutra, Mustelidae, Carnivora). R. Ont. Mus. Life Sci. Contrib. 80, 104 p.

Vaughan, T., and P. Krutzsch.
1964. Seasonal distribution of the hoary bat in southern California. J. Mammal. 35:431-432.

Vaughan, T. A.
1964. Mammals of the San Gabriel Mountains of California. Univ. Kans. Mus. Nat. Hist. Publ. 7:513-582.

Vaughan, T. A.
1970a. The skeletal system. In Biology of bats, p. 98138. Vol 1. W. A. Wimsatt, ed. Acad. Press, New York.

Vaughan, T. A.
1970b. The muscular system. In Biology of bats, p. 104-193. Vol. 1. W. A. Wimsatt, ed. Acad. Press, New York.

Vaughan, T. A.
1970c. Flight patterns and aerodynamics. In Biology of bats, p. 195215. Vol. 1. W. A. Wimsatt, ed. Acad. Press, New York.

Vedros, N. A., A. W. Smith, J. Schonewald, G. A. Migaki, and R. C. Hubbard.
1971. Leptospirosis epizootic among California sea lions. Science 172:1250-1251.

Verts, B. J.
1967a. Summer breeding of brush rabbits. Murrelet 48:19.

Verts, B. J.
1967b. The biology of the striped skunk. 218 p. Univ. Ill. Press, Urbana.

Vestal, E. H.
1938. Biotic relations of the woodrat (Neotoma *fuscipes*) in the Berkeley Hills. J. Mammal. 19:1-36.

Viret, J., and M. Casoli.
1962. Su un rongeur de la famille americaine des aplondontides decouvert dans le Stapien superieur de la Limagne bourbonnaise. Eclogae Geol. Helv. 54:441-545.

Vogl, R. J.
1967. Woodrat densities in southern California manzanita chaparral. Southwest. Nat. 12:176-179.

Voth, E. H.
1968. Food habits of the Pacific mountain beaver, *Aplodontia rufa pacifica* Merriam. Ph. D. thesis. Oreg. State Univ., Corvallis. 263 p.

Voth, E. H., and H. C. Black.
1973. A histologic technique for determining feeding habits of small herbivores. J. Wildl. Manage. 37:223-231.

Voth, E. H., C. Maser, and M. L. Johnson.
[In press.] Food habits of *Arborimus albipes*, the white-footed vole, in Oregon. Northwest Sci.

Wade, J. G.
1929. Mountain lion seen killing a doe. Calif. Fish and Game 15:73-75.

Walker, A.
1923. A note on the winter habits of Eutamias townsendii. J. Mammal. 4:257.

Walker, A.
1930. The "hand-stand" and some other habits of the Oregon spotted skunk. J. Mammal. 11:227-229.

Walker, A.
1942. The fringed bat in Oregon. Murrelet 23:62.

Walker, E. P.
1929. Evidence on the gestation period of martens. J. Mammal. 10:206-209.

Walker, E. P., F. Warnick, S. Hamlet, and others.
1975. Mammals of the world. 3d ed. 1,500 p. Johns Hopkins Univ. Press, Baltimore, Md.

Walker, E. P., F. Warnick, S. E. Hamlet, and others.
1968. Mammals of the world. 2d ed. 1,500 p. Johns Hopkins Press, Baltimore, Md.

Walker, K. M.
1949. Distribution and life history of the black pocket gopher, *Thomomys niger* Merriam. MS. thesis. Oreg. State Coll. [Univ.], Corvallis. 94 p.

Walker, K. M.
1955. Distribution and taxonomy of the small pocket gophers of northwestern Oregon. Ph. D. thesis. Oreg. State Coll. [Univ.], Corvallis. 200 p.

Wallmo, O. C., R. B. Gill, L. H. Carpenter, and D. W. Reichert.
1973. Accuracy of field estimates of deer food habits. J. Wildl. Manage. 37:556-562.

Wallmo, O. C., W. L. Regelin, and D. W. Reichert.
1972. Forage use by mule deer relative to logging in Colorado. J. Wildl. Manage. 36:1025-1033.

Walters, R. D.
1949. Habitat occurrence and notes on the history of the dusky-footed woodrat, *Neotoma fuscipes* Baird. MS. thesis. Oreg. State Coll. [Univ.], Corvallis. 122 p.

Warren, E. R.
1926. A study of the beaver in the Yancey Region of Yellowstone National Park. Roosevelt Wild Life Ann. 1:13-192.

Weber, Y. B., and L. Giacometti.
1972. Sickling phenomenon in the erythrocytes of wapiti (*Cervus canadensis*). J. Mammal. 52:917-919.

Weckwerth, R. P.
1957. The relationship between the marten population and the abundance of small mammals in Glacier National Park. M.S. thesis. Mont. State Univ., Missoula. 76 p.

Weckwerth, R. P., and V. D. Hawley.
1962. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26:55-74.

Weinmann, C. J., J. R. Anderson, W. M. Longhurst, and G. Connolly.
1973. Filarial worms of Columbian black-tailed deer in California. I. Observations in the vertebrate host. J. Wildl. Dis. 9:213-220.

Wells, F. G., and D. L. Peck.
1961. Geologic map of Oregon west of the 121st meridian. U.S. Geol. Surv., Misc. Geol. Invest. Map I-325.

Western World.
1971. Unidentified critter shot. West. World, April 8, Sect. 3:5.

Whitaker, J. O., Jr.
1963. A study of the meadow jumping mouse, *Zapus hudsonius* (Zimmerman), in central New York. Ecol. Monogr. 33:215-254.

Whitaker, J. O., Jr.
1966. Food of *Mus musculus*, *Peromyscus maniculatus bairdi*, and *Peromyscus leucopus* in Vigo County, Indiana. J. Mammal. 47:473-486.

Whitaker, J. O., Jr.
1967. Hoary bat apparently hibernating in Indiana. J. Mammal. 48:663.

Whitaker, J. O., Jr.
1970. Parasites of feral housemice, *Mus musculus*, in Vigo County, Indiana. Proc. Indiana Acad. Sci. 79:441-448.

Whitaker, J. O., Jr.
1972a. Food habits of bats from Indiana. Can. J. Zool. 50:877-883.

Whitaker, J. O., Jr.
1972b. *Zapus* hudsonius. Mamm. Spec. 11, 7 p.

Whitaker, J. O., Jr., and C. Maser.
1976. Food habits of five western Oregon shrews. Northwest Sci. 50:102-107.

Whitaker, J. O., Jr., C. Maser, and L. E. Keller.
1977. Food habits of bats of western Oregon. Northwest Sci. 51:46-55.

White, J. A.
1953a. Genera and subgenera of chipmunks. Univ. Kans. Mus. Nat. Hist. Publ. 5:543-561.

White, J. A.
1953b. The baculum in the chipmunks of western North America. Univ. Kans. Mus. Nat. Hist. Publ. 5:61 l-631.

White, M.
1973. Description of remains of deer fawns killed by coyotes. J. Mammal. 54:291-293.

Wick, W. Q.
1961. Mole control takes some doing! Oreg. Farmer 84:5-6.

Wiedemann, A. M.
1966. Contributions to the plant ecology of the Oregon coastal sand dune. Ph. D. thesis. Oreg. State Univ., Corvallis. 255 p.

Wiedemann, A. M., L. J. Dennis, and F. H. Smith.
1974. Plants of the Oregon coastal dunes. 117 p. Oreg. State Univ. Book Stores, Inc., Corvallis.

Wight, H. M.
1926. Food habits of Townsend's mole, Scapanus townsendii (Bachman). J. Mammal. 9:19-33.

Willey, R. L.
1970. Sound location of insects by the dwarf weasel. Am. Midl. Nat. 84:563-564.

Williams, 0.
1955. Food habits of the deer mouse. J. Mammal. 40:415-419.

Wilson, J. F., A. C. Diddams, and R. L. Rausch.
1968. Cystic hydatid disease in Alaska. Am. Rev. Respir. Dis. 98:1-15.

Wilson, K. A.
1954. The role of mink and otter as muskrat predators in northeastern North Carolina. J. Wildl. Manage. 18:199-207.

Wimsatt, W. A.
1944. Further studies on the survival of spermatozoa in the female reproductive tract of the bat. Anat. Rec. 88:193-204.

Wimsatt, W. A.
1945. Notes of breeding behavior, pregnancy, and parturition in some vespertilionid bats of the Eastern United States. J. Mammal. 26:23-33.

Wimsatt, W. A.
1960. An analysis of parturition in Chiroptera, including new observations on *Myotis l. lucifugus*. J. Mammal. 41:183-200.

Wimsatt, W. A.
1963. Delayed implantation in the Ursidae, with particular reference to the black bear (*Ursus americanus* Pallas). *In* Delayed implantation, p. 49-76. A. C. Enders, ed. Univ. Chicago Press, Chicago.

Wimsatt, W. A., Ed.
1970. Biology of bats. 2 vols. Acad. Press, New York.

Winecoff, T. E.
1933. Tree-cutting by muskrats? J. Mammal. 14:75.

Wobeser, G., and T. W. Rock.
1973. *Capillaria hepatica* (Nematoda: Trichuridae) in a coyote (*Canis latrans*). J. Wildl. Dis. 9:225-226.

Wood, F. D.
1935. Notes on the breeding behavior and fertility of *Neotoma fuscipes macrotis* in captivity. J. Mammal. 16:105-109.

Wood, J. E.
1958. Age structure and productivity of a gray fox population. J. Mammal. 39:74-86.

Wood, W.
1974. Muskrat origin, distribution, and range extension through the coastal areas of Del Norte Co. Calif. & Curry Co. Oregon. Murrelet 55:1-4.

Woods, C. A.
1973. Erethizon dorsatum. Mamm. Spec. 29:1-6.

Wright, B. S.
1948a. Survival of the northeastern panther (*Felis concolor)* in New Brunswick. J. Mammal. 29:235-246.

Wright, B. S.
1953a. Further notes on the panther in the northeast. Can. Field-Nat. 67:12-28.

Wright, B. S.
1971. The cougar in New Brunswick. *In* Proceedings of a symposium on the native cats of North America: Their status and management, p. 108-119. S. E. Jorgensen and L. D. Mech, eds. US. Dep. Inter. Fish and Wildl. Serv., Bur. Sport Fish. and Wildl., Reg. 3, Fort Snelling, Twin Cities, Minn.

Wright, P. L.
1942a. Delayed implantation in the long-tailed weasel (Mustela frenata), the short-tailed weasel (Mustela ciognani), and the marten (Mattes americana). Anat. Rec. 83:341-353.

Wright, P. L.
1942b. A correlation between the spring moult and spring changes in the sexual cycle in the weasel. J. Exp. Zool. 91:103-110.

Wright, P. L.
1947. The sexual cycle of the male long-tailed weasel (*Mustela frenata).* J. Mammal. 28:343-352.

Wright, P. L.
1948b. Breeding habits of captive long-tailed weasels (Mustela frenata). Am. Midl. Nat. 39:338-344.

Wright, P. L.
1948c. Preimplantation stages in the long-tailed weasel (Mustela frenata). Anat. Rec. 100:593-608.

Wright, P. L.
    1953b. Intergradation between
    Martes americana and *Martes
    caurina* in western Montana. J.
    Mammal. 34:74-86.

Wright, P. L., and M. W. Coulter.
    1967. Reproduction and growth in
    Maine fishers. J. Wildl. Manage.
    31:70-87.

Yablokov, A. V., V. M. Bel'kovich, and
V. I. Borisov.
    1974. Whales and dolphins. 472 p.
    Nuaka, Moscow.

Yeager, L. E.
    1950. Implications and some
    harvest and habitat factors of pine
    marten management. Trans. North
    Am. Wildl. Conf. 15:319-334.

Yeager, L. E., and W. H. Elder.
    1945. Pre- and post-hunting season
    foods of raccoons on an Illinois
    goose refuge. J. Wildl. Manage.
    9:48-56.

Yoakum, J.
    1965. Observations of feeding
    habits of captive bobcats. Murrelet
    46:37-39.

Yocom, C. F.
    1971. Invasion of Humboldt and Del
    Norte Counties of northwestern
    California by porcupines. Murrelet
    52:1-6.

Yocom, C. F.
    1974. Status of marten in northern
    California, Oregon, and
    Washington. Calif. Fish and Game
    60:54-57.

Yocom, C. F., and M. T. McCollum.
    1973. Status of the fisher in north-
    ern California, Oregon, and Wash-
    ington. Calif. Fish and Game
    59:305-309.

Young, S. P.
    1956. The bobcat of North America.
    193 p. Stackpole Co., Harrisburg,
    Pa.

Young, S. P., and E. A. Goldman.
    1946. The puma mysterious
    American cat. 356 p. Am. Wildl.
    Inst., Washington, DC.

Young, S. P., and H. H. T. Jackson.
    1951. The clever coyote. 411 p.
    Stackpole Co., Harrisburg, Pa., and
    Wildl. Manage. Inst., Washington,
    DC.

Young, W. A.
    1961. Range extension of dusky
    footed woodrat. Murrelet 42:6.

Zenkovich, B. A.
    1937. [The humpback or long
    limbed whale.] Vestn. Dal'nevost.
    Fil. Akad. AN SSSR 27:37-62. [In
    Russ.]

Zwickel, F. G. J., and H. Brent.
    1953. Movement of Columbian
    black-tailed deer in the Willapa
    Hills Area, Washington. Murrelet
    34:41-46.

Glossary[1]

blow the exhaled breath of a cetacean

blowhole nostril; hole through which a cetacean breathes

cecal pellet a pellet produced in the cecum that is expelled and re-ingested, as opposed to a fecal pellet that is defecated as waste material

cecum the large, blind pouch that forms the beginning of the large intestine

chitin a semitransparent horny substance forming the principal component of an insect's external skeleton

crepuscular active in twilight

Cretaceous Period about 135 million years ago

Eocene about 58 million years ago

exoskeleton the external skeleton of *chitin*

midden piles refuse piles of accumulated, uneaten scales and cores of the cones of coniferous trees; also called kitchen **middens**

Miocene about 25 million years ago

nictitating membrane thin membrane found in many animals at the inner angle or beneath the lower lid of the eye and capable of being drawn across the eyeball

Oligocene about 36 million years ago

Paleocene about 63 million years ago

placenta vascular organ in most mammals that unites the fetus to the mother's uterus

Pleistocene about 1 million years ago

Pliocene about 13 million years ago

prehensile adapted for seizing or grasping an object by wrapping around it

Recent about 1 million years ago

sudoriferous producing or secreting sweat

vibrissae stiff hairs located especially around the nostrils or on other parts of the face of many mammals; often serve as tactile organs

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[1] Terms and abbreviations are defined as they are used in this book, especially words that may have several definitions.

Common and Scientific Names of Plants

Trees
Bigleaf maple	*Acer macrophyllum* Pursh
Black cottonwood	*Populus trichocarpa* Torr. & Gray
California laurel	*Umbellularia californica* (Hook. & Am.) Nutt.
Coast redwood	*Sequoia sempervirens* (D. Don) Endl.
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
Lodgepole pine (also shore pine)	*Pinus contorta* Dougl. ex Loud.
Oregon ash	*Fraxinus latifolia* Benth
Pacific madrone	*Arbutus menziesii* Pursh
Port-Orford-cedar	*Chamaecyparis lawsoniana* (A. Murr.) Parl.
Red alder	*Alnus rubra* Bong.
Sitka alder	*Alnus sinuata (Reg.)* Rydb.
Sitka spruce	*Picea sitchensis* (Bong.) Carr.
Tanoak	*Lithocarpus densiflorus* (Hook. & Am.) Rehd.
Western hemlock	*Tsuga heterophylla* (Raf.) Sarg.
Western redcedar	*Thuja plicata* Donn

Herbs
Bracken fern	*Pteridium aquilinum* (L.) Kuhn
Fireweed	*Epilobium* spp.
Horsetails	*Equisetum* spp.
Horseweed	
Oregon oxalis	*Oxalis oregana* Nutt. ex. T. & G.
Ragweed	*Senecio* spp.
Sedges	*Carex* spp.
Skunkcabbage	*Lysichitum americanum* Holt. & St. John
Swordfern	*Polystichum munitum* (Kaulf.) Presl

Shrubs

Blackberries	*Rubus* spp.
Blueblossom	*Ceanothus thyrsiflorus* Esch.
Bog labradortea	*Ledum groenlandicum* Hulten
Deerbrush	*Ceanothus integerrimus* H. & A.
Evergreen huckleberry	*Vaccinium ovatum* Pursh
Gorse	*Ulex europaeus* L.
Hairy manzanita	*Arctostaphylos columbiana* Piper
Huckleberry	*Vaccinium* spp.
Pacific rhododendron	*Rhododendron macrophyllum G.* Don
Red huckleberry	*Vaccinium parvifolium* Smith
Rose	*Rosa* spp.
Rusty menziesia (also fools huckleberry)	*Menziesia ferruginea* Smith
Salal	*Gaultheria shallon* Pursh
Salmonberry	*Rubus spectabilis* Pursh
Silk tassel bush	*Garrya elliptica* Dougl.
Thimbleberry	*Rubus parviflorus* Nutt.
Vine maple	*Acer circinatum* Pursh
Waxmyrtle	*Myrica californica* Cham.
Western azalea	*Rhododendron occidentale* (T. & *G.)* Gray
Willow	*Salix* spp.

English Equivalents[1]

Length

25 millimeters = 1 inch
2.5 centimeters = 1 inch
30.5 centimeters = 1 foot
91.4 centimeters = 1 yard
1.6 kilometers = 1 mile

Weight

28 grams = 1 ounce
454 grams = 1 pound
1 kilogram = 2.2 pounds
1 metric ton = 1.02 tons

Area

1 hectare = 2.47 acres

Temperature

($\frac{9}{5}$ °C) + 32 = °F

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[1] Approximate.

The book presents detailed information on the biology, habitats, and life
histories of the 96 species of mammals of the Oregon coast. Soils,
geology, and vegetation are described and related to wildlife habitats for
the 65 terrestrial and 31 marine species. The book is not simply an iden-
tification guide to the Oregon coast mammals but is a dynamic portrayal
of their habits and habitats. Life histories are based on fieldwork and
available literature. An extensive bibliography is included. Personal anec-
dotes of the authors provide entertaining reading. The book should be of
use to students, educators, land-use planners. resource managers, wildlife
biologists, and naturalists.