# Society of American Foresters Committee on Natural Areas

## NATURAL AREA NOMINATION FORM

**Instructions:** Complete and forward to Committee along with a sketch type map of the area and a location map (highway map) indicating general location of proposed area. Information on past ownership and management, scientific or educational use, hydrologic features, rare plants or animals or other pertinent facts should be included. Please type. Photos if available will be welcomed.

**Name of Proposed Natural Area:** Wildcat Mountain Natural Area

**Location:** State: Oregon  County: Linn  Total Area: 1000 Acres

Nearest Town and Distance: Blue River (Name) 16 (Miles)

**Agency/Owner:** USDA Forest Service

**Administrative Unit:** Willamette National Forest
(Natl Forest, Natl Park, Wildlife Refuge, State, Univ, etc)

Address: 210 W 11th Ave Eugene OR 97401

**Permanence Afforded How:** U-4 (36 CFR 251 23)
(Laws, Regulation, Will, Endowment, Letter o Agreement, etc)

**Primary Forest Type**

SAF: 226 (Type Number) Pacific silver fir hemlock (Type Name) 612 (Type Area) Acres

Dominant Trees: D B H ______ Hgt ______ Age ______

**Other Important Types or Vegetation**

| SAF Type Number and Name (Dominant Trees) | Name | D B H | Hgt | Age | Area |
|---|---|---|---|---|---|
| 205 | Mountain hemlock ~~subalpine fir~~ | | | | 55 |
| 230 | Douglas fir-western hemlock | | | | 43 |
| | | | | | |

**Barren, Water, Buffer Zone, etc:** 290 Acres  cliffs & brushfields (Area and Nature)

**Description of Vegetation and Other Distinguishing Characteristics:** old growth noble fir predominates associates are Douglas-fir mountain hemlock & Pacific silver fir (probable climax species)

**Elevation:** 3800 5353 Feet (Range and Average)  **Topography:** Rolling to steep (Level, Rolling, Steep, etc)

**Geology and Soils:** andesite tuff breccia/ash brown podsols
(Alluvial, Volcanic, Moraine, Podsol, Serpentine, Etc)

Justification Briefly outline why this tract should be designed an SAF natural area

The area will be utilized for possible research on 1) watershed management (on eastern half of site) 2) subalpine forest of various age composition and productivity (including pure stands of noble fir) 3) mountain meadow ecology and 4) succession on small recently cutover tracts Past research on the area includes cone production by noble fir vegetation/soil comparisons soil fungi ecology and stem analysis of noble fir and related species

Submitted by Russell M Burns Title Forest Service RNA Coordinator Date

Mailing Address USDA Forest Service
P O Box 2417
Washington D C 20013

Approved ______________________
Section Natural Area Chairman or
Natural Area Liaison Officer

Approved for Listing in Register of SAF Natural Areas ______________________ ____________
Chairman
Committee on Natural Areas Date

Committee on Natural Areas Society of American Foresters

5400 Grosvenor Lane Washington D C 20014

ATTACHMENTS TO WILDCAT MOUNTAIN RESEARCH

NATURAL AREA ESTABLISHMENT REPORT

A Vicinity Map

B Topographic Map Showing Boundary of Natural Area

C Planimetric Map

D Forest Type Map

E Topographic Map Showing Boundary of Management Unit

F Aerial Photos (District Ranger's, Forest Supervisor's and Experiment Station Director's Copies Only)

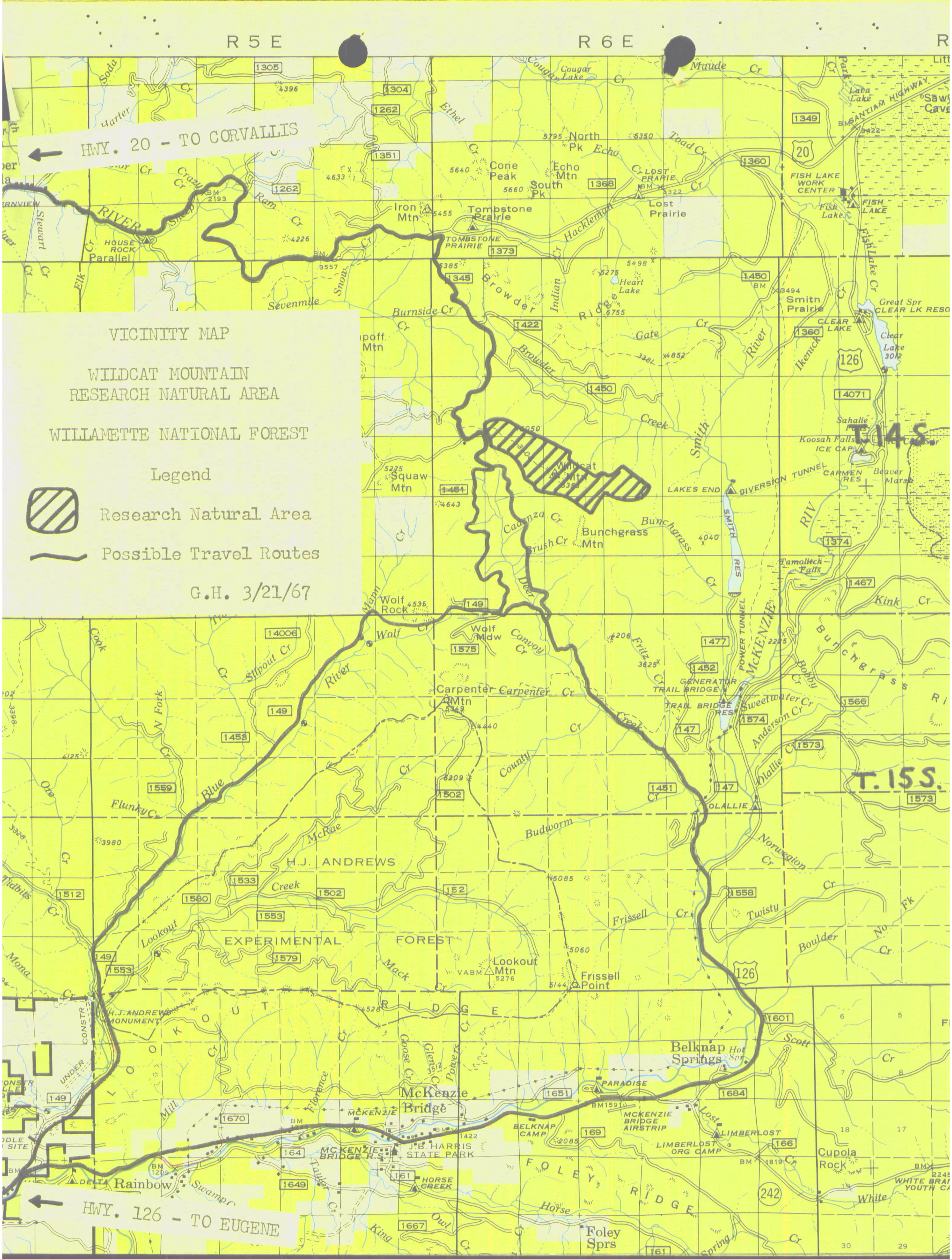
EGI 35 - 41 <u>42</u> 43

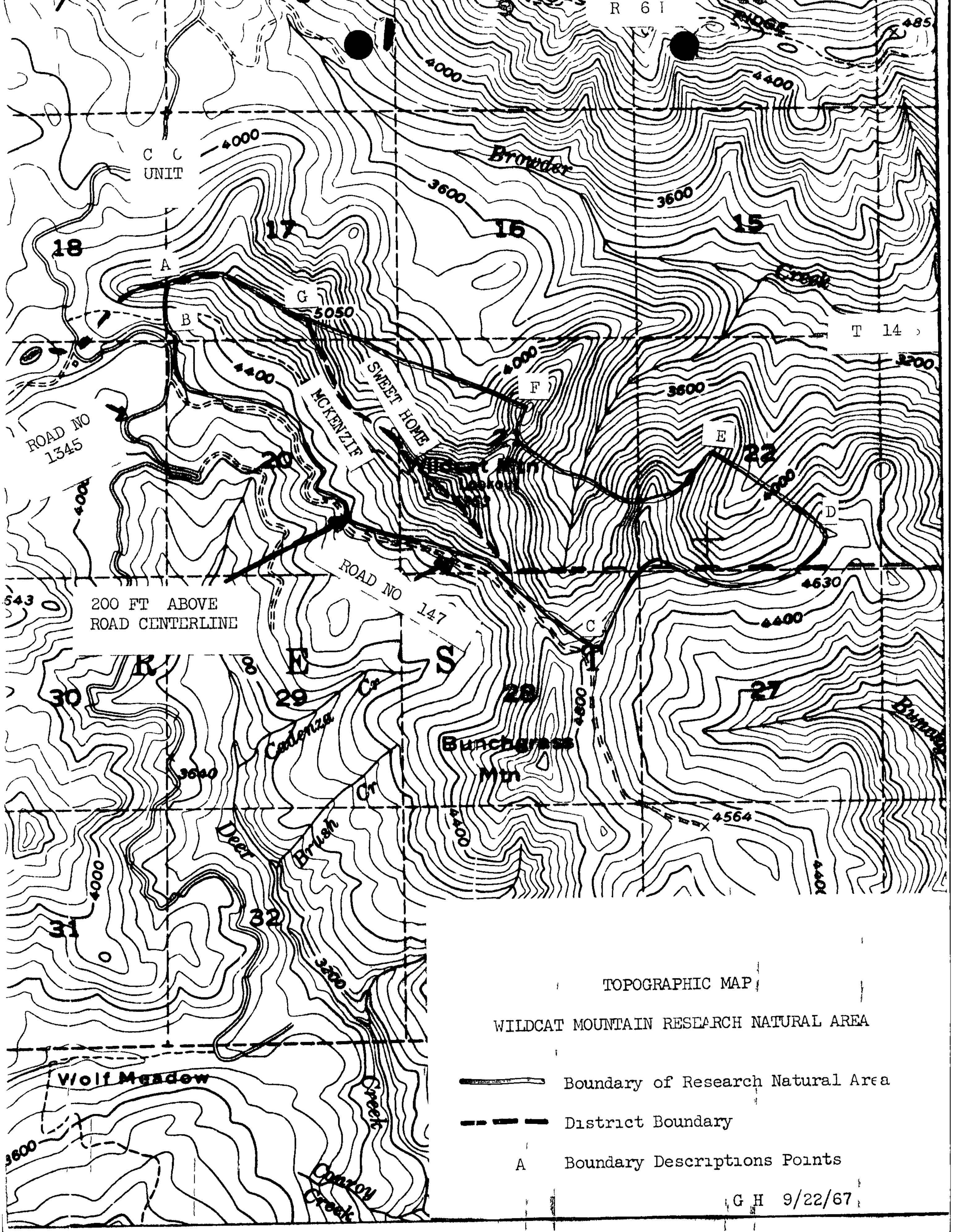
35 - 135, <u>136</u>, <u>137</u> 138

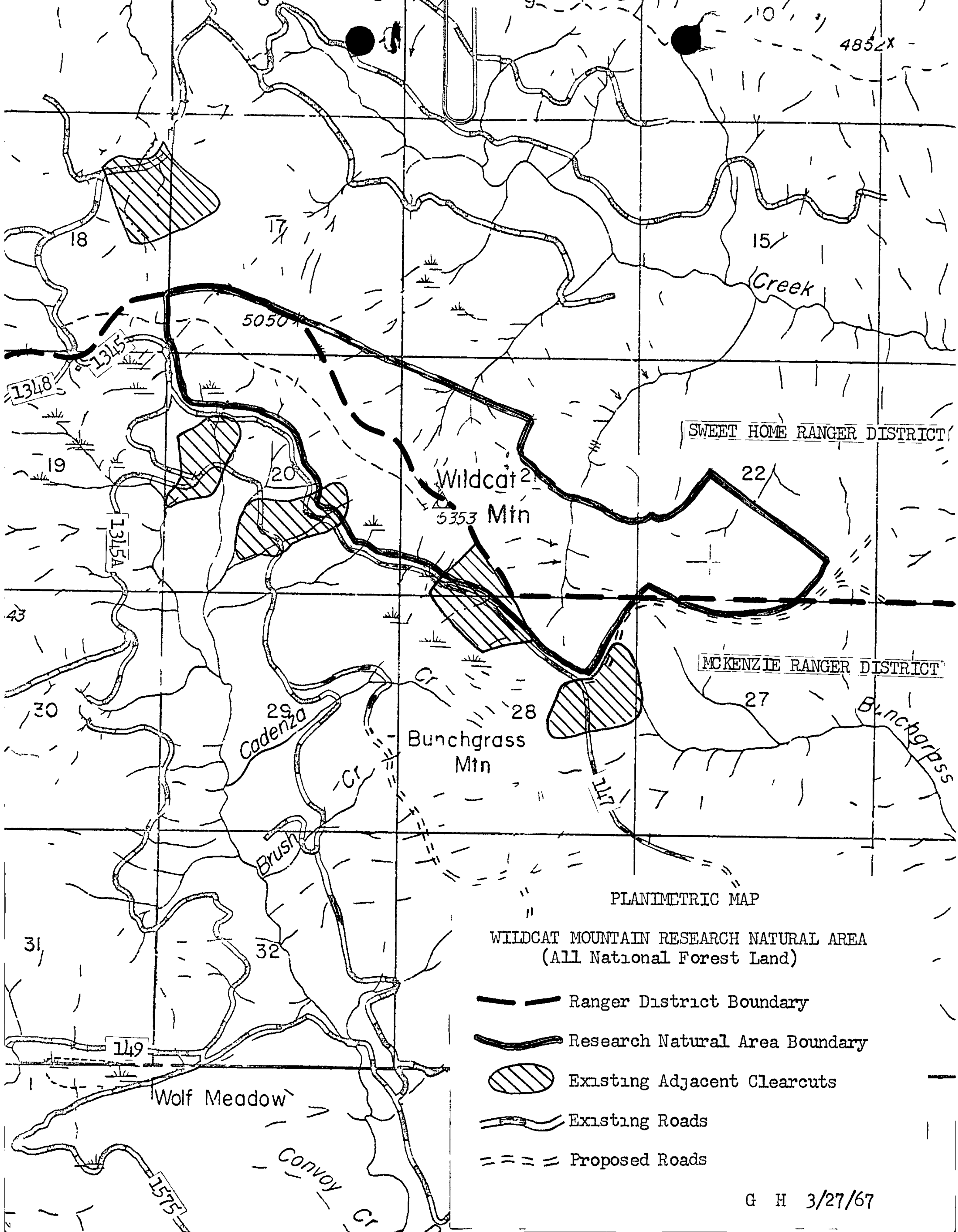
37 - <u>102</u>, <u>103</u>, 104

39 - 9 <u>10</u> 11

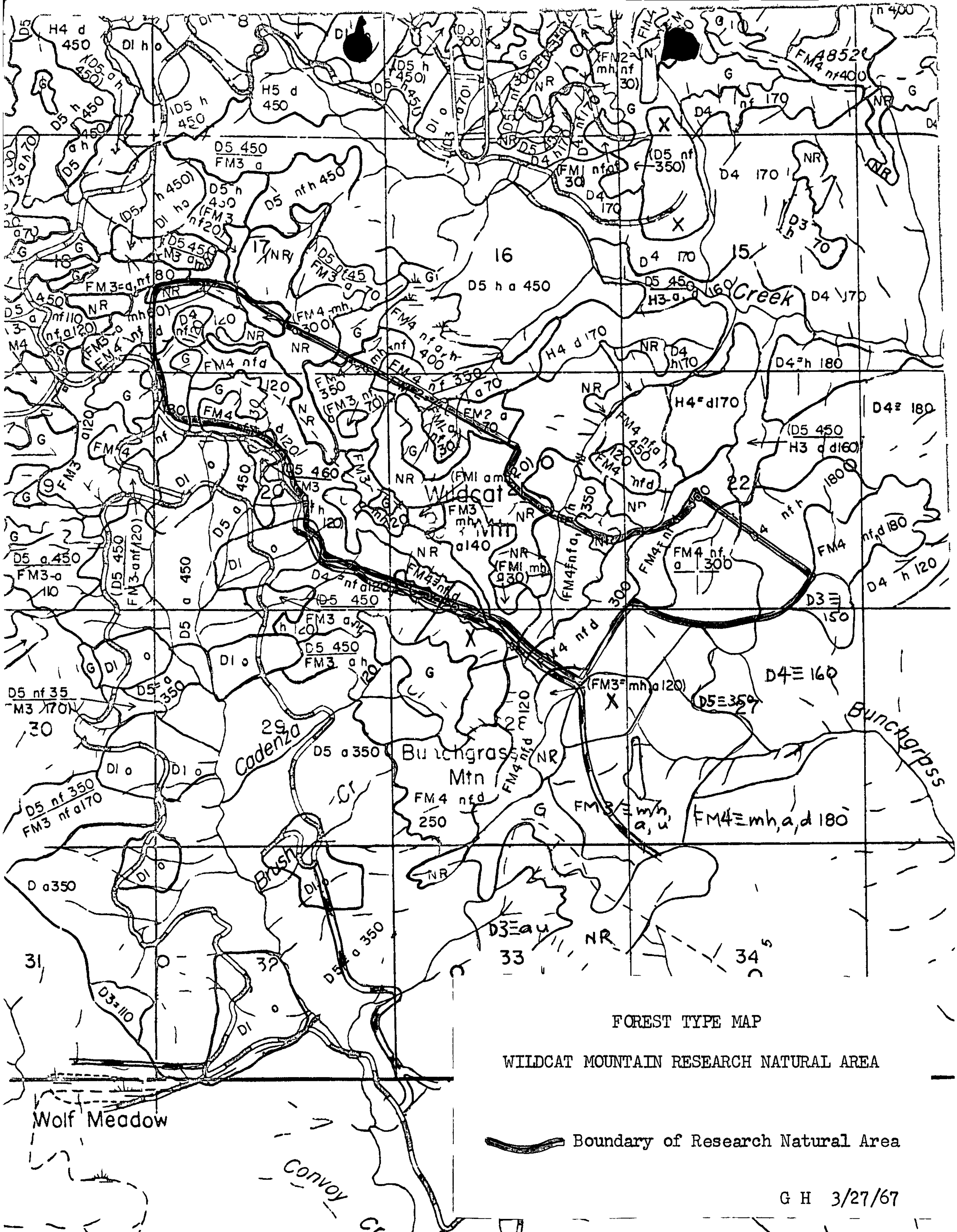
(Underlined numbers are photos with boundary lines drawn on them )


VICINITY MAP
WILDCAT MOUNTAIN RESEARCH NATURAL AREA
WILLAMETTE NATIONAL FOREST
Legend
Research Natural Area
Possible Travel Routes
G.H. 3/21/67
HWY. 20 - TO CORVALLIS
HWY. 126 - TO EUGENE
R5E
R6E
T.14S.
T.15S.
Wildcat Mtn
H.J. ANDREWS EXPERIMENTAL FOREST
LOOKOUT RIDGE
FOLEY RIDGE
McKenzie Bridge
Belknap Springs
Rainbow
Tombstone Prairie
Lost Prairie
Fish Lake
Clear Lake
Smith Res
Trail Bridge Res
Carpenter Mtn
Lookout Mtn
Frissell Point
Wolf Rock
Squaw Mtn
Bunchgrass Mtn
Iron Mtn
Cone Peak
North Pk
South Pk
Echo Mtn
Foley Sprs
Cupola Rock


R 6 E
RIDGE
4000
4400
C C
UNIT
4000
Browder
3600
3600
18
17
16
15
Creek
A
G
5050
B
T 14 S
3200
4000
4400
F
3600
SWEET HOME
MCKENZIE
ROAD NO
1345
E
22
20
Wildcat Mtn
Lookout
D
ROAD NO 147
4630
200 FT ABOVE
ROAD CENTERLINE
543
C
4400
R
E
S
T
30
29
Cr
28
27
Cadenza
4600
Bunchgrass
Mtn
3640
Cr
4400
Deer
Brush
4564
4000
31
32
3200
Wolf Meadow
Creek
3600
Conroy
Creek
TOPOGRAPHIC MAP
WILDCAT MOUNTAIN RESEARCH NATURAL AREA
Boundary of Research Natural Area
District Boundary
A Boundary Descriptions Points
G H 9/22/67



4852
18
17
15
Creek
5050
1345
1348
SWEET HOME RANGER DISTRICT
19
20
Wildcat
Mtn
5353
22
1345A
43
MCKENZIE RANGER DISTRICT
30
29
28
27
Cadenza
Cr
Bunchgrass
Mtn
Bunchgrass
147
Brush
31
32
149
Wolf Meadow
Convoy
Cr
1575
PLANIMETRIC MAP
WILDCAT MOUNTAIN RESEARCH NATURAL AREA
(All National Forest Land)
Ranger District Boundary
Research Natural Area Boundary
Existing Adjacent Clearcuts
Existing Roads
Proposed Roads
G H 3/27/67

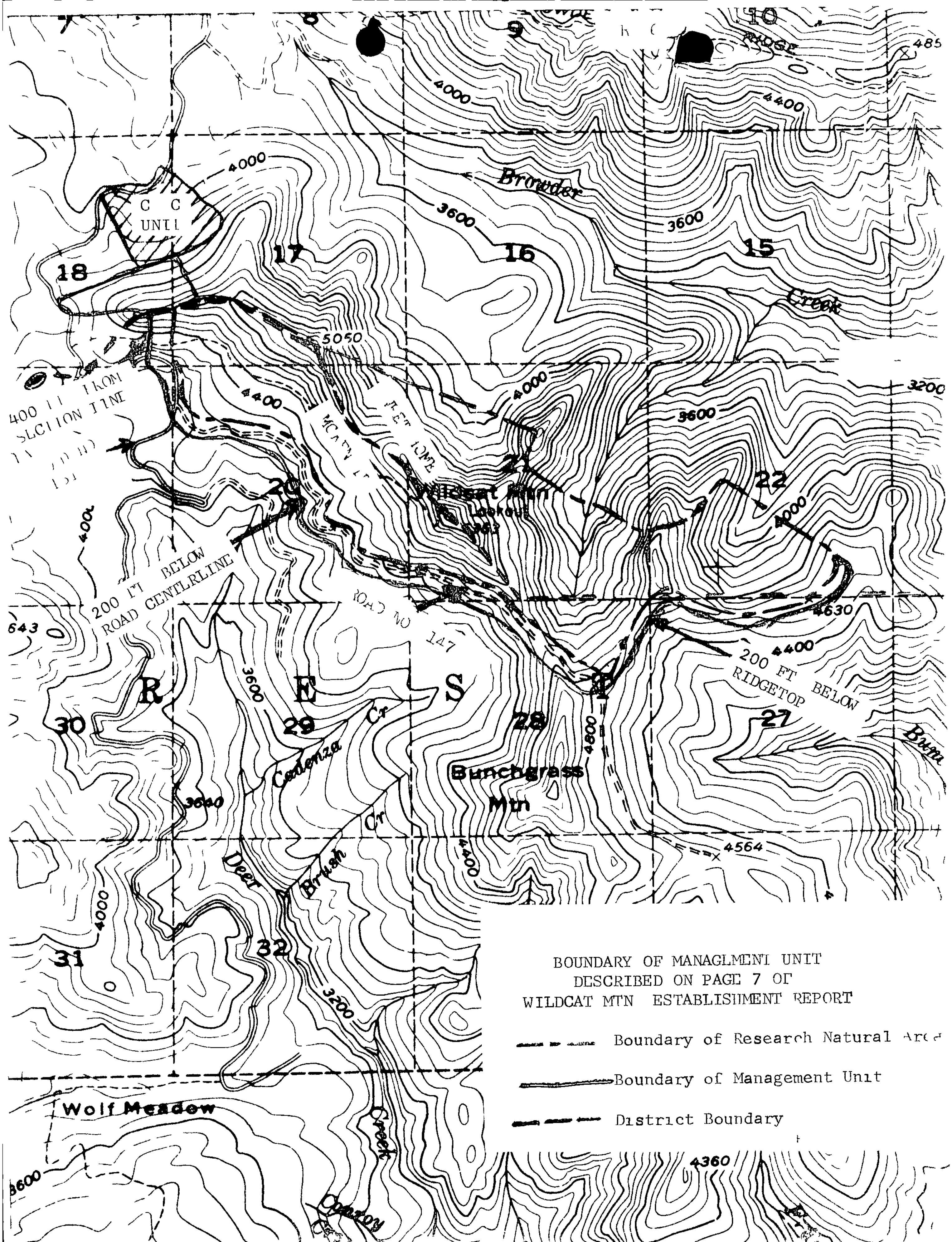



FOREST TYPE MAP

WILDCAT MOUNTAIN RESEARCH NATURAL AREA

Boundary of Research Natural Area

G H 3/27/67


BOUNDARY OF MANAGLMENT UNIT
DESCRIBED ON PAGE 7 OF
WILDCAT MTN ESTABLISHMENT REPORT
Boundary of Research Natural Area
Boundary of Management Unit
District Boundary
C C UNIT
400 FT FROM SECTION LINE
200 FT BELOW ROAD CENTERLINE
200 FT BELOW RIDGETOP
Browder
Creek
Wildcat Mtn
Bunchgrass Mtn
Cadenza Cr
Brush Cr
Deer
Wolf Meadow
Creek
Canyon
R
E
S
T
ROAD NO 147
4000
3600
4400
5050
3200
4630
4564
4800
3640
4360
643

Designation Order

By virtue of the authority vested in me by Regulation U-4 of the regulations of the Secretary of Agriculture I hereby designate as the Wildcat Mountain Research Natural Area the lands described in the following report by John R Robertson and Gerhard Hubbe, dated January 31, 1968, said lands shall hereafter be administered as a research natural area subject to the said regulations and instruction thereunder

March 18, 1968
Date

Edward P. Cliff
Chief

ESTABLISHMENT REPORT FOR WILDCAT MOUNTAIN RESEARCH NATURAL AREA WITHIN WILLAMETTE NATIONAL FOREST, LINN COUNTY, OREGON

## Principal Distinguishing Features

The research natural area contains 1000 acres of predominantly noble fir forest types on the slopes of a moderately high mountain ridge within the commercial forest land area representative of the western Cascades It provides an example of SAF forest type 205, Mountain hemlock - subalpine fir (key species Noble fir), as listed in FSM 4065, R6 Supplement No 182, September 1965

## Location

The area straddles the Ranger District boundary in Sections 17, 20, 21, 22, 27, and 28, Township 14S , Range 6E, W M There are 536 acres on Sweet Home district and 464 acres on McKenzie district It is entirely within the Willamette National Forest

## Boundary

The boundary of the research natural area was located on aerial photos in stereo Most of the points along the north boundary can be located on the ground only with the aid of these photos A set of permanently marked stereo photos is included with the Forest Supervisor's, District Ranger's, and director, P N W Exp Sta copies of this report The boundary shown on the attached maps was taken from these photos

The Topographic Map shows the location of the points referred to in the following boundary descriptions

## Natural Area Boundary-

Begins at a point (A) where the section line between Sec 17 and 18, T14S, R6E,W M , crosses the ridge separating Browder Creek from Deer Creek, proceeds south on the section line to a point (B) 200 feet north of the centerline of existing road No 1345, thence southeasterly, remaining 200 feet from the centerlines of road No 1345 and 147 to a point (C) on the top of the ridge separating Bunchgrass Creek from the fork of Browder Creek just east of Wildcat Mtn , thence northeasterly along this ridge top to a high point (D) shown on the map and aerial photos From this point (D), the boundary is a straight line to a point (E) which is a small rocky opening on a ridge top The boundary from point (E) to point (F) follows rock slides and openings which may be located on the ground from the lines shown on the aerial photos From point (F), which is a high point on the northeast ridge of Wildcat Mountain, the boundary is a straight line to a high point (G) on the ridge between Browder Creek and Deer Creek, marked as Elev 5050 on the topographic map The boundary then proceeds westerly along this ridge top to point (A)

## Area by Cover Types (Acres)

| | | Age 1960 Inventory | Acres Within Type |
|---|---|---|---|
| NR | | | 200 |
| G | | | 90 |
| | Subtotal Non-Comercial & Non Forest Types | | 290 |
| X | | | 7 |
| FM 1 | mh a | 30 | 10 |
| FM 1 | a mh | 20 | 10 |
| FM 2 | a | 70 | 5 |

| | | | |
|---|---|---|---|
| FM 1 | nf | 30 | 10 |
| FM 3 | a mh | 120 | 30 |
| FM 3 | mh a | 140 | 45 |
| FM 3 | nf | 70 | 10 |
| FM 4 | nf | 120 | 20 |
| FM 4 | nf d | 120 | 180 |
| FM 4 | nf d | 300 | 120 |
| FM 4 | nf a | 300 | 90 |
| FM 4 | nf a mh | 350 | 70 |
| FM 4 | a mh nf | 350 | 50 |
| D 1 | | 95 | 3 |
| D 4 | nf | 120 | 10 |
| D 4 | nf h | 180 | 40 |
| | Subtotal Commercial Types | | 710 |
| | Total Acreage Within Boundary of Res Nat Area | | 1000 |

Physical and Climatic Conditions

The area can be considered as having two aspects, southwest and north

(1) The southwest facing slope of Wildcat Mountain ridge has elevations from 4150 feet to 5353 feet The lower moderate slopes (20-40%) have deep soil, fast growing timber and moist meadows while the higher steeper slopes (50-70%) have rock outcroppings, slower growing timber and dry meadows, exposed to sun and prevailing winds

(2) The north facing slopes and ridges have elevations from 3800 feet to 5353 feet The ground is generally steeper than the southwest slope (30-80%) These slopes have scattered brush

patches and rock slides The canyon is protected from sun and prevailing winds

The climate is typical of high elevations in the western Cascades with prevailing southwest winds, annual precipitation over 80 inches, much of it as snow Temperatures range from about 10 to 80 degrees fahrenheit

Description of Values

(1) Flora

The forest type map reflects the predominant tree species noble fir, Douglas-fir, Pacific silver fir, mountain hemlock and western hemlock Western redcedar, incense-cedar, Alaska-cedar, Pacific yew, and common juniper are also present Hardwood species include tag alder, red alder, mountain ash, ocean spray and manzanita Range plants include ribes, devil's club, and several grasses and herbs

(2) Fauna

Many of the common animals of the western Cascades have been observed in the area blacktail deer, coyote, rabbit, bobcat and rodents, grouse, hawks, and numerous smaller birds

(3) Geology

The area is considered as part of the "old Cascades "
A superficial examination shows there are breccia and andesitic rocks in the area Part of the work of scientific study of the area should be a detailed geological survey

(4) Minerals

No mineral use is known or anticipated

(5) Water

Browder Creek flows into Smith Reservoir, and the entire area is in the McKenzie River drainage which serves the Eugene-Springfield area

(6) Recreation

The area is open to hunting, hiking, nature study, gathering mushrooms and berries, picnicking, and sight-seeing (driving) It has no occupancy sites, unusual recreation attraction or recreation key value zones The Deer Creek road (No 1451), parallel to western boundary, is a connecting road between the McKenzie and Sweet Home Ranger Districts This and the Fritz Creek road (No 147), parallel to the southern boundary, enable people to drive alongside the area The trail (No 3406) to the abandoned Wildcat Lookout site may attract hikers, but recreation use will probably be about the same as on other similar timber key value areas of the Forest

(7) Other Uses

Cone collecting from squirrel caches by independent cone pickers in the fall may conflict with research studies

Accessibility

The area is about a two-hour drive (75 miles) from Corvallis and the U S F S Forestry Science Laboratory A gravel-surfaced road runs parallel to and outside the southern boundary An abandoned trail runs through the center of the western end to Wildcat Mountain The least accessible place is the northeast corner, in the bottom of the south fork of Browder Creek, about a mile from and 1,000 feet below the road

Effect on Administration of Adjacent National Forest Land

The research natural area does not block transportation system development or occupy critical landings or cable yarding anchor points The commercial forest land in this natural area contributes about 400 thousand board feet per year to the allowable annual cut  Establishing the natural area will, in fact, keep this yield from being harvested and will theoretically reduce the allowable annual cut by 0 4 MM board feet However, considering the facts that in practice the District calculated AAC's are rounded to the nearest 1 MM board feet, the basic inventory has a sampling error of 2 5% (a tolerance of 14 8 MM board feet from the 590 1 MM board feet Willamette AAC), and a new AAC based on a reinventory will be made in 1973, the 0 4 MM board feet is not significant, and the present calculated AAC should not be adjusted

| | | |
|---|---|---|
| | 710 acres | Commercial Forest Land in Natural Area |
| X | 538 board feet | per acre per year (average annual yield per acre North Willamette W C , Principal Forest noble fir) |
| = | 0 4 MM Board feet per year yield from Natural Area | |

Protection and Management

(1) Signs

In accordance with R-6 Standards, permanent boundary markers (metal signs) will be posted on the boundary of the research natural area  This project will be assigned to the McKenzie District Ranger, and will be completed not later than the summer of 1968 (Fiscal Year 1969)

(2) Maps

The area boundary will be shown on the multiple-use maps for Sweet Home and McKenzie Districts

(3) Protection

The objective of management in the research natural area is to maintain undisturbed the natural ecology of the area Since management of adjacent areas will affect attainment of this objective a management unit will be established on the lands adjacent to the natural area The ranger district multiple use plan will provide management direction for all uses in the management unit

The management objective for the management unit will be to harvest mature timber reforest the area and grow a new crop of timber in a manner which will exert a minimum of influence on the ecological conditions now present in the adjacent research natural area

The boundaries of the management unit will initially be set as shown on the attached map The management unit includes an area on the south and west of the natural area where modification of cutting practices in adjacent stands will be necessary to protect the stands inside the natural area from windthrow and sun scald

Regeneration cutting in the area above the road on the south and west sides of the natural area should be deferred for as long as possible Sanitation salvage should be planned to utilize mortality keep the stand vigorous and prolong the rotation period It may be desirable to place this area in a reduced allowable cut category similar to roadside foreground areas at the time of the next management plan revision

The management unit also includes an area on the north slope of Wildcat Mtn Ridge in Sections 17 and 18 T14S R6E This area contains young growth noble fir stands on a site not represented in other parts of the area It was not included in the natural area because it blocks transportation access to the area north of Wildcat Mtn Studies of growth and yield of this stand should be made by the experiment station prior to scheduling of timber harvest in this area After these studies have been completed the area north of Wildcat Ridge should be eliminated from the management unit

The written management direction for this unit will include

1 Harvest and logging plan for the area within the management unit
2 Cutting schedules showing the order in which settings are to be cut and the desired time interval between entries
3 Transportation system required
4 Limitations on other uses of the area

Each district ranger will be responsible for preparing securing approval for and carrying out the management direction for the portion of the management unit on his district If it becomes apparent that the management direction for the management unit requires future modification to meet the management objective the ranger concerned will recommend necessary changes and secure approval of the Forest Supervisor

(4) Public Use

No effort will be made to prohibit recreational use unless such use conflicts with the utilization of the area for research purposes or its maintenance in a natural condition

Recommendation

I recommend that the Wildcat Mtn Research Natural Area be established on the lands described in this report

Signature

| Date | | |
|---|---|---|
| JAN 24 1968 Date | Submitted | Forester |
| | | Forester |
| Date | Recommended | Supervisor Willamette National Forest |
| Date | Recommended | Acting Director, PNW Exp Station |
| Date | Recommended for | Regional Forester R-6 |
| Date | Approved Acting | Director Division of Recreation and Land Use |
| 3/12/68 Date | Approved | Deputy Chief Research |
| 3/18/68 Date | Approved | Chief |

D

21. Wildcat Mountain Research Natural Area. Older stand (approximately 180 years) of noble fir showing abundant seedlings and saplings of Pacific silver fir, the probable climax species. FS, Oregon

R-6

(21)

21. Wildcat Mountain Research Natural Area. Older stand (approximately 180 years) of noble fir showing abundant seedlings and saplings of Pacific silver fir, the probable climax species. FS, Oregon

R-6

WILDCAT MOUNTAIN RESEARCH NATURAL AREA, WILLAMETTE NATIONAL FOREST, OREGON

R-6 / PNW

1. Dense 120-year-old stand of noble fir along trail to summit of Wildcat Mountain

2. Old-growth stand of noble fir (300 years or more) in process of being replaced by the climax species, Pacific silver fir.

**No.** ______

**Name** ______

Order ______

Remarks ______

Retouched ______

Order Finished ______

Reorder ______

Reorder ______

FORESTRY RESEARCH NEWS
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
P O BOX 3141 PORTLAND, OREGON 97208

IMMEDIATE RELEASE 11 61968

Wildcat Mountain Research Natural Area Established

Designation of a 1 000 acre tract of noble fir forest 45 miles east of Eugene in the Willamette National Forest as the Wildcat Mountain Research Natural Area has been approved by Edward P Cliff Chief of the U S Forest Service

Selection of the area climaxes an exhaustive search by foresters and ecologists for the best available sample of old growth noble fir in the National Forests of Oregon and Washington It was a joint effort by the Forest Service s Pacific Northwest Forest and Range Experiment Station and Pacific Northwest Region

Regional Forester Charles A Connaughton said the area will be preserved for the primary purposes of research and education Station Director Philip A Briegleb said researchers will explore plant succession and soil development in an undisturbed forest environment Results of these and other supporting studies are needed by private and public resource managers to assure sound management of noble fir whether for timber use forest landscape or recreation

The climate and geology of the new research natural area 16 miles northeast of Blue River Oregon is typical of high elevations in the western Cascades Elevation is about 4 500 feet prevailing winds are from the southwest and the annual precipitation is over 80 inches

# RELATIONSHIPS OF ENVIRONMENT TO COMPOSITION STRUCTURE AND DIVERSITY OF FOREST COMMUNITIES OF THE CENTRAL WESTERN CASCADES OF OREGON

DONALD B ZOBEL ARTHUR MCKEE AND GLENN M HAWK
*Department of Botany and Plant Pathology Oregon State University*
*Corvallis Oregon 97331 USA*

AND

C T DYRNESS
*U S Forest Service Pacific Northwest Forest and Range Experiment Station*
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# RELATIONSHIPS OF ENVIRONMENT TO COMPOSITION STRUCTURE AND DIVERSITY OF FOREST COMMUNITIES OF THE CENTRAL WESTERN CASCADES OF OREGON[1]

DONALD B ZOBEL ARTHUR McKEE AND GLENN M HAWK
*Dcpaitment of Botany and Plant Pathology Orcgon State Unıversıty*
*Corvallıs Oıegon 97331 USA*

AND

C T DYRNESS
*U S Forest Servıce Pacıfıc Northwest Forest and Range Expeiıment Statıon*
*Corvallıs Oıegon 97331 USA*

*Abstract* Temperature and moısture stress of conıfer saplıngs and needle nıtrogen content of conıfer saplıngs were measured at reference stands representıng 16 forest communıtıes ın the central portıon of the western Cascades provınce of Oregon

Most specıes occur over a wıde range of temperature and moısture stress many occupy a wıder range of envıronments ın the western Cascades than they do ın the eastern Sıskıyou Mountaıns of southwest Oregon Dıfferences between vegetatıon zones are reflected ın a temperature ındex wıthın zones communıtıes are dıstınguıshed by moısture stress and to a lesser extent by temperature In two cases vegetatıon dıfferences appear to be related to low needle nıtrogen contents Use of complex gradıents for vegetatıon ordınatıon suggests certaın envıronmental dıfferences between communıtıes whıch are contrary to the dıfferences measured therefore we prefeı the measured gradıents over the complex gradıents defıned

Specıes dıversıty (the total number of vascular specıes) ıncreases and domınance (Sımpson s ındex) decreases away from moderate envıronmental condıtıons to warmer drıer and colder communıtıes Dıversıtıes of dıfferent strata are unrelated Domınance ıs concentrated ın fewer strata of the vegetatıon on the colder sıtes However dıscontınuıtıes ın the pattern of dıversıty wıth envıronment occur whıch are not related to major dıffeıences ın our measured envıronmental ındexes Evergreenness of shrubs ıs hıghest ın stands wıth the lowest folıar nıtrogen levels

*Key woıds Conıfeıous foıcst dıversıty vegetatıon moıstuıe stress conıfeıs ordınatıon vegctatıon Oıegon tcmpcrature stıcss conıfeıs*

## INTRODUCTION

Studıes of ecosystem characterıstıcs and processes requıre some method of stratıfyıng ecosystems and theır subunıts ın all but the most homogeneous of areas The ıntensıty and tımıng of many ecosystem processes are ın part determıned by the type of vegetatıon Because vegetatıon ıs such an ımportant part of the ecosystem and ıntegrates the effect of the total envıronment (Bıllıngs 1952) changes ın vegetatıon should b﹏ related to varıabılıty ın many processes of ınterest For these reasons a classıfıca tıon of forest communıtıes was used as one of the major bases for stratıfyıng the H J Andrews Ex perımental Forest the Oregon Intensıve Study Sıte of the Conıferous Forest Bıome U S Internatıonal Bıologıcal Program Thıs forest classıfıcatıon for the central portıon of the Western Cascades Provınce (Dyrness et al 1974) was center d on the H J An drews Experımental Forest and ıncluded an area 64 × 32 km ın extent (Fıg 1) Along wıth theır forest classıfıcatıon the authors ıncluded an ınterpretatıon of the major factors underlyıng the vegetatıonal pat tern They belıeve that temperature dıfferentıates vegetatıon zones whereas ıntrazonal varıatıon ıs thought to be prımarıly related to moısture stress

A stratıfıcatıon system provıded by vegetatıon analysıs alone may not ınclude all the ınformatıon desıred on envıronmental relatıonshıps Plant com munıtıes may dıffer from ecosystem processes ın theır sensıtıvıty to envıronmental factors or they may react to factors not ımportant to a partıcular process To provıde further data on the varıous stratıfıcatıon unıts ın thıs area we made envıron mental measurements ın selected stands representa tıve of varıous forest communıtıes These measure ments allow a fırmer decısıon on how approprıate the vegetatıon unıts are as stratıfıcatıon unıts They also allow a dırect gradıent analysıs (Whıttaker 1967) of the forest vegetatıon of thıs regıon where we have ob served envıronmental changes along a predefıned vegetatıon gradıent Thıs paper reports the envıron mental measurements made and the gradıents de fıned from them We compared measured gradıents wıth those ınferred from the vegetatıon and from physıographıc and edaphıc condıtıons and wıth

Manuscrıpt receıved 27 November 1974 accepted 20 June 1975

Present address Instıtute of Northern Forestry Faır banks Alaska USA

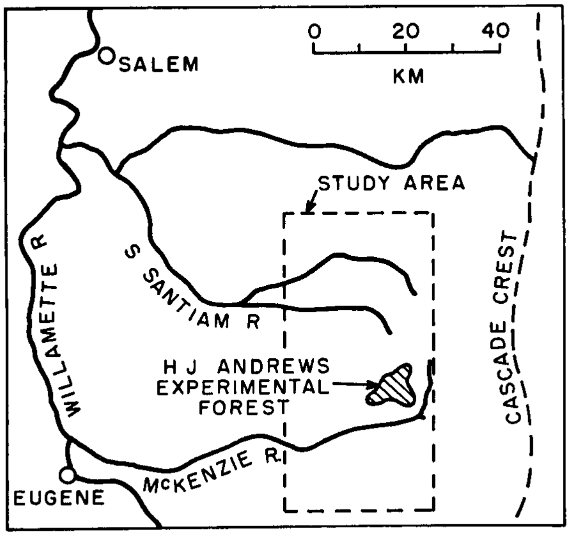


FIG 1 Location of the study area in western Oregon

gradients of vegetation composition diversity and structure in this paper we present the relationship of the environmental patterns to distributions of species and of vegetation types Comparisons are made with previous work of a similar nature particularly that in mountainous western North America

Vegetation data provided in Dyrness et al (1974) include coverage only tree dimensions and biomass for some communities we sampled were determined in separate studies extensive in themselves and will be reported elsewhere

## STUDY AREA

The western Cascades of Oregon are deeply dissected with generally well developed soils on Tertiary volcanic substrates Movement of moisture laden air off the Pacific Ocean results in high precipitation 2 000 to perhaps 4 000 mm annually in this area and a relatively mild climate although summers are very dry Snow accumulates to great depths at higher elevations but does not form a continuous cover over the lower slopes and valley bottoms Dyrness et al (1974) provide further climatic and edaphic data for the western Cascades and Franklin and Dyrness (1973) place it in the overall context of the Pacific Northwest

The forests of the western Cascades represent primarily two major vegetation zones the *Tsuga heterophylla* zone (14 communities 11 of them considered to be climax) and the *Abies amabilis* zone (9 communities 7 of them climax) Dyrness et al (1974) present individual plot data as well as summaries for each of the communities recognized Stands of the three nonclimax units used in our study are almost all dominated by trees 100–150 yr old compared to > 300 yr for dominants of most stands of the climax communities Four of the *Tsuga heterophylla* zone communities are considered transitional to the higher elevation *Abies amabilis* zone In this paper these are considered to represent a transition zone Only one community is recognized which belongs to the *Tsuga mertensiana* zone of Franklin and Dyrness (1973) and Dyrness et al (1974) include it in the *Abies amabilis* zone of this study Six of the more important *Tsuga heterophylla* zone communities have also been described in Franklin and Dyrness (1973)

At lower elevations *Pseudotsuga menziesii* dominates most communities and *Tsuga heterophylla* is the dominant reproducing tree on all but a few sites In the *Abies amabilis* zone *Abies amabilis* accounts for most of the tree reproduction Within zones community recognition is primarily dependent on shrubs and herbs Most species are quite widely distributed making shifts in species importance rather than their presence the basis for community differentiation except on the most extreme sites (Dyrness et al 1974) The recognized forest communities are summarized in Table 1 Community names in the text include only genera names on figures use four letter abbreviations (Table 1) Nonforest vegetation and forests of the major alluvial areas are described in detail elsewhere and are not included in this study (Hickman 1968 Hawk and Zobel 1974)

Relationships of vegetation units to environment inferred by Dyrness et al (1974) are presented (Fig 2) for comparison with our results Dyrness et al modified their original community ordinations based on their intuition to produce this figure (However our use of ordination coordinates from their work involves the original values produced by the ordinations these coordinates were not determined from Fig 2)

From the vegetation classification 16 communities were chosen for further study To include as many communities as possible in the sampling only a single stand represented most communities (Table 2) (The two exceptions *Tsuga/Rhododendron/Berberis* and *Tsuga/Castanopsis* were sampled twice) Such a stand was called a reference stand Each reference stand was chosen from among those areas sampled by Dyrness et al (1974) to be close to modal in species composition and importance in the community it represented thus hopefully eliminating stands nonrepresentative of or transitional between the community types recognized The stands we used were chosen by C T Dyrness and J F Franklin after completion of their community classification The only considerations used besides being representative were that stands should have reasonable accessibility and not be recently disturbed These latter factors were not allowed to force use of non

TABLE 1 Forest communities recognized in the study area by Dyrness et al (1974) NS = not sampled in this study

| Community name | Abbreviation | No plots | Climax | Reference stand no |
|---|---|---|---|---|
| *Tsuga heterophylla* zone | | | | |
| *Pseudotsuga menziesii/Holodiscus discolor* | Psme/Hodi | 8 | yes | *1* |
| *Pseudotsuga menziesii Tsuga heterophylla/Corylus cornuta* | Psme Tshe/Coco | 15 | yes | *8* |
| *Tsuga heterophylla/Castanopsis chrysophylla* | Tshe/Cach | 16 | yes | *6 16* |
| *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* | Tshe/Rhma/Gash | 17 | yes | *10* |
| *Pseudotsuga menziesii/Acer circinatum/ Gaultheria shallon* | Psme/Acci/Gash | 13 | no | NS |
| *Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa* | Tshe/Rhma/Bene | 18 | yes | *2 17* |
| *Pseudotsuga menziesii/Acer circinatum/ Berberis nervosa* | Psme/Acci/Bene | 14 | no | *11* |
| *Tsuga heterophylla Acer circinatum/ Polystichum munitum* | Tshe/Acci/Pomu | 12 | yes | *9* |
| *Tsuga heterophylla/Polystichum munitum* | Tshe/Pomu | 15 | yes | *15* |
| *Tsuga heterophylla/Polystichum munitum Oxalis oregana* | Tshe/Pomu Oxor | 8 | yes | *7* |
| Transition zone | | | | |
| *Tsuga heterophylla Abies amabilis/ Rhododendron macrophyllum/Berberis nervosa* | Tshe Abam/Rhma/ Bene | 22 | yes | *5* |
| *Tsuga heterophylla Abies amabilis/ Rhododendron macrophyllum/Linnaea borealis* | Tshe Abam/Rhma/ Libo | 12 | yes | NS |
| *Tsuga heterophylla Abies amabilis/ Linnaea borealis* | Tshe Abam/Libo | 21 | yes | *3* |
| *Pseudotsuga menziesii/Acer circinatum/ Whipplea modesta* | Psme/Acci/Whmo | 11 | no | *18* |
| *Abies amabilis* zone | | | | |
| *Abies amabilis Tsuga mertensiana/ Xerophyllum tenax* | Abam Tsme/Xete | 8 | yes | *14* |
| *Abies amabilis/Vaccinium membranaceum/ Xerophyllum tenax* | Abam/Vame/Xete | 9 | yes | NS |
| *Abies amabilis/Rhododendron macrophyllum Vaccinium alaskense/Cornus canadensis* | Abam/Rhma Vaal/ Coca | 11 | yes | NS |
| *Abies amabilis/Vaccinium alaskense/ Cornus canadensis* | Abam/Vaal/Coca | 8 | yes | *12* |
| *Abies procera/Achlys triphylla* | Abpr/Actr | 6 | no | NS |
| *Abies amabilis/Achlys triphylla* | Abam/Actr | 13 | yes | NS |
| *Abies procera/Clintonia uniflora* | Abpr/Clun | 7 | no | *13* |
| *Abies amabilis/Tiarella unifoliata* | Abam/Tiun | 12 | yes | *4* |
| *Chamaecyparis nootkatensis/Oplopanax horridum* | Chno/Opho | 7 | yes | NS |

representative stands Vegetation data for the individual reference stands and for the communities which they represent are available from the National Auxiliary Publication Service[3] Site characteristics for reference stands are given in Table 2

The environmental characteristics as measured on the reference stands should describe the variation within the study area well However a measured difference between two communities surely includes variability induced by the exact choice of sample stands and thus may not represent the average difference between the communities

All except two reference stands were located on or immediately adjacent to the H J Andrews Experimental Forest stands *13* and *14* were located at the Wildcat Mountain Research Natural Area 7 5 km north northwest of the center of the H J Andrews in communities not well represented on the H J Andrews Forest

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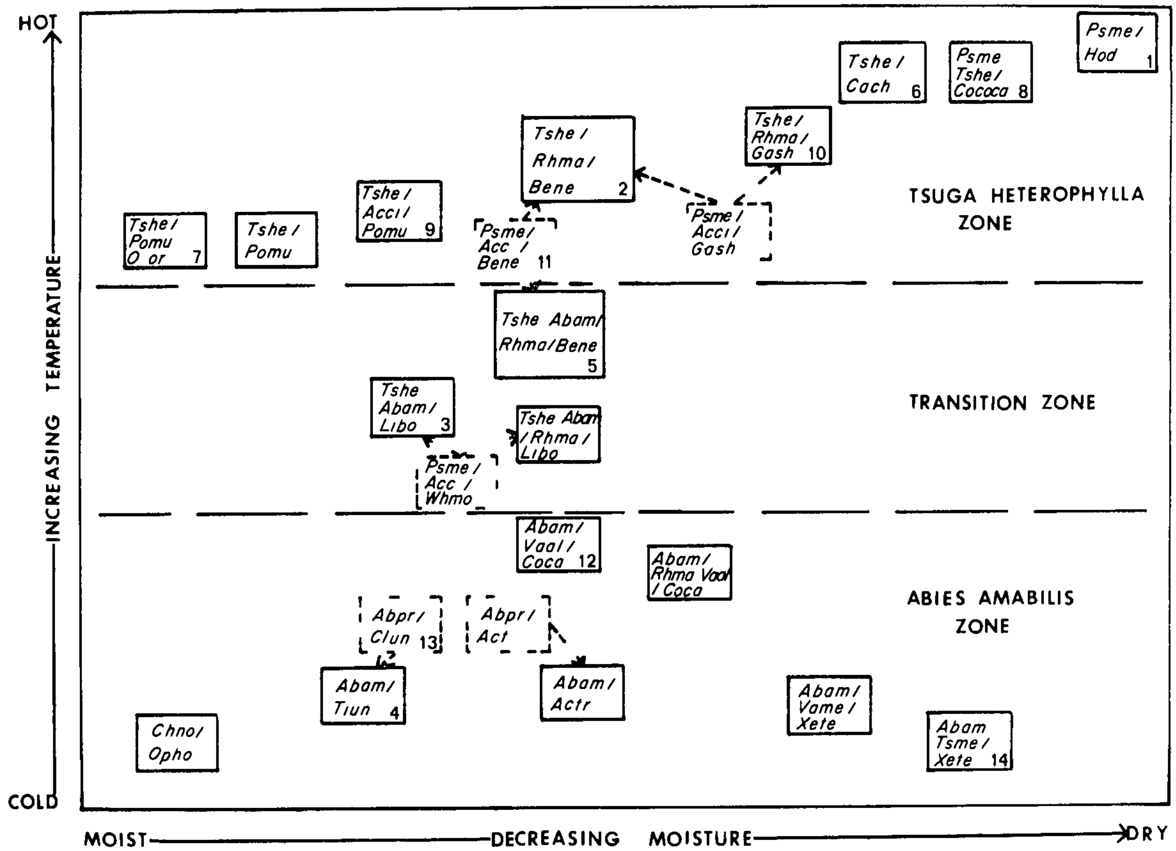


FIG 2 Hypothesized relationships between forest communities and environment in the central western Cascades (Dyrness et al 1974 Fig 5) This figure is based on their vegetation ordination somewhat modified by the intuition of the investigators Communities enclosed with dashed borders are considered to be seral the others to be climax Communities sampled in this study are identified by the reference stand number in the box Abbreviations for communities are identified in Table 1

## Measurement of Environmental Indexes

### *Methods*

The environmental measurements we made were related to small conifer saplings in order to quantify the environment as integrated by trees of this size Indexes of moisture and mineral nutrient availability were determined by direct measurements of plant moisture stress and needle nutrient content respectively Air and soil temperature were measured for major strata occupied by foliage and roots of these understory trees The length of the summary season for the temperature index was partially determined by sapling phenology

Temperature was measured continuously at one site in each reference stand using a two pen 30 day thermograph Air temperature was taken at 1 m under an insulated A frame shield which shaded the probe The soil temperature probe was buried nearby at a depth of 20 cm Air temperatures were digitized and each daily maximum minimum and mean was computed Separate means were computed for day light and night Daylength for the 15th of each month was used to determine the day and night summation periods Average daily soil temperatures were read from the charts manually Monthly means seasonal extremes and other data were determined as needed

In August 1973 soil temperature at 20 cm was measured at 11 points in each stand in order to assess how representative the sampling point was One measurement was at the site of the thermograph probe the others at the base of 1–3 m conifer saplings Means for each stand were computed and compared with the measurement at the thermograph probe

A temperature summing formula was used which weights temperatures by their effect on production of seedlings of *Pseudotsuga menziesii* in controlled environments (Cleary and Waring 1969) This calculates an index originally called Optimum Temperature Days which has been renamed Temperature Growth Index (TGI) by its originators Average soil and daylight air temperature were used to compute the index for each day and the daily

TABLE 2 Characteristics of reference stands sampled Percent cover is for a 50 × 50 m area at each stand Specific names of plants in the community names are given in Table 1

| Zone | Reference stand no | Community | Elevation (m) | Aspect | Slope (°) | Percent cover: Tree Mature | Percent cover: Tree Reproducing | Percent cover: Shrub | Percent cover: Herb |
|---|---|---|---|---|---|---|---|---|---|
| *Tsuga heterophylla* | *1* | *Pseudotsuga/Holodiscus* | 510 | SW | 35 | 50 | 20 | 46 | 36 |
| | *2* | *Tsuga/Rhododendron/Berberis* | 520 | NW | 20 | 105 | 10 | 30 | 24 |
| | *6* | *Tsuga/Castanopsis* | 710 | S | 40 | 83 | 30 | 123 | 14 |
| | *7* | *Tsuga/Polystichum Oxalis* | 490 | NW | 18 | 110 | 42 | 17 | 41 |
| | *8* | *Pseudotsuga Tsuga/Corylus* | 500 | W | 40 | 81 | 25 | 64 | 27 |
| | *9* | *Tsuga/Acer/Polystichum* | 490 | WNW | 45 | 100 | 35 | 72 | 48 |
| | *10* | *Tsuga/Rhododendron/ Gaultheria* | 670 | SSW | 5 | 89 | 60 | 118 | 7 |
| | *11* | *Pseudotsuga/Acer/Berberis* | 1 060 | SSE | 25 | 96 | 35 | 62 | 10 |
| | *15* | *Tsuga/Polystichum* | 720 | NW | 45 | 108 | 43 | 14 | 18 |
| | *16* | *Tsuga/Castanopsis* | 670 | SW | 40 | 107 | 48 | 108 | 7 |
| | *17* | *Tsuga/Rhododendron/ Berberis* | 530 | NNW | 18 | 102 | 47 | 43 | 37 |
| Transition | *3* | *Tsuga Abies/Linnaea* | 950 | SW | 10 | 120 | 88 | 38 | 24 |
| | *5* | *Tsuga Abies/Rhododendron/ Berberis* | 920 | N | 8 | 90 | 27 | 125 | 5 |
| | *18* | *Pseudotsuga/Acer/Whipplea* | 1 080 | SE | 30 | 81 | 24 | 92 | 23 |
| *Abies amabilis* | *4* | *Abies/Tiarella* | 1 440 | SW | 10 | 116 | 50 | 9 | 39 |
| | *12* | *Abies/Vaccinium/Cornus* | 1 020 | W | 5 | 103 | 31 | 56 | 33 |
| | *13* | *Abies/Clintonia* | 1 480 | S | 15 | 93 | 20 | 12 | 32 |
| | *14* | *Abies Tsuga/Xerophyllum* | 1 570 | NW | 15 | 100 | 27 | 3 | 33 |

indexes were summed over a growing season to obtain TGI The definition of growing season in this study was from the date of budbreak of conifer saplings (A McKee *personal observations*) to the date of the second frost in the fall

The moisture index used was Plant Moisture Stress (PMS) the reading of the pressure chamber (Scholander et al 1965) Twigs of understory conifers were sampled before dawn near the end of the growing season (Waring and Cleary 1967) The PMS was determined on 4–6 trees at each reference stand and was measured at least twice each season from 1970 to 1973 The highest average PMS for each reference stand for the several dates was the index for a given year All measurements were made between midnight and dawn At this time PMS should be at or near its minimum value which is limited by the soil moisture conditions around the root system (Waring and Cleary 1967) PMS is given in bars and is the negative of the pressure potential of the xylem sap (Boyer 1967) Diurnal patterns of PMS were determined for contrasting sites in midsummer of 1970 and 1971

Needle samples were collected for nutrient analysis from 1 yr old needles of four to six understory conifers at selected reference stands in early summer The nutrient stress on these needles should be the greatest at this time (Krueger 1967*b* Waring and Youngberg 1972) Samples were oven dried at 70 C and stored in sealed containers until analysis Nitrogen analyses were done by the Oregon State University Forestry Research Laboratory using a micro Kjeldahl procedure

Early results of this investigation are presented by Zobel et al (1974)

### *Results and discussion*

*Temperature variation in time and space* Air temperature showed a definite July–August peak considerably above both June and September levels (Fig 3) Soil temperatures usually peaked in August (Fig 4) their rise and decline was less precipitous than that of air temperature except on sites with late snow melt (as at the *Abies Tsuga/Xerophyllum* stand in 1972)

Minimum air temperatures were relatively mild except in early December 1972 when record low temperatures of –26 C occurred at Eugene and Salem Oregon in the Willamette Valley east of the Cascades low temperatures were about –34 C At that time low temperatures at our thermographs ranged from –16 to –22 C well above the valley temperatures and the –27 to –29 C recorded with similar instruments at 1 100 m on the east flank of the high Cascades In 1973 minima ranged from –7 to –9 C at lower elevations to –17 C at reference stand *14* The length of the frostless season within the area varied by a factor of about two from 90 to 182 days in 1972 and from 130 to 286 days in 1973 when the first frost occurred as late as December on some sites Extended soil freezing at 20 cm occurred

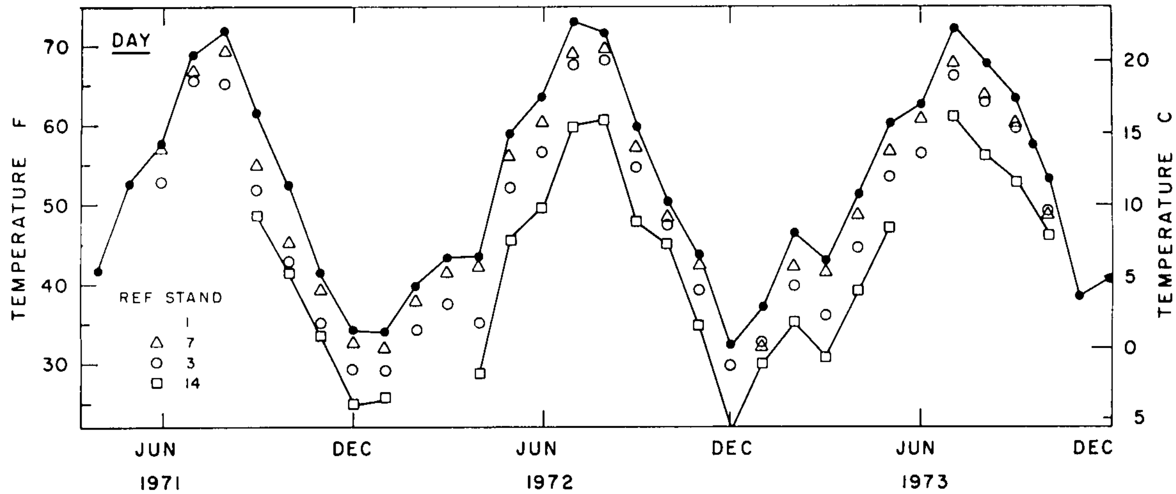


FIG 3 Monthly averages of daytime air temperature at the *Pseudotsuga/Holodiscus* (reference stand *1*) *Tsuga/Polystichum Oxalis* (*7*) *Tsuga Abies/Linnaea* (*3*) and *Abies Tsuga/Xerophyllum* (*14*) sites representing most of the variability found in the study

only in the winter of 1971–1972 One transition zone community (*Tsuga Abies/Linnaea*) had soil at or below 0 C for 139 days while at three *Abies amabilis* zone stands it lasted 153 137 and 213 days Soil freezing in the *Tsuga heterophylla* zone com munities did not exceed 31 days and did not occur at most reference stands

Annual maxima of air temperatures usually ex ceeded 38 C on the warmer sites at reference stands *13* and *14* in 1973 they never exceeded 27 C

Data from weather stations (Baker 1944) reveal a low July temperature lapse rate on the west slope of the Oregon Cascades –0 42 C/100 m compared to –0 64 for the mountainous western U S in general Our data confirmed this low lapse rate up to about 1 100 m (Table 3) Night temperatures showed no significant decrease with elevation and the minima actually increased up to 1 100 m resulting in a mid elevation thermal belt Above 1 050 m the decline in temperatures was more rapid although night temperatures dropped less with elevation than those during the day (Table 3) These temperature in versions probably arise partially from cold air drain age They may also result from advection from the more continental climate east of the crest of the Cascades Steady warm dry east winds have been observed at higher elevations during some of the more extreme temperature inversions January lapse rates were similar for both day and night tempera tures although the rates were considerably different in 1972 and 1973 (Table 3)

There is considerable variability in temperature at

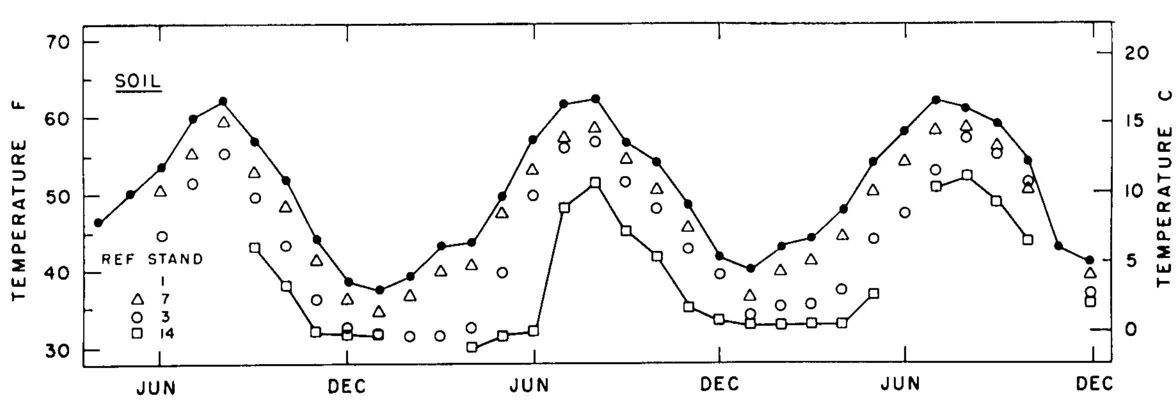


FIG 4 Monthly averages of soil temperature at the *Pseudotsuga/Holodiscus* (reference stand *1*) *Tsuga/Polystichum Oxalis* (*7*) *Tsuga Abies/Linnaea* (*3*) and *Abies Tsuga/Xerophyllum* (*14*) sites representing most of the variability found in the study

TABLE 3 Temperature changes ( C/100 m) with elevation on the study area Two sites at lower elevations ad jacent to the H J Andrews Forest are included in the data Significant correlation of temperature with elevation at 0 05 and 0 01 levels are designated by the symbols * and ** respectively

| | July | | | | | January | |
|---|---|---|---|---|---|---|---|
| | Below 1 100 m | | | Above 1 050 m | | Below 1 100 m | |
| | 1971 | 1972 | 1973 | 1972 | 1973 | 1972 | 1973 |
| No samples | 11 | 16 | 16 | 5 | 6 | 9 | 17 |
| Mean day | –0 26 | –0 33** | –0 28* | –0 80 | –0 71* | –0 43* | –0 24* |
| Mean night | –0 09 | –0 09 | –0 17 | –0 46 | –0 40 | –0 37** | –0 18* |
| Mean max | –0 38 | –0 54* | –0 54** | –1 13* | –0 98** | –0 46* | –0 22* |
| Mean min | +0 16 | +0 18 | +0 06 | –0 47 | –0 21 | –0 28 * | –0 24 |
| Mean range | –0 54 * | –0 73** | –0 61 | –0 65* | –0 79* | –0 18 | +0 02 |
| Mean soil | –0 28 | –0 47** | –0 37 | –0 67 | –0 43 | –0 34 | –0 21 |

a given elevation For example the seven stands with elevations ≈ 500 m had the following temperature ranges in July 1972 absolute minimum 3–8 C absolute maximum 31–40 C and daytime mean 19–23 C

Baker (1944) also noted a 18 C diurnal tempera ture variation in July for our region which he said changed little with elevation Our summer diurnal range approached this figure only at low elevations and it declined 0 54 C or more per 100 m over all elevations (Table 3) Winter diurnal range was about 3–6 C it showed little change with elevation (Table 3)

Variability within stands could lead to serious anomalies in our data if the sampling point were not representative However soil temperatures measured throughout the stand generally compared fairly well with those measured at the probe On only 5 of the 18 reference stands did soil temperature at the probe site in August 1973 differ by more than 1 0 C from the mean of 11 points in the stand and all were within 2 C of the mean Means for the stand were almost always lower than the temperature at the probe Correlation between soil temperature at the thermograph site and stand soil temperature mean was $r = 0\ 94$

Values for stands within the same vegetation type would also be expected to vary We replicated only two communities *Tsuga/Rhododendron/Berberis* and *Tsuga/Castanopsis* each at two sites (Table 1) Monthly averages of air and soil temperatures varied up to 2 2 C between replicate stands of the same community (Table 4) The temperature relationship reversed itself with season in most cases For ex ample in April stand *2* was 1 1 C cooler than stand *17* in October it was 1 7 C warmer The pattern of difference between replicate reference stands was not the same for soil temperature as for air temperature with stands *6* and *16* between stands *2* and *17* soil and air temperature varied in a parallel fashion

*Temperature growth index* Temperature growth index (TGI) at the reference stands varied consider ably during 1971 to 1973 (Table 5) In 1973 the index was higher than for the other 2 yr especially at the cooler sites due to unusually late fall frosts However the relative positions of communities were similar from year to year Correlation analysis of TGI of individual stands in 1971 with that in 1972 gave a coefficient of determination ($r^2$) of 0 98 ($n =$ 12) the comparison of 1972 TGI with TGI in 1973 had $r^2 = 0\ 96$ ($n = 14$)

Communities sampled in the different vegetation zones are clearly separated by TGI in all 3 yr (Table 5) However variability in TGI does not correspond particularly well with vegetational changes within the *Tsuga heterophylla* and transition zones (Fig 5) A major cause of the poor relationship between TGI and the $Y$ axis coordinate is the position of reference stands *6* and *10* for the other stands TGI generally decreases as the $Y$ coordinate increases with a similar pattern repeated for the 3 yr represented in Fig 5 A possible cause for the failure of stands *6* and *10* to conform to the general relationship is presented in the section on foliar nutrition

Use of TGI accentuates the differences among sites seen in unweighted temperature data There is rela

TABLE 4 Differences between monthly means of day air temperature and soil temperature in replicate refer ence stands representing the same community Data are for July 1972 through December 1973 Stands *2* and *17* represent the *Tsuga/Rhododendron/Berberis* community stands *6* and *16* represent the *Tsuga/Castanopsis* community

| | Day air temperature ( C) | | Soil temperature ( C) | |
|---|---|---|---|---|
| Reference stand | *(2 17)* | *(6 16)* | *(2 17)* | *(6 16)* |
| Mean difference | +0 41 | +0 91 | +0 58 | –0 23 |
| Range of monthly differences | –1 9 to +1 9 | –0 1 to +2 2 | –1 3 to +1 7 | –1 6 to +0 9 |

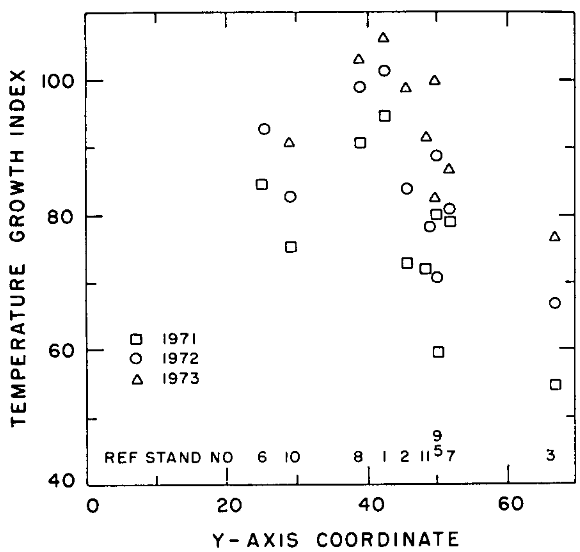


FIG 5 Relationship of Temperature Growth Index of reference stands and the *y* axis coordinate of the community the stands represent in a vegetation ordination for *Tsuga heterophylla* zone and transitional communities Communities represented by the reference stands are identified in Table 2

tively more variation within elevational zones and the overall rate of decline with increasing elevation is considerably greater than any lapse rate for mean temperature Although TGI is significantly correlated with plot elevation ($r$ = 0 74 0 86 and 0 84 for 1971 1972 and 1973) there is considerable variability within elevational zones enough to justify use of a temperature index other than elevation itself For example vegetation at reference stand *12* at 1 020 m placed it in the *Abies amabilis* zone whereas stand *11* at 1 060 m was in the *Tsuga heterophylla* zone The TGI values conform to the zone determined by the vegetation and do not overlap (Table 5)

The large change in TGI from the transition to the *Abies amabilis* zone stands appears to be due partially to the steeper lapse rate at higher elevations as well as possibly to sampling idiosyncracies Another large environmental change seems to occur below the highest elevation stand in the study The *Abies Tsuga/Xerophyllum* community there would be placed into the *Tsuga mertensiana* zone in a regional context (Franklin and Dyrness 1973) This site often has the deepest snowpack and has the coldest soil of any of our sample sites This situation may be analogous to southern British Columbia where snow accumulation increases and species composition changes abruptly above a certain elevation with the loss of *Tsuga heterophylla* and *Pseudotsuga menziesii* (Brooke et al 1970) this same shift in tree composition occurs from our *Abies/Clintonia* to the *Abies Tsuga/Xerophyllum* stand

At the replicate stands of the *Tsuga/Castanopsis* community (stands *6* and *16*) the 1973 TGI differed only by 1 unit despite the relatively larger differences in air and soil temperature means (Table 4) How

TABLE 5 Temperature growth index (TGI) for reference stands in 1971 to 1973

| Vegetation zone | Reference stand no | Plant community | TGI 1971 | TGI 1972 | TGI 1973 |
|---|---|---|---|---|---|
| *Tsuga heterophylla* | *1* | *Pseudotsuga/Holodiscus* | 95 | 102 | 107 |
| | *2* | *Tsuga/Rhododendron/Berberis* | 74 | 84 | 99 |
| | *6* | *Tsuga/Castanopsis* | 85 | 93 | 92 |
| | *7* | *Tsuga/Polystichum Oxalis* | 80 | 82 | 88 |
| | *8* | *Pseudotsuga Tsuga/Corylus* | 90 | 98 | 101 |
| | *9* | *Tsuga/Acer/Polystichum* | 81 | 87 | 98 |
| | *10* | *Tsuga/Rhododendron/Gaultheria* | 76 | 83 | 91 |
| | *11* | *Pseudotsuga/Acer/Berberis* | 73 | 78 | 92 |
| | *15* | *Tsuga/Polystichum* | | | 89 |
| | *16* | *Tsuga/Castanopsis* | | | 93 |
| | *17* | *Tsuga/Rhododendron/Berberis* | | | 88 |
| | | *Zone average* | 82 | 88 | 94 |
| Transition | *3* | *Tsuga Abies/Linnaea* | 56 | 67 | 77 |
| | *5* | *Tsuga Abies/Rhododendron/Berberis* | 60 | 70 | 82 |
| | | *Zone average* | 58 | 69 | 80 |
| *Abies amabilis* | *4* | *Abies/Tiarella* | 34 | 38 | 52 |
| | *12* | *Abies/Vaccinium/Cornus* | 40 | 49 | 68 |
| | *13* | *Abies/Clintonia* | | 37 | 52 |
| | *14* | *Abies Tsuga/Xerophyllum* | | 32 | 53 |
| | | *Zone average* | 36 | 39 | 56 |

ever the replicates of *Tsuga/Rhododendron/Berberis* (stands *2* and *17*) had a TGI difference of 11 units Much of this difference is attributable to a local late occurrence of fall frost at stand *2* allowing it 28 more days during which TGI units were accumulated

*Plant moisture stress* Rainfall during the four summers in which plant moisture stress was measured varied considerably Summers of 1970 and 1972 were quite dry leading to similarly high PMS levels late in the season 1971 was relatively wet with no dry spell longer than 3 wk In 1973 although there was little precipitation and very low streamflows there were only intermediate levels of moisture stress

Dyrness et al (1974) believe that the *X* axis of their vegetation ordination represents a moisture gradient *X* axis coordinates from the ordination of *Tsuga heterophylla* zone and transition zone com munities correspond well with the late summer pre dawn PMS measured on the reference stands which represent them especially in the driest years (Fig 6) The only major exceptions to this are the *Tsuga Abies/Linnaea* (stand *3*) in 1970 1971 and 1973 and the *Ps udotsuga/Acer/Berberis* (stand *11*) in 1973 Both have PMS 3–6 bars below that predicted from their *X* axis position in these years These sites are within 1 4 km of each other in different soil types and geologic substrates than the other reference stands compared in Fig 6 The lower moisture stress at the *Tsuga Abies/Linnaea* stand may reflect shading of th very dense tree canopy (Table 2) The *Pseudotsuga/Acer/Berberis* site is one of only two reference stands with an easterly aspect A ridge rises rather steeply to the west which may reduce after noon heating and evaporative stress somewhat The only other east trending slop is at the *Pseudotsuga/Acer/Whipplea* site which is below the regression line also The *Tsuga Abies/Linnaea* stand fit the regression (Fig 6) in 1972 but this was immediately after salvage logging within 70 m west of the plot The lower PMS level exhibited by this site during the other 3 yr is considered more characteristic of the community Despite these exceptions the *X* axis of the *Tsuga heterophylla* zone ordination is well corre lated with the influence of moisture on conifer sap lings This is a welcome contrast to many ordination axes which are not interpretable directly in terms of environment in the field (Whittaker 1967)

The PMS at all four reference stands in the *Abies amabilis* zone was measured only in 1973 The PMS varied only from 6 1 to 9 2 bars but a correlation with the *X* axis is present ($r^2 = 0\ 79$) similar to that in the lower zones However the regression coef ficient of PMS on the *X* coordinate is only –0 07 (not significant with the small sample) compared to –0 21 to –0 32 for the lower zones

The PMS was measured on different species at different stands contributing a possible source of

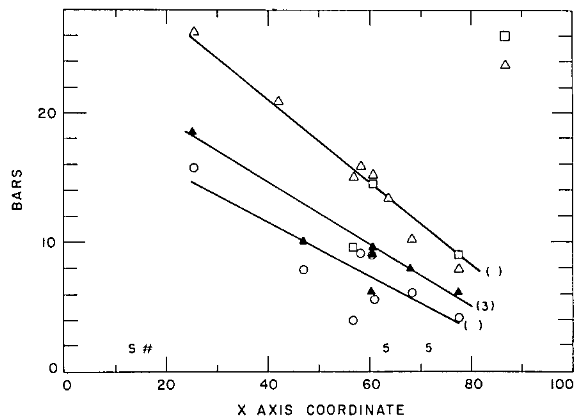


FIG 6 Relationship of maximum yearly predawn moisture stress to position of the *Tsuga heterophylla* and transition zone communities on the *x* axis of the vegeta tion ordination of Dyrness et al (1974) The community represented by each reference stand (R S ) is listed in Table 2 Linear regressions (1) 1970 + 1972—$Y = -33\ 96 + 0\ 319\ X$ $r^2 = 0\ 95$ (2) 1971—$Y = -20\ 00 + 0\ 207\ X$ $r = 0\ 83$ (3) 1973—$Y = -24\ 31 + 0\ 241\ X$ $r = 0\ 82$ (Data from reference stand *3* were excluded from the regression equations )

error However where two species were compared on the same sites there was no consistent difference be tween species and use of different species appears to contribute no systematic error to the data (A McKee and G M Hawk *unpublished observations*)

The diurnal course of plant moisture tress was followed on several days in 1970 and 1971 Maxi mum stress reached on clear warm days was 6–10 bars drier than the predawn stress

Plant moisture stresses have been measured simi larly elsewhere in Oregon The range of PMS sampled in the eastern Siskiyou Mountains during 1967 (Waring 1969) was very similar to that of 1970 and 1972 on the H J Andrews Forest In the South Umpqua Basin of the Oregon Cascades com munities varied from < 3 to 21 bars PMS in 1969 (Minore 1972) which was a somewhat moister year than 1970 and 1972 in this region In the central western Cascades river terraces and open rocky slopes at high elevations support *Abies grandis* sap ling populations which frequently have PMS more severe than the driest H J Andrews community (Zobel 1974 1975)

*Foliar nutrition* Foliar nutrient content varied with species time of year and site Sampling was not inten sive enough to allow all communities to be ordered by nutrition as they were by TGI or PMS However it did reveal certain stands to have very low foliar nitrogen contents

Site differences in nutrient availability should be clearest following bud burst when 1 yr old leaves lose some of their nutrients to developing shoots (Krueger

TABLE 6 Foliar nitrogen content following budbreak in 1971 Measurements were on needles produced in 1970 NA = budbreak dates were very late but were not observed

| Reference stand | Community | Species | No trees | Date | Days after bud break | Percent N Mean | Percent N Range |
|---|---|---|---|---|---|---|---|
| 6 | Tshe/Cach | Psme | 3 | 21 Jun | 33 | 0 68 | 0 65–0 72 |
| *1* | Psme/Hodi | Psme | 4 | 21 Jun | 33 | 0 87 | 0 85–0 91 |
| *8* | Psme Tshe/Coca | Psme | 4 | 21 Jun | 33 | 0 87 | 0 78–1 00 |
| *6* | Tshe/Cach | Tshe | 3 | 21 Jun | 24 | 0 64 | 0 60–0 71 |
| *10* | Tshe/Rhma/Gash | Tshe | 4 | 23 Jun | 26 | 0 79 | 0 68–0 86 |
| *9* | Tshe/Acci/Pomu | Tshe | 4 | 21 Jun | 17 | 0 86 | 0 75–0 99 |
| *2* | Tshe/Rhma/Bene | Tshe | 4 | 23 Jun | 19 | 0 86 | 0 81–0 92 |
| *7* | Tshe/Pomu Oxor | Tshe | 4 | 23 Jun | 27 | 0 87 | 0 78–0 92 |
| *5* | Tshe Abam/Rhma/Bene | Tshe | 4 | 23 Jun | 13 | 0 87 | 0 80–0 92 |
| *3* | Tshe Abam/Libo | Tshe | 3 | 27 Jul | 33 | 1 24 | 1 16–1 39 |
| *12* | Abam/Vaal/Coca | Abam | 4 | 19 Jul | NA | 0 96 | 0 84–1 04 |
| *4* | Abam/Tiun | Abam | 4 | 22 Jul | NA | 0 99 | 0 95–1 04 |
| *14* | Abam Tsme/Xete | Abam | 4 | 23 Aug | NA | 1 01 | 0 98–1 03 |
| *13* | Abpr/Clun | Abam | 4 | 23 Aug | NA | 1 05 | 0 95–1 11 |
| *3* | Tshe Abam/Libo | Abam | 3 | 27 Jul | 33 | 1 13 | 1 04–1 19 |

1967*b* Waring and Youngberg 1972) Foliar nitrogen content of *Tsuga heterophylla* and *Pseudotsuga* averaged 0 86% or 0 87% at this time at several sites The exceptions were the *Pseudotsuga/Holodiscus Tsuga/Castanopsis* and *Tsuga/Rhododendron/Gaultheria* communities (stands *1 6* and *10*) with lower concentrations and the *Tsuga Abies/Linnaea* site (stand *3*) with higher nitrogen (Table 6) *Tsuga heterophylla* and *Pseudotsuga* were sampled only in the *Tsuga/Castanopsis* community there nitrogen contents of the two species were similar (Table 6) Foliar nitrogen levels of *Pseudotsuga* determined in this study are below most of those determined in previous foliar analyses (Krueger 1967*a* van den Driessche 1969 Lavender 1970 Waring and Youngberg 1972)

The low foliar nitrogen content of *Tsuga* at the *Tsuga/Castanopsis* and *Tsuga/Rhododendron/Gaultheria* stands is reflected in the position of these stands on the vegetation temperature correlation (Fig 5) Their poor nutritional status may very well explain vegetational *Y* coordinate values for these stands well below what would be expected from their TGI

## SPECIES DISTRIBUTION IN RELATION TO ENVIRONMENT

Many studies of vegetation and environment have as their objective the construction of relationships which will allow the environment (or timber site quality or the most appropriate tree species to plant

TABLE 7 Distribution patterns of tree species in the study area with limits of Temperature Growth Index (TGI) and Plant Moisture Stress (PMS) in the communities studied Other distribution refers to the occurrence of the species with importance less than that in its center of importance

| Species | Mature (M) or reproduction (R) | Center of importance | Other distribution | Limits of TGI Min | Limits of TGI Max | Limits of PMS Min | Limits of PMS Max |
|---|---|---|---|---|---|---|---|
| *Arbutus menziesii* | M+R | Hot dry | | 93 | | 20 | |
| *Libocedrus decurrens* | M | Hot dry | Moderate | 78 | | 10 | |
| *Libocedrus decurrens* | R | Hot dry | | 83 | | 17 | |
| *Pinus lambertiana* | M+R | Hot dry | | 83 | | 17 | |
| *Acer macrophyllum* | M | Hot dry+Moderate | | 78 | | All | |
| *Acer macrophyllum* | R | | Hot dry+Moderate | 75 | | 10 | |
| *Pseudotsuga menziesii* | M | Hot dry+Moderate | All | All | | All | |
| *Pseudotsuga menziesii* | R | Hot dry | Cold | (38)87 | | (8)17 | |
| *Thuja plicata* | M | Moderate | Cold+Med Hot dry | 38 | 98 | | 21 |
| *Thuja plicata* | R | Moderate | Med Hot dry | 67 | 98 | | 21 |
| *Tsuga heterophylla* | M+R | Moderate to Cool | All except extremes | 38 | 98 | | 21 |
| *Abies grandis* | M | | Moderate to cold | | 82 | | 10 |
| *Abies grandis* | R | | Moderate | 67 | 83 | 10 | 18 |
| *Abies procera* | M | Cold | Moderate | | 72 | | 17 |
| *Abies procera* | R | | Moderate to cold | 37 | 78 | 9 | 18 |
| *Abies amabilis* | M | Cold | Moderate | | 84 | | 17 |
| *Abies amabilis* | R | Cold | Moderate | | 78 | | 18 |
| *Tsuga mertensiana* | M+R | Cold | | | 38 | 9 | 10 |

TABLE 8 Distribution patterns of shrub and herb species central part of western Cascades with limits of TGI and PMS in the communities studied Species of little importance in any community are excluded

| Group | Species | Center of importance | Other distribution | Limits of TGI Min | Limits of TGI Max | Limits of PMS Min | Limits of PMS Max |
|---|---|---|---|---|---|---|---|
| 1 | *Lathyrus polyphyllus* | Hot dry | None | 98 | | 21 | |
| | *Madia gracilis* | Hot dry | None | 98 | | 21 | |
| | *Rhus diversiloba* | Hot dry | None | 93 | | 20 | |
| | *Collomia heterophylla* | Hot dry | None | 93 | | 20 | |
| | *Holodiscus discolor* | Hot dry | None | 73 | | 18 | |
| | *Lonicera ciliosa* | Hot dry | None | 83 | | (9)20 | |
| 2 | *Whipplea modesta* | Hot dry | Moderate | 67 | | 10 | |
| | *Synthris reniformis* | Hot dry | Moderate | 67 | | 10 | |
| | *Corylus cornuta* | Hot dry | Moderate | 67 | | All | |
| | *Iris tenax* | Hot dry | Moderate | 73 | | 10 | |
| | *Festuca occidentalis* | Hot dry | Moderate | 73 | | 10 | |
| 3 | *Berberis nervosa* | Hot Dry + Moderate | All | 38 | | All | |
| | *Linnaea borealis* | Hot Dry + Moderate | All | 38 | | All | |
| | *Taxus brevifolia* | Hot Dry + Moderate | All | 38 | | All | |
| | *Acer circinatum* | Hot Dry + Moderate | All | All | | All | |
| 4 | *Gaultheria shallon* | Medium hot Dry | Moderate + Hot | 67 | | 9 | |
| | *Castanopsis chrysophylla* | Medium hot Dry | Moderate + Hot | 49 | | All | |
| | *Cornus nuttallii* | Medium hot Dry | Moderate + Hot | 49 | | All | |
| 5 | *Rhododendron macrophylum* | Medium hot Dry | All | All | | All | |
| 6 | *Hieraceum albiflorum* | Hot Dry + Cold | Moderate | Absent 40–70 | | | |
| 7 | *Polystichum munitum* | Warm wet | Varies | All | | All | |
| | *Oxalis oregana* | Warm wet | Varies | 38 | 83 | 8 | 15 |
| 8 | *Coptis laciniata* | Moderate | Varies | 38 | 98 | 8 | 21 |
| | *Rubus nivalis* | Moderate | Varies | All | | 9 | 21 |
| 9 | *Viola sempervirens* | Cold + Moderate | All | All | | All | |
| 10 | *Pteridium aquilinum* | Cold | All | 38 | | All | |
| | *Achlys triphylla* | Cold | All | All | | All | |
| | *Campanula scouleri* | Cold | All | All | | All | |
| 11 | *Listera caurina* | Cold | Disjunct moderate or Hot | All | | All | |
| | *Montia siberica* | Cold | Disjunct moderate or Hot | 38 | 90 | 8 | 21 |
| | *Galium oreganum* | Cold | Disjunct moderate or Hot | 38 | 73 | 8 | 15 |
| | *Arnica latifolia* | Cold | Disjunct moderate or Hot | 38 | 67 | 8 | 10 |
| | *Viola glabella* | Cold | Disjunct moderate or Hot | 38 | 73 | 8 | 15 |
| 12 | *Osmorhiza purpurea* | Cold | None | 37 | 38 | 8 | 9 |
| | *Streptopus roseus* | Cold | None | 38 | 48 | 8 | 9 |
| 13 | *Rubus lasiococcus* | Cold | Moderate | | 73 | | 18 |
| | *Clintonia uniflora* | Cold | Moderate | | 83 | | 18 |
| | *Pyrola secunda* | Cold | Moderate | | 78 | | 18 |
| | *Vaccinium membranaceum* | Cold | Moderate | | 93 | | 19 |
| | *Smilicina stellata* | Cold | Moderate | | 98 | | 21 |
| | *Cornus canadensis* | Cold | Moderate | 38 | 82 | | 18 |
| | *Vaccinium alaskense* | Cold | Moderate | 38 | 84 | | 15 |
| | *Tiarella unifoliata* | Cold | Moderate | 38 | 87 | | 18 |
| 14 | *Chimaphila umbellata* | Scattered | Varies | All | | All | |
| | *Smilacina racemosa* | Scattered | Varies | All | | All | |
| | *Xerophyllum tenax* | Scattered | Varies | All | | All | |
| 15 | *Vancouveria hexandra* | Wet fringe | All | 38 | | All | |
| 16 | *Athyrium filix femina* | None | Wet fringe | 38 | 83 | | 12 |
| | *Blechnum spicant* | None | Wet fringe | 49 | 83 | | 12 |

TABLE 8 Continued

| Group | Species | Center of importance | Other distribution | Limits of TGI Min | TGI Max | PMS Min | PMS Max |
|---|---|---|---|---|---|---|---|
| 17 | *Fragaria vesca* var *bracteata* | None | Dry fringe | All | | 10 | |
| 18 | *Pyrola asarifolia* | None | 2 of three extremes absent | 38 | 98 | | 21 |
| | *Pyrola picta* | None | 2 of three extremes absent | 38 | 93 | | 19 |
| | *Rosa gymnocarpa* | None | 2 of three extremes absent | 38 | | All | |
| | *Asarum caudatum* | None | 2 of three extremes absent | 38 | 87 | | 18 |
| | *Corallorhiza mertensiana* | None | 2 of three extremes absent | 38 | 82 | | 18 |
| | *Pachistima myrsinites* | None | 2 of three extremes absent | 38 | | All | |
| | *Disporum hookeri* | None | 2 of three extremes absent | 38 | 98 | | 21 |
| 19 | *Galium triflorum* | None | All except coldest | 38 | | All | |
| | *Rubus ursinus* | None | All except coldest | 38 | | All | |
| | *Adenocaulon bicolor* | None | All except coldest | 38 | | All | |
| | *Vaccinium parvifolium* | None | All except coldest | 38 | | All | |
| | *Trientalis latifolia* | None | All except coldest | 38 | | All | |
| | *Symphoricarpos mollis* | None | All except coldest | 38 | | All | |
| 20 | *Anemone deltoidea* | None | All | All | | All | |
| | *Chimaphila menziesii* | None | All | All | | All | |
| | *Trillium ovatum* | None | All | | 98 | | 21 |
| | *Goodyera oblongifolia* | None | All | All | | All | |

or the best silvicultural technique to use) to be predicted from the flora of the site In many cases the environmental indexes derived from indicator plants are effective predictors of the measured environmental index (Waring and Major 1964 Griffin 1967 Waring et al 1972 Minore 1972) However it is stressed that their use should be confined to the region studied (Griffin 1967 Minore 1972 MacLean and Bolsinger 1973) Within our study area most species grow in a variety of habitats although some preferential species are recognized (Dyrness et al 1974) When species importance values are plotted on a TGI PMS diagram a number of distributional types emerge (Tables 7 and 8) Species with very low cover or low constancy in all communities were not considered in compiling these data

The ranges of TGI and PMS within which a species occurs in our area were compared with the habitat ranges of the species studied elsewhere in the Northwest Most species which Waring (1969) considered sufficiently restricted in distribution to have indicator value were less restricted in our area (Table 9) Most species used as moisture indicators occupied drier environments in our area than they did in the eastern Siskiyous Several plants used as temperature indicators in the Siskiyous extended to both warmer and cooler environments in our study area and almost all occupied warmer habitats General comparisons possible with other gradient analyses in southern Oregon (Whittaker 1960 Minore 1972) show the same type of difference i e many species occupying environments relatively drier or warmer in our study area than they do further south Such differences are not surprising Higher rainfall and humidity a shorter dry season or different competitive pressures in our area may allow the expansion of species into the warmer drier habitats as defined by our indexes

Comparisons with species distribution patterns from the redwood region of California (Waring and Major 1964) reveal no general pattern of differences Many species have an apparently broader range in our area (*Gaultheria shallon* *Achlys triphylla* and *Acer macrophyllum* for example) Some species (*Oxalis oregana* and *Polystichum munitum*) are more restricted to the wetter habitats here than they are in the redwood region *Rhus diversiloba* on the other hand is more restricted to dry habitats in our study area *Libocedrus decurrens* is limited to the warmest (and driest) habitats here but to the coolest (and driest) in northwestern California

Interpretation of the significance of these TGI and PMS limits (Tables 7 8 and 9) is somewhat difficult as the relative effects of biotic and abiotic factors on range limitation are unknown Within one small area in the southern Appalachians some tree species were apparently limited by environment one by competition and others by a combination of the two (Mowbray and Oosting 1968) The mix of com

TABLE 9 Environments occupied in the central western Cascades by species with indicator value in the eastern Siskiyou Mountains (Waring 1969) TGI = Temperature Growth Index PMS = Plant Moisture Stress (TGI is numerically equivalent to Waring s Optimum Temperature Days)

| Species | TGI | | PMS (bars) | |
|---|---|---|---|---|
| | Siskiyou | W Cascades | Siskiyou | W Cascades |
| *Lathyrus polyphyllus* | | | 5–10 | 21 up |
| *Rhus diversiloba* | 80–100 | 93 up | 15–25 | 20 up |
| *Whipplea modesta* | 60–90 | 67 up | 5–10 | 9 up |
| *Corylus cornuta* | 70–100 | 67 up | | |
| *Linnaea borealis* | 50–80 | 38 up | 5–15 | All |
| *Viola sempervirens* | | | 5–10 | All |
| *Campanula scouleri* | | | 5–15 | All |
| *Viola glabella* | | | 5–10 | 8–9 18 |
| *Arnica latifolia* | | | 5–15 | 8–10 |
| *Clintonia uniflora* | | | 5–10 | 8–18 |
| *Pyrola secunda* | 30–60 | 32–80 | 5–15 | 8–18 |
| *Tiarella unifoliata* | | | 5–10 | 8–18 |
| *Xerophyllum tenax* | 40–80 | All | | |
| *Smilicina racemosa* | 30–60 | All | | |
| *Pachistima myrsinites* | 40–80 | 38 up | | |
| *Disporum hookeri* | | | 5–15 | 8–21 |
| *Galium triflorum* | | | 5–15 | All |
| *Rubus ursinus* | 60–90 | 38 up | | |
| *Adenocaulon bicolor* | 70–90 | 38 up | 5–15 | All |
| *Anemone deltoidea* | | | 5–15 | All |
| *Trillium ovatum* | | | 5–15 | All |
| *Goodyera oblongifolia* | | | 5–15 | All |

petitive and environmental limitation undoubtedly changes within a species range as the flora and environment simultaneously vary from place to place We have no basis for separating these two limitations This confuses the interpretation of the meaning of the species limits given here and emphasizes the statement that their utility is strictly local

## Community Distribution in Relation to Environment

### *Communities in relation to measured environmental gradients*

Much of the variation in community ordinations in our area is associated with the temperature and moisture indexes TGI and PMS Nutrition influences community composition most obviously on the nitrogen poor sites A two dimensional environmental field separates the reference stands (and therefore presumably the communities they represent) in a useful manner (Fig 7) It illustrates the importance of TGI in differentiating vegetation zones and the usefulness of PMS in arraying communities within the warmer *Tsuga heterophylla* zone The portion of this environmental field which is occupied in our area is similar to the eastern Siskiyou Mountains (Waring 1969) although vegetation composition differs appreciably between the two regions

The array of communities in the two factor environmental field (Fig 7) generally reflects the conclusions based on synecological work alone (Fig 2 Dyrness et al 1974) The only major discrepancy between Figs 2 and 7 is the lack of sites with high growing season moisture stress in the *Abies amabilis* zone as originally had been predicted

Past studies of vegetation along environmental gradients have shown that factors related to temperature moisture available nutrients and mechanical stress often correlate with the observed vegetation pattern Usually only two or three of these major factors are concluded to be of prime importance for any single area Earlier work of this nature is reviewed by Waring and Major (1964) in this paper we consider the more recent work of particular significance to our area

Chemistry of the soil plays an important role in distinguishing vegetation in the Klamath Mountain and redwood regions (Whittaker 1960 Waring and Major 1964 Waring 1969) and in the Bighorn Mountains of Wyoming (Despain 1973) In several western mountain systems soil differences are important only at a secondary level in accounting for the vegetation pattern (Whittaker and Niering 1965 Daubenmire and Daubenmire 1968 Fonda and Bliss 1969 Minore 1972) However on Vancouver Island nutritional factors do apparently modify the moisture induced pattern in *Pseudotsuga* forests (McMinn 1960) All these authors with others (Griffin 1967 Brooke et al 1970 del Moral 1972) emphasize the role of moisture in influencing forest pattern most also use a temperature gradient of some type

At higher elevations snow plays an important role via mechanical force as well as modifying temperature and moisture regimes (Daubenmire and Daubenmire 1968 Fonda and Bliss 1969 Brooke et al 1970 del Moral 1972) Rapid changes in vegetation may occur at the usual elevations of a winter freezing isotherm presumably associated with snowpack accumulation (Brooke et al 1970)

In our area a temperature index proved most important for distinguishing major vegetation zones whereas moisture factors differentiated communities only within the warmer zone Some minor exceptions apparently were due to soil nutrient availability This appears similar to the Olympic Mountains (Fonda and Bliss 1969) and to the more mesic series of forest communities in northern Idaho and eastern Washington (Daubenmire 1956 Daubenmire and Daubenmire 1968) where weather bureau data

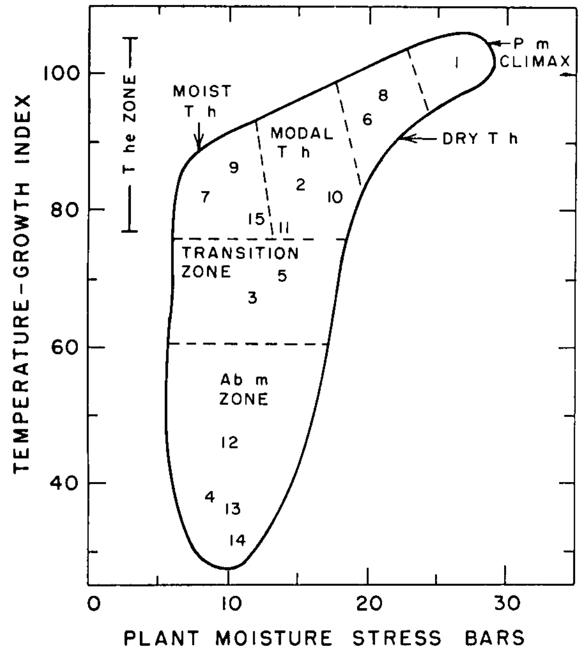


FIG 7 Position of reference stands in a two dimen sional environmental field Temperature is represented by Temperature Growth Index computed by the method of Cleary and Waring (1969) Moisture is assessed as the late summer predawn moisture stress on conifer saplings (plant moisture stress) Most data are for 1972 Psme = *Pseudotsuga menziesii* Tshe = *Tsuga heterophylla* Abam = *Abies amabilis* The community represented by each reference stand is listed in Table 2

were correlated with vegetation pattern over a large area Measurements of soil moisture confirmed that no differences in drought exist between the upper forest zones in the northern Rocky Mountains (Daubenmire 1968) There drought differentiates the lower forest zones from each other and from the *Tsuga heterophylla* series but was not severe in the upper elevation zones Extension of our study to the vegetation zone adjacent to the lower limits of our *Tsuga heterophylla* zone (the *Quercus Pseudotsuga* forest and woodland of foothills surrounding the Willamette Valley) would almost certainly show a parallel difference in our area with PMS differentiating most *Tsuga heterophylla* zone communities from most foothill woodland communities Our *Pseudotsuga* climax community drier than the other *Tsuga heterophylla* zone communities is also a parallel situation in this way to the *Pseudotsuga* zone in the northern Rocky Mountains Some of Waring s (1969) drier forest types in the eastern Siskiyous are differentiated from each other by PMS although the majority differ primarily in temperature Waring s type is a narrower unit than our zone but broader than our community

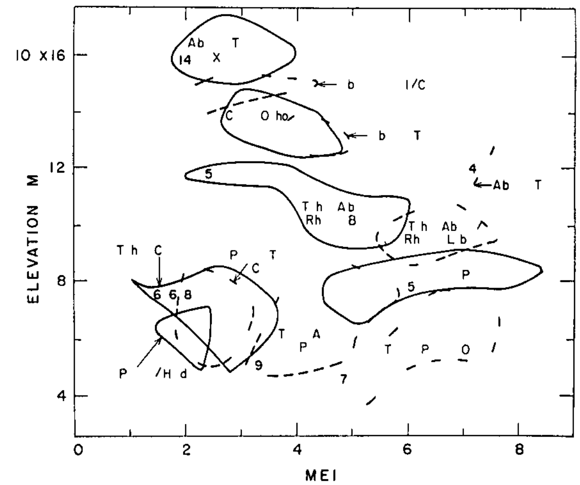


FIG 8 Mosaic chart showing the usual location of climax forest communities in relation to elevation and a master environmental index (MEI) computed from topo graphic and soil characteristics (0 = xeric 9 = mesic) These are the more restricted communities Each enclosed figure includes at least 80% of the stands A total of only 10 stands fall outside the figures shown Numbers identify reference stands Community abbreviations are identified in Table 1

*Communities in relation to complex gradients*

The distribution of communities in relation to the temperature and moisture gradients may be com pared with their distribution in relation to complex gradients (Whittaker 1967) C T Dyrness J F Franklin and W H Moir (*unpublished observa tions*) computed a Master Environmental Index (MEI) for their reconnaissance plots Four environ mental variables representing topography and soils were assigned scaling factors of from 1 to 10 where 1 represented the most xeric and 10 the most favor able condition of each factor

$$MEI = \tfrac{1}{2}\ \{X_1 + [(X_2 + X_3 + X_4)/3]\}$$

where $X_1$ = factor for topographic location
$X$ = factor for soil series incorporating ef fects of texture and other properties
$X_3$ = factor for estimated rooting depth and
$X_4$ = factor for soil stoniness

A two dimensional environmental field was again constructed this time using elevation and MEI as the axes Figures 8 and 9 show this relationship for the climax communities The enclosed area shown for each community includes at least 80% of the stands measured To be excluded from the enclosed figure for its community a point if included would have had to increase the enclosed area by at least 30% Most of the communities include only a small portion of the total field (Fig 8) and in some cases

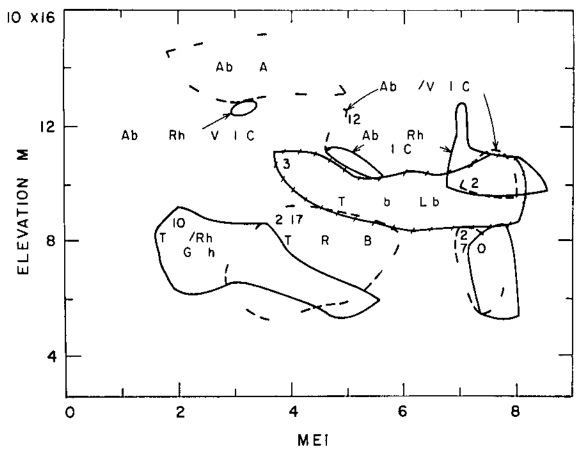


FIG 9 Same as Fig 8 showing locations of five widely distiibuted climax communities

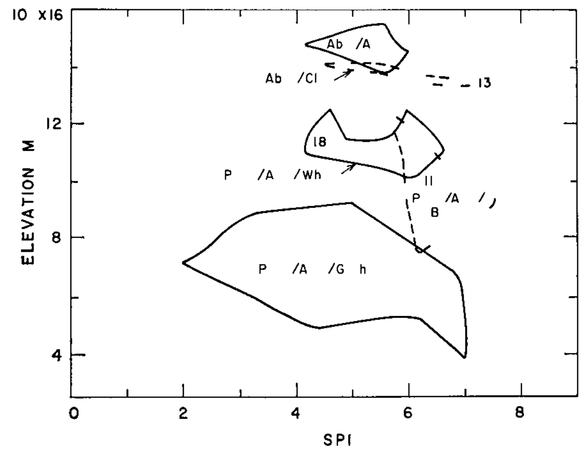


FIG 10 Mosaic chart showing locations of five seral forest communities in relation to elevation and a soil profile index (SPI) (0 = xeric 9 = mesic)

the overlap between communities is not very large However there are several communities with a broad or a bimodal MEI distribution (Fig 9) which greatly overlap some of the more restricted com munities The bimodal nature is a consequence of variation in topographic location not the soil factors included in MEI

Comparison with the PMS TGI ordination shows several differences between the two methods of de fining the environmental field (Figs 8 and 9 vs Fig 7) The complex gradient diagram suggests that the mid to high elevation communities are mostly xeric whereas the PMS at all those measured is quite low At lower elevations the MEI axis shows differences between communities which are relatively smaller than those shown by PMS The temperature dif ferences between zones and the temperature patterns within zones are not as apparent using the elevational axis Of course some overlap in communities could be expected if several stands per community were measured for PMS and TGI but this probably would not correct the distortions mentioned above The MEI axis constructed to represent a mesic to xeric scale has different meanings at different elevations in terms of actual moisture stress

The dispersion of the five climax communities which show a bimodal distribution on Figs 8 and 9 is more restricted if one uses a Soil Profile Index (SPI = $[X_2 + X_3 + X_4]/3$) as the $X$ axis rather than MEI All the seral communities are better separated by SPI than by MEI (Fig 10) Their pat tern of occurrence is probably greatly influenced by historical factors The single community at low ele vations occupies a very wide range of soil variation

*Advantages of measured environmental gradients*

Using measured environmental gradients has several definite advantages although many workers choose to identify only complex gradients rather than measuring one or a few factors to represent the en vironmental changes along these gradients One would expect an elevational complex gradient in our area to consist substantially of temperature related factors with modifications in intensity related to the depth and persistence of the snowpack The com plex gradient referred to in topographic terms is pri marily a moisture gradient (Whittaker 1967) In many cases no single factor can be isolated which varies over the entire gradient of vegetation (John son and Risser 1972) making measurement of two or more factors imperative That one or two mea sured factors do correlate well with the vegetation gradient does not necessarily imply that they are the sole causal agent(s) of the pattern of course For example Mowbray and Oosting (1968) found the clay/sand ratio in the soil to be the factor best cor related with tree importance and growth Their dis cussion emphasizes that besides direct influences on plants via soil aeration and moisture retention this ratio integrated many microclimatic factors operating over a long time

Despite the uncertainty as to the degree of causal influence that a measured environmental factor has we believe that gradient quantification is a worthwhile endeavor A working knowledge of the nature of effective environmental gradients is necessary to gain understanding of the adaptive strategies of the popu lations involved and to generate testable hypotheses about the specific competitive and selective forces acting on these populations For example a moisture gradient may involve either (or both) atmospheric and soil moisture Adaptive responses to a moisture gradient vary depending on the exact nature of the gradient Grand fir saplings on the more arid east slope of the Oregon Cascades are indeed subject to greater evaporative stress than west slope populations but maximum measured plant moisture stresses are below those of west slope populations the reverse of the situation expected These populations exhibit stomatal reaction patterns which are related to the differences in the type of moisture stress to which they are subjected (Zobel 1974 1975)

Complex gradients are often defined in physio graphic and elevational terms However topographic position does not effectively differentiate most vegeta tion types in our area (J F Franklin C T Dyrness and W H Moir *personal observations*) Reversal of the aspect occupied by a forest type occurs as eleva tion increases on many mountain systems as seen in complex gradient mosaic charts from these areas (e g Whittaker and Niering 1965) This physio graphic reversal of a vegetation type as elevation increases is well developed in the southern Rocky Mountains The reversal is absent from the upper vegetation zones of the northern Rocky Mountains which are especially affected by moist westerly winds and it is suggested that it also should be absent on the western slopes of the Cascades (Daubenmire and Daubenmire 1968) In our *Tsuga heterophylla* zone communities the highest plots of each vegetation type are indeed only rarely on topography considered to be relatively xeric nor are the lower ones con sistently mesic (Figs 8 and 9) In the *Abies amabilis* zone the patterns are less clear cut about half the types having highest plots on relatively xeric topo graphic positions The degree of aspect elevation compensation is hardly consistent among mountain systems

The mosaic chart with complex gradients as its axes is a useful device for visualizing what a vegeta tion pattern looks like in the field However its use to decipher autecological relationships of species may lead to distortions The environmental field of a mosaic chart includes all possible combinations of factors defining it In studies using quantified gradients all possible combinations of two factors seldom if ever occur Gradients such as wet fertile to dry sterile (Monk 1965) may be found without the other possible combinations (dry fertile wet sterile) Measured environmental fields lack many types of combinations of factors low temperature mesic and mesic infertile (Waring and Major 1964) or cool xeric and hot mesic (Waring 1969 and this study) The few plots on which unusual conditions have been measured (e g cool xeric in our area) have vegetation of limited extent and of very little significance in a regional context (Zobel 1975 and *personal observations*) Thus the implication of the full field mosaic chart is contrary to the observed en vironmental patterns It is probably unusual to have all topographic and soil conditions occurring at all elevations

The aspect elevation relationships of vegetation which occur in many areas may lead to a shift toward the mesic with elevation for many species This could be interpreted as a change in species response to moisture when the explanation is more likely a shift in the moisture availability on a given topo graphic position However use of direct measure ments as axes of an environmental field (Fig 7) tends to prevent this ambiguity Furthermore the degree of aspect elevation compensation varies as discussed above complicating the interpretations Finally the length of the complex moisture gradient may represent a very different plant moisture stress gradient at different elevations as we found for our area

The use of complex gradients does avoid giving the impression that vegetation pattern responds to only one or two factors of the environmental complex However such distortions as mentioned above make formation of autecological hypotheses from vegeta tion patterns displayed in these charts more difficult than if measured gradients are used

## Species Diversity in Relation to Environment

### *Species richness*

Whittaker (1972) suggests species number per unit area as the most generally appropriate measure of diversity within a community ($\alpha$ diversity) we use species number in this study The stand samples analyzed by Dyrness et al (1974) were not on measured quadrats but should be uniform enough and large enough to eliminate any major errors in comparison of species numbers Community descrip tions are based on a composite of 7–22 stand samples per community This variation in sample size could affect our estimate of species number in each com munity however it does not seem to have a great effect as correlation of species richness with number of samples in a mean for a community gives $r^2 =$ 0 005

Alpha diversity is presented here both as species number in the composite community sample and as the average number of species per stand sample within each community These two measures vary in a somewhat parallel manner with $r = 0\ 66$ Com parison of richness to TGI PMS coordinates shows approximately the same pattern whether composite species number or species number per sample is used (Fig 11) In our area diversity increases away from the moderate environmental conditions toward both cooler and more xeric environments with the sole exception of the *Abies Tsuga/Xerophyllum* commu nity (TGI = 32)

Study of the relationship of species diversity to environmental conditions has not led to any widely acceptable generalities (Whittaker 1972) In some

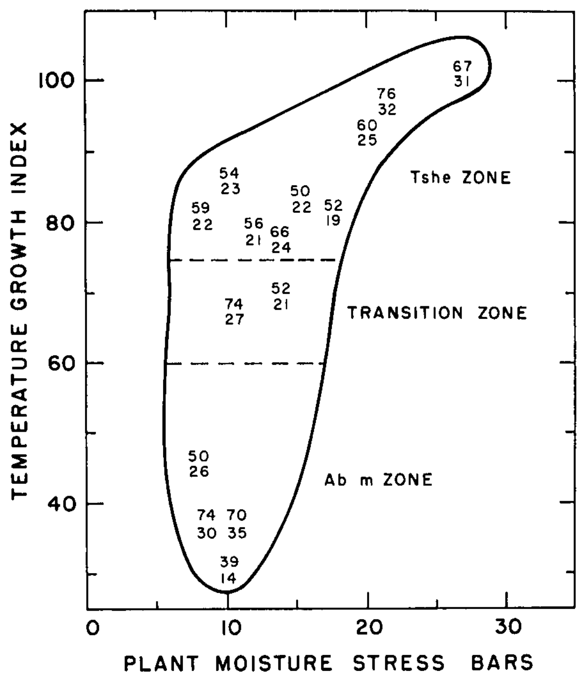


FIG 11 Vascular species diversity (number of species) of forest communities in relation to temperature and moisture conditions at the reference stand representing it The top figure is the species number in the composite sample the bottom is the average species number per stand sampled The reference stand at each position is identified in Fig 7

cases diversity is highest in more mesic communities in others it is not Terborgh (1973) states that the general case in temperate North American vegetation is to have greatest species number in the middle part of a moisture gradient rather than in wetter or drier areas This is contradicted by our study as well as several others (cited in Whittaker 1972 del Moral 1972) One must consider the relative xeric mesic hydric range which occurred in each study In our area the wettest sites did not appear too wet for optimum growth of the dominants This is probably also true in Whittaker s studies cited by Terborgh (1973) However in other studies he cites very wet areas were included A comparison of diversities at the midranges of moisture gradients which have greatly different end points of hydrism and xerism (Terborgh 1973) should not it seems allow strong inference from the results

Often diversity in one stratum of vegetation cannot be predicted from the diversities of the other strata (Whittaker 1972) This is also true for this study That diversities of d fferent strata are unrelated is indicated by th $r$ between species richness of layers tree shrub = 0 01 shrub herb = 0 02 and tree herb = 0 06

The dominance of one stratum (as opposed to its diversity) may affect the diversity of another (Whittaker 1972) The greater herb diversity on dry sites in our area contrasts to findings for some temperate forests (Daubenmire and Daubenmire 1968) but is similar to others (Rochow 1972) This pattern may result from a less dense canopy cover over these dry sites leading to greater light intensities The reduced tree density should also cause greater availability of nutrients and water less chance of allelopathic influence and a greater variety of available microhabitats (Daubenmire and Daubenmire 1968 del Moral 1972 Rochow 1972 Whittaker 1972) In our study the number of herbaceous species was inversely related to the percent cover of evergreen trees and shrubs in the community ($r^2 = 0\ 38$ $n = 22$ excluding the *Abies Tsuga/Xerophyllum* community) Using seral communities alone this $r^2$ was 0 74 ($n = 5$) The model for control of forest species diversity (del Moral 1972) suggests that conditions on our *Pseudotsuga* climax and *Abies amabilis* zone sites are rigorous enough to cause a more open canopy but are not rigorous enough to greatly deplete the flora The net effect is increased diversity The *Abies Tsuga/Xerophyllum* community on the other hand apparently has an environment rigorous enough to delete many of the less hardy species thus decreasing diversity

On a given site in many temperate forests species richness may increase for some time and then decrease with canopy closure and establishment of strong dominance (Whittaker 1972) In our area the seral communities average more species than the old growth communities (68 vs 60 total 29 vs 25 per stand)

The degree to which species composition changes along environmental gradients within an area is termed $\beta$ diversity A simple and generally appropriate measure of $\beta$ diversity is (BD – 1 0) where BD = $Sc/\bar{S}$ $Sc$ being the number of species in the composite sample and $\bar{S}$ the average number of species in the communities (Whittaker 1972) The total vascular $\beta$ diversity of our study area is 1 473 $\beta$ diversity is somewhat lower for trees and shrubs (1 26 and 1 25) and higher for herbs (1 63)

Gamma diversity is the species richness in a particular range of habitats The forests studied by Dyrness et al (1974) include 153 vascular species However the total flora is much larger and is probably estimated best from Franklin and Dyrness (1971) who list 480 vascular plants in the H J Andrews Forest This latter number includes a few introduced tree species and many species characteristic of meadows and disturbed areas (e g clearcuts)

*Species dominance*

Communities vary in the degree to which some measure of importance is shared among the species

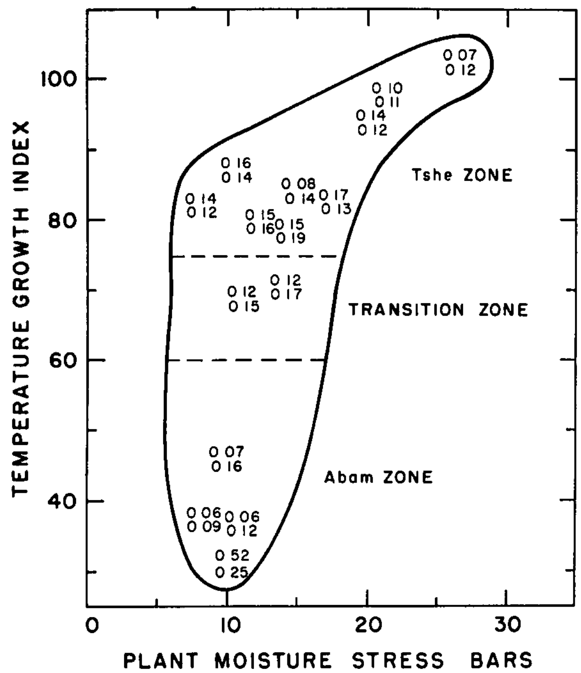


FIG 12 Dominance (Simpson s index) in relation to temperature and moisture conditions of the reference stands representing each community The top figure is calculated for all vascular species the bottom for shrubs and herbs only Percent cover is the measure of importance

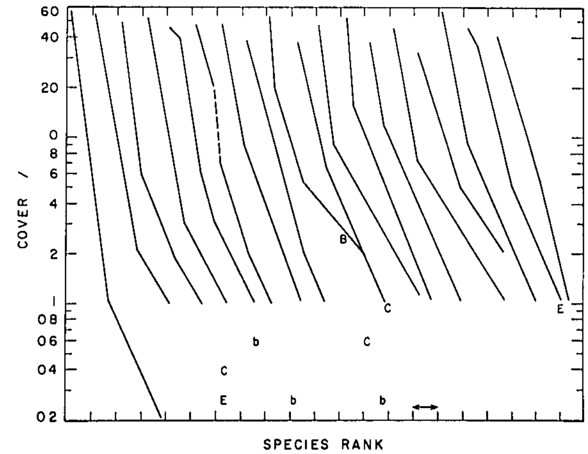


FIG 13 Dominance diversity curves for climax communities in the central western Cascades constructed for the 20 most important species in the composite sample for each community Curves are ordered by the percent cover of the 10th species from lowest to highest (i e approximately the steepest to flattest slope in the top half of the line) Numbers refer to reference stands Tables 1 and 2 identify communities

present called equitability or conversely the concentration of dominance We chose a simple measure of the concentration of dominance Simpson s index ($C$)

$C = \sum_{=1} p^2$ where $s$ is number of species in the collection and $p_i$ is the proportion of the importance value belonging to the $i$th species Whittaker (1972) suggests that this index is appropriate for communities exhibiting strong dominance as ours do We used average percent cover in the composite community sample as our measure of importance

Dominance varies considerably among communities (Fig 12) generally being more pronounced in lower elevation and seral stands *Abies amabilis* zone $C = 0\ 115$ *Tsuga heterophylla* zone $C = 0\ 140$ seral communities $C = 0\ 148$ climax communities $C = 0\ 126$ However the *Abies Tsuga/Xerophyllum* community which is excluded from the means has a very high dominance When tree species are excluded from the calculations the same generality holds for zones but the understory dominance is similar in both seral and climax stands Vascular dominance and especially understory dominance generally decrease away from the area of moderate environment toward the dry and the cold communities (Fig 12) Thus species richness and dominance are generally negatively related $C$ values are generally in the range of those found by del Moral (1972) for the Wenatchee Mountains

## DOMINANCE DIVERSITY CURVES

Another way to look at dominance diversity relationships is to plot the log of importance of species (cover in our case) over species rank of importance Different shapes of the resulting curve should theoretically arise depending on the type of theory one invokes for determining how niches are occupied (Whittaker 1972) Curves for the 20 most important species of each composite community sample (Dyrness et al 1974) are of a form generated by a geometric series (Fig 13) theoretically produced by the hypothesis of niche preemption Such a form is often exhibited by vascular plant communities of low diversity (Whittaker 1972) All our curves have a somewhat similar steep initial slope However all except one have at least two parts with the slope decreasing after 3–10 species This broken curve appears to represent two groups of plants the first group is the dominant trees and the most important understory species the other the rest of the lower strata These groups have somewhat different dominance relationships as indicated by the slope of the lines with the less important species groups having a smaller degree of dominance

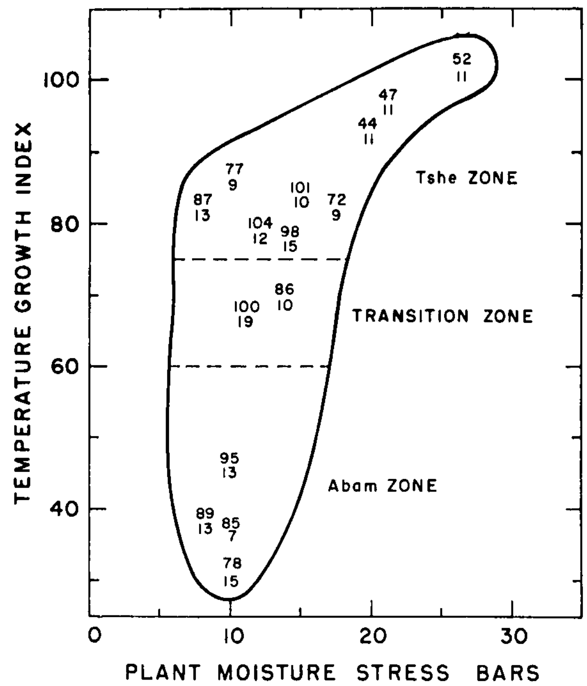


FIG 14 Percent cover by mature trees (top figure) and tree reproduction (bottom figure) in relation to temperature and moisture conditions Cover figures are the sum of cover for individual species and thus may exceed 100%

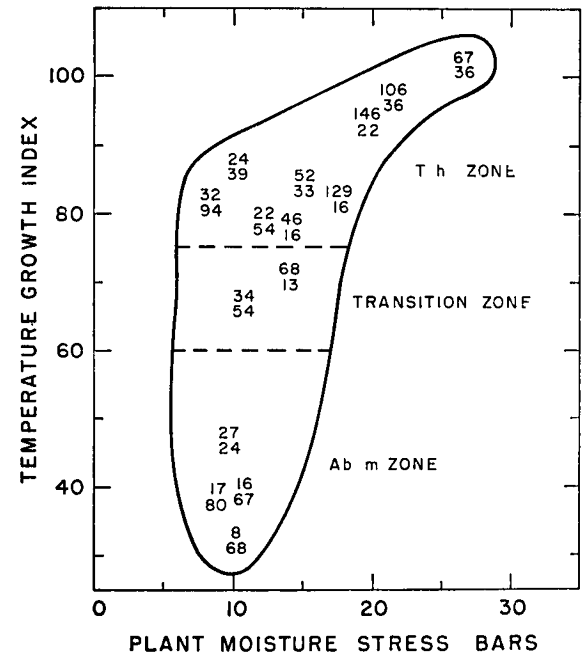


FIG 15 Percent cover by shrubs (top figure) and herbs (bottom figure) in relation to temperature and moisture conditions Cover figures are the sum of cover for individual species and thus may exceed 100%

## COMMUNITY STRUCTURE IN RELATION TO ENVIRONMENT

The coverage of each stratum has its own pattern in relation to the environment Tree cover is greatest in moderate environments decreasing toward all extremes especially the dry stands (Fig 14) Shrub cover is highest in the warm dry stands and lowest in the coldest communities (Fig 15) This is very roughly the opposite pattern found in herbaceous cover (Fig 15) which is high in cold and mesic stands Siccama et al (1970) attribute greater herbaceous importance with elevation in New Hampshire to factors related to a decrease in tree cover and the fact that environmental change with elevation may be more moderated for the herb layer than for the trees

The communities studied vary considerably in the importance and relative importance of the various strata (Figs 14 and 15) we summarized this property in a manner analogous to computing species dominance Simpson s index was computed considering each of five vascular strata (mature trees tree reproduction tall shrub low shrub and herb) as a unit using the total cover for each stratum from the composite community description A definite pattern emerges from the data Stratum dominance is greatest on the colder sites intermediate on sites of moderate environment and lowest on the dry sites (Fig 16) The *Tsuga/Acer/Polystichum* community is the single exception to this trend Thus dominance is concentrated in fewer growth forms on colder and moister sites

*Acer macrophyllum* the only deciduous canopy tree in the study area accounts for more than 3% tree cover in only three communities (maximum = 7%) However evergreenness in the shrub layer is much more common although it varies markedly from community to community Most low shrub cover is evergreen (63%–100%) especially in warmer stands Percent evergreenness of tall shrubs varies more being highest in the moderately warm dry stands and decreasing in all directions The absolute amount of evergreen tall shrub cover varies in a somewhat similar manner (Fig 17) Interestingly communities with the largest amounts of foliar nitrogen had the lowest evergreen shrub cover (Fig 18)

The concentration of evergreenness on dry sterile sites in the western Cascades follows the pattern described by Monk (1965 1966) for forests of northern Florida He emphasizes the probable role of evergreenness in nutrient conservation this role appears possible from our limited data (Fig 18) Sclerophylly is often associated with evergreenness

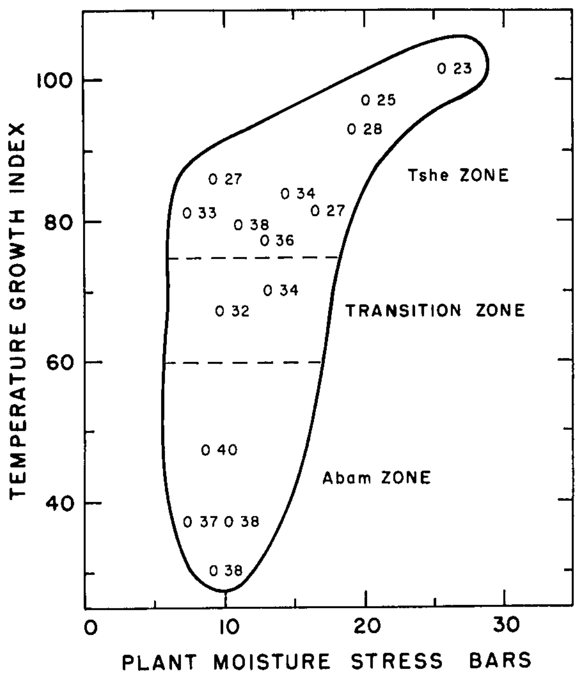


FIG 16 Stratum dominance Simpson s index computed for percent cover of five layers (mature tree tree reproduction tall shrub low shrub and herb) in relation to temperature and moisture conditions

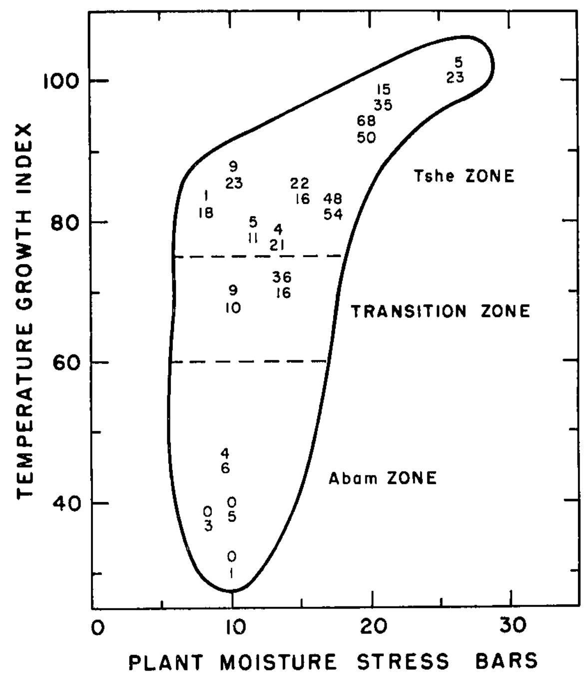


FIG 17 Percent cover by tall (top figure) and low (bottom figure) evergreen shrubs in relation to temperature and moisture conditions

its importance in moisture conservation appears to be of secondary importance or at least to be ineffective on our driest areas The percentage of evergreenness is low in our two driest communities

## SOME IMPLICATIONS OF PATTERNS OF STRUCTURE AND DIVERSITY

The different community properties which we have examined exist in a variety of patterns over the environmental field we defined Species richness increases toward our environmental extremes whereas tree coverage and concentration of dominance decrease toward these extremes Stratum dominance shrub cover and herbaceous cover vary in a more unidirectional manner across the environmental gradients Shrub cover is highest on warm dry sites and the other two are highest on the cooler moister sites The pattern of diversity within a single stratum varies in a manner unrelated to diversity of other strata however herbaceous diversity is related to the coverage of evergreen shrubs and trees

The *Abies Tsuga/Xerophyllum* community (reference stand *14*) although the coldest we measured still has environmental indexes not very different from the *Abies amabilis* zone stands This is reflected in the pattern of structural characteristics the trends set by the adjoining stands extend to stand *14* (Figs 14 15 and 16) However this is not true for the general trends for diversity (Figs 11 and 12) which reverse themselves at stand *14* The sharp discontinuities which occur here reinforce the conclusion based on composition that this community really represents a different vegetational zone (the *Tsuga mertensiana* zone of Franklin and Dyrness 1973) and suggest that major changes occur here which are not reflected in our environmental indexes If such dis

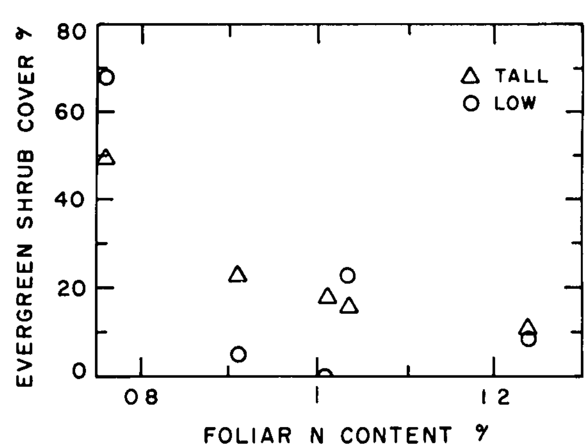


FIG 18 Percent cover by evergreen shrubs in relation to summer N contents of needles of conifer saplings Nutrient data are for *Tsuga heterophylla* or *Pseudotsuga menziesii*

continuities in the relationship of diversity to environment occur frequently in vegetation generally applicable models of community diversity would be very complex and difficult to conceptualize This may explain why widely acceptable models relating diversity to environment have not been developed


### Acknowledgments

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INTERNATIONAL BIOLOGICAL PROGRAMME

SECTION CT CONSERVATION OF TERRESTRIAL BIOLOGICAL COMMUNITIES

## CHECK SHEET (Mark VII) FOR SURVEY OF IBP AREAS

To be completed with reference to the GUIDE TO THE CHECK SHEET

Serial Number

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1

1 Name of surveyor Jerry F Franklin

2 Address of surveyor FORESTRY SCIENCES LABORATORY
PACIFIC NORTHWEST FOREST AND
RANGE EXPERIMENT STATION
P.O BOX 887
CORVALLIS, OREGON 97330

3 Check Sheet completed (a) on site ✓ (b) from records ✓

4 Date Check Sheet completed JUNE 20, 1971

2

1 Name of IBP Area WILDCAT MOUNTAIN RESEARCH NATURAL AREA

2 Name of IBP Subdivision (or serial letter)

3 Map of IBP Area* showing boundaries attached? Yes ✓ No

4 Sketch map of IBP Area* Please mark direction of north the scale and grid numbers where applicable

* For IBP Area read IBP Area and/or IBP Subdivision

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3 **Location of IBP Area***

1 Latitude 44° ° 20' N/S Longitude 122 ° 06' E/W

2 Country UNITED STATES OF AMERICA

State or Province OREGON County LINN

(State or Province County )

4 **Administration**

**National** 1 Official category FEDERAL RESEARCH NATURAL AREA

2 Address of administration

Pacific Northwest Forest &
Range Experiment Station
P O Box 3141
Portland Oregon 97208

**International Class**

3

| Included in U N List | Rejected from U N List | Area with formal conservation status | No formal cons status |
|---|---|---|---|
| (A) | (B) | (C) ✓ | (D) |

5 **Characteristics of IBP Area***

1 Surface area (state units of measurement) 405 HA

2 Altitude (state units of measurement) Maximum 1,632 M

Minimum 1,160 M

6 **Climate**

Nearest climatological station

1 Name WILLAMETTE BASIN SNOW LABORATORY, OREGON

2 Climatological station on IBP Area*? Yes No ✓

3 If (2) not distance from edge of IBP Area* (state units) 1 KM.

4 Direction from IBP Area* WEST

5 Additional data sheet attached? Yes ✓ No

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7 **Vegetation and Soil**

1 **Vegetation**

| Community Reference Number | Vegetation Code: Primary Structural Group | Class | Group | Formation | Sub Formation | Plant communities (give usual name using full Latin names of a species where applicable) | Area (state units) HA |
|---|---|---|---|---|---|---|---|
| 1 | 1 | A | 1 | 7a | e | Abies procera / Clintonia uniflora | 209 (1–2) |
| 2 | 1 | A | 1 | 7a | e | Abies procera / Achlys triphylla | |
| 3 | 1 | A | 1 | 7a | e | Abies amabilis - Tsuga mertensiana / Xerophyllum tenax | 22 |
| 4 | 1 | A | 1 | 7a | e | Abies amabilis / Vaccinium membranaceum / Xerophyllum tenax | 38 |
| 5 | 1 | A | 1 | 7a | e | Pseudotsuga menziesii / Acer circinatum / Berberis nervosa | 17 |
| 6 | 1 | B | 2 | 1a | e | Alnus sinuata / Carex spp | 117 (6–8) |
| 7 | 1 | N | 2 | 1 | | Rubus parviflorus - Pteridium aquilinum | |
| 8 | 1 | N | 2 | 1 | | Arctostaphylos uva-ursi / Eriogonum compositum | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
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| 13 | | | | | | | |
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| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |

Please give information about further communities on a separate sheet

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7 (cont ) 2

**Soil**

| Community Reference Number | Soil type | Other notes |
|---|---|---|
| 1 | $F_5$ | BROWN PODZOLIC SOILS WITH MINIMAL A2 |
| 2 | $F_5$ | " " |
| 3 | $F_5$ | " " |
| 4 | $F_5$ | " " |
| 5 | $F_8$ | " " |
| 6 | $F_3$ | |
| 7 | $F_3$ | |
| 8 | $I_2$ | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |

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8 **Similar Communities in Country (or State)**

| Community Reference Number | Protected | | | | | Protected and Unprotected | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Abundant | Infrequent | None known | Decreasing | Increasing | Abundant | Infrequent | None known | Decreasing | Increasing |
| 1 | | ✓ | | | | | ✓ | | ✓ | |
| 2 | | ✓ | | | | ✓ | | | ✓ | |
| 3 | | ✓ | | | | ✓ | | | ✓ | |
| 4 | | ✓ | | | | ✓ | | | ✓ | |
| 5 | | ✓ | | | | ✓ | | | ✓ | |
| 6 | | ✓ | | | | ✓ | | | | |
| 7 | | ✓ | | | | ✓ | | | ✓ | |
| 8 | | ✓ | | | | ✓ | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
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| 19 | | | | | | | | | | |
| 20 | | | | | | | | | | |

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9 **Landscape**

1 General Landscape (give brief description) CREST AND UPPER SLOPES OF A MOUNTAIN RIDGE IN STEEP, DEEPLY DISSECTED VOLCANIC MOUNTAIN RANGE

2 Relief Type

| | Flat | Undulating (0) 200 m | Hilly 200 1000 m | Mountainous > 1000 m | / |
|---|---|---|---|---|---|
| Sharply dissected | | | 100 | | 100 |
| Gently dissected | | | | | |
| Incised | | | | | |
| Skeletonised | | | | | |
| / | | | 100 | | 100 / |

3 Special landscape features (list)

10 **Coastline of IBP Area*** NONE

1 Protected bays and/or inlets Many [ ] Few [ ] None [ ]

2 Substratum / of coast

| Rock | Boulder Beach | Shingle Beach | Sand Beach | Shell Beach | Mud | Coral | Ice |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

3 Physiography / of coast

| Cliffed | Sloping | Flat |
|---|---|---|
| | | |

4 Special Coastal Features (list)

5 Tide Maximum range (state units of measurement)

6 Total length of coastline

Less than 1 km [ ] 1 10 km [ ] Above 10 km [ ]

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11 **Freshwater within IBP Area***

1

| | Permanent | Intermittent |
|---|---|---|
| General | | |
| Standing | | |
| Running | ✓ | ✓ |

2 Standing Water

| | Permanent | Intermittent | Unproductive | Productive |
|---|---|---|---|---|
| Swamps | | | | |
| Ponds | | | | |
| Lakes | | | | |

3 Running Water

| | Permanent | Intermittent |
|---|---|---|
| Springs cold | ✓ | |
| Springs hot | | |
| Streams | ✓ | ✓ |
| Rivers | | |

4 Special freshwater features

12 **Salt and Brackish Water within IBP Area*** NONE

| | | | | |
|---|---|---|---|---|
| Salt Lakes | | Lagoon | | |
| Estuaries | | Salt pools | | |

13 **Adjacent Water Bodies (not within IBP Area*)** NONE

1 Fresh [ ] Lake [ ] River [ ] Stream [ ]

2 Salt and Brackish

| Estuary | Salt lake | Salt pool | Lagoon | Ocean | | |
|---|---|---|---|---|---|---|
| | | | | | | |

15 **Exceptional Interest of IBP Area*** List items and salient facts (e g botanical ornithological teaching area site of classic research since 1930 )

16(1) **Significant Human Impact. General** Check one line

(2) **Particular** types of significant human impact Types of human impact additional to the 16 types listed should be entered in the vacant rows Where the impact does not operate today but has operated in the past check past Where it does operate now but did not operate before 1900 check Present only Where a present day impact operated before 1900 check both past and present For all types of present impact check off the trend Only check increasing or decreasing if this is certain otherwise check no certain change

(3) **Additional details on each type of impact attached? Yes/No** Check

17 **Conservation Status** Refers to human influence on material objects within the IBP Area* This influence may be partial in space time or manner

Protection (from exploitation) Refers to current legal position regarding deleterious influence of man If practice falls significantly short of theory this fact should be noted in 19

Utilisation Restrained exploitation to take a long term crop The extent and period of utilisation may be legally limited ( Controlled ) or not ( Uncontrolled )

Conservation Management Utilisation with the primary object of maintaining restoring or creating an ecosystem which has some special interest to biologists Status refers to biological status which may be equated with vegetation type for the purposes of this survey

Permitted Research Observational research does not interfere with the ecosystem Experimental research usually involves interference of some sort

18(1) **List major biological/geographical references for the IBP Area*** Attach list and check

(2) **List main maps available for the IBP Area*** Attach list and check

(3) **Aerial photographs for the IBP Area* available?** Check one space

19 **Other relevant information** Can also be used when there is insufficient space for the answer to another question

**Additional Information**

In a number of sections surveyors are asked to attach additional information when this is available on separate sheets These sections are

2(4) Map of IBP Area*

6(5) Climatological Data

16(3) Significant Human Impact Explanatory notes

18(1) Major biological/geographical references

(2) List of main maps available

**Data Centre**

Completed Check Sheets should be returned to the national organiser or direct to the Data Centre whose address is

IBP/CT Survey
Biological Records Centre
The Nature Conservancy
Monks Wood Experimental Station
Abbots Ripton
Huntingdon England

For Data Centre Use only

14 **Outstanding Floral and Faunal Features**

1 None

2 Fauna

| | Species diversity | Abundance of individuals | Superabundance of individuals | Rare species | Threatened/Relict species | Spp of biogeographical interest | Exceptional Associations | Breeding or Nesting Populations | Migrating Populations | Wintering Populations | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mammalia | | | | | | | | | | | | |
| Aves | | | | | | | | | | | | |
| Reptilia | | | | | | | | | | | | |
| Amphibia | | | | | | | | | | | | |
| Pisces | | | | | | | | | | | | |
| Insecta | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

3 Names of main threatened endemic relict and rare species

Sloping  Cliffed coastlines in which no part is inaccessible to land animals
Flat  Coastlines which lack cliffs and sloping cliffs

(4) **Special coastal features** should be listed accordingly to widely terms (e g reefs sand bars )

(5) **Tide Maximum Range** State units

(6) **Total length of coastline** Check appropriate value

11 **Freshwater within IBP Area***

(1) (2) and (3) Check in the spaces the features which are present Surveyors may insert indications of abundance e g many few etc provided it is clear which features are present and which absent

Definitions

| | |
|---|---|
| General | All types of freshwater |
| Standing | Water not flowing continuously in a definite direction |
| Running | Water flowing in a definite direction |
| Swamp | A lake pond or other site of such small depth that it is occupied ± completely by emergent vegetation |
| Pond | A body of standing water whose area of open water is less than 10 000 m² |
| Lake | A body of standing water whose area of open water is greater than 10 000 m² |
| Spring | A site at which water is issuing through a natural opening in such quantity as to form an appreciable current A hot spring has an average temperature more than 10°C above the yearly mean for the surrounding air |
| Stream | A watercourse or part of a watercourse whose mean width is less than 5 m |
| River | A watercourse or part of a watercourse whose mean width is greater than 5 m |
| Permanent | Never or very rarely disappears All other situations are regarded as Intermittent |
| Productive | Eutrophic waters and those with relatively high biological productivity which are morphometrically oligotrophic |
| Unproductive | Other oligotrophic waters and those of relatively low biological productivity |

(4) **Special freshwater features** should be listed according to widely known terms (e g rapids geysers seasonally inundated land )

12 **Salt and Brackish Water within IBP Area*** Check

13 **Adjacent water bodies** i e those whose margins form part or all of the boundary of the IBP Area* which are therefore not within the IBP Area*

Definitions as follows

| | |
|---|---|
| Freshwater | Salinity generally within the range 15 300 p p m |
| Salt and Brackish water | Salinity above the normal range of freshwater |
| Ocean | Should only be used for the interconnected oceans |
| Salt Lake | A body of standing salt water whose area of open water is greater than 10 000 m² |
| Salt Pool | A body of standing salt or brackish water whose area of open water is less than 10 000 m² |
| Lagoon | Shallow lake formed in association with coral |
| Estuary | Tid l portion of a river mouth |

14(1) **Outstanding Floral and Faunal Features** Check if none known

(2) and (4) Only the presence of outstanding features should be noted by checking the appropriate box No other information is required here we do not want for example the number of bird species present inserted under Aves — species diversity because this is not in itself an indication that this number is outstanding Columns have been left vacant for additional types of outstanding feature and additional taxonomic groups may be added in the vacant rows The vacant rows may also be used to give more precise data for the groups listed e g if the outstanding interest centres on the Carnivora of the Mammalia Carnivora may be inserted in a vacant row Always designate taxonomic groups by their Latin name

(3) and (5) **Names of main threatened endemic, relict and rare species** List the species by their Latin names Vernacular names in addition are welcome but not obligatory

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4 Flora

| | Species diversity | Abundance of particular species | Rare species | Threatened/relict species | Spp of biogeographical interest | Exceptional associations | Outstanding specimens | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Angiospermae | | | | | | | | | | | |
| trees | | | | | | | | | | | |
| shrubs | | | | | | | | | | | |
| herbs | ✓ | | | | ✓ | | | | | | |
| grass | | | | | | | | | | | |
| Gymnospermae | | ✓ | | | | | | | | | |
| Pteridophyta | | | | | | | | | | | |
| Bryophyta | | | | | | | | | | | |
| Lichens and Algae | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

5 Names of main threatened endemic relict and rare species

15 **Exceptional Interest of IBP Area***

EXTENSIVE, WELL-DEVELOPED UNDISTURBED STANDS OF ABIES PROCERA

7(2) **Soil**

**Soil Type** Enter the code number for the soil type which occurs under each Community These can be identified in Appendix 2 Where more than one soil type occurs under one Community either the definition of the Community should be revised or an explanatory note should be added under Other notes

**Other Notes** Sub types present should be mentioned together with short descriptions of significant features e g colour humus content depth

8 **Similar Communities in Country (or State)**

This Section will normally refer to the entire Country but in the case of large countries (Australia Brazil Canada China India U S A U S S R ) it should refer to states or provinces (primary administrative subdivisions) All Communities should be considered here — in exactly the same order as in 7 using the Community Reference Number for cross reference

Insert up to four checks in each row

Protected refers to sites of A B and C (see 4(3) above)

Protected and Unprotected refers to all sites within the Country (or State)

None known The Community does not occur elsewhere in the country/state

Infrequent Other examples of the Community exist in the country/state but the loss of any one of them would be a grave depletion of its type

Abundant Other examples of the Community are sufficiently common and widespread that the loss of any one of them would not be a significant depletion of its type

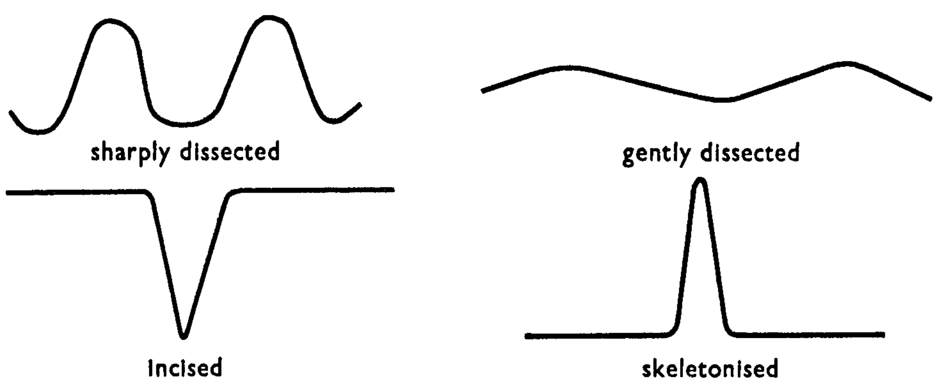
Decreasing/Increasing Insert a check only when the change observed appears to be leading to a permanent change in the status of the Community

9(1) **General Landscape** Describe in less than 50 words Confine description to geomorphological features It is permissible to consider land outside the IBP Area* (see Part 3)

(2) **Relief Type** Check off type(s) present It is possible to consider land outside the IBP Area* (see Part 3)

Altitudinal range divided into four classes of which the lowest is flat in which there is very little variation in altitude

Erosion Types may be illustrated as follows




(3) **Special Landscape Features** should be listed according to widely known terms (e g cliff ice fields dunes recent vulcanism ) Interpret special liberally

10(1) **Protected Bays and Inlets** **Many/Few/None** Check

(2) **Substratum** Insert approximate percentage value for the length of coast occupied by each type of substratum It is possible for the total to exceed 100/ Definitions are as follows

Rock Fixed stable unweathered rock

Beach Mobile or potentially mobile material of which the particle size ranges from very large (boulder) to minute (mud)

(3) **Physiography** Insert approximate percentage value for the length of coast occupied by each type These values should total 100/

Definitions are as follows

Cliffed Wholly or partially vertical with at least some part inaccessible to land animals

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16 **Significant Human Impact**

1 General None in entire IBP Area*

None in part of IBP Area* ✓

Impact on entire IBP Area*

2 Particular

| | Past impact | Present impact | Trend: Increasing | Trend: Decreasing | Trend: No change | Trend: No information |
|---|---|---|---|---|---|---|
| Cultivation | | | | | | |
| Drainage | | | | | | |
| Other soil disturbance | | | | | | |
| Grazing | ✓ | | | ✓ | | |
| Selective flora disturbance | | | | | | |
| Logging | ✓ | | | ✓ | | |
| Plantation | ✓ | | | ✓ | | |
| Hunting | ✓ | ✓ | | | | ✓ |
| Removal of predators | ✓ | ✓ | | | | ✓ |
| Pesticides | | | | | | |
| Introductions — plants | | | | | | |
| Introductions — animals | | | | | | |
| Fire | ✓ | | | ✓ | | |
| Permanent habitation | | | | | | |
| Recreation and tourism | ✓ | ✓ | ✓ | | | |
| Research | | | | | | |
| | | | | | | |
| | | | | | | |

3 Additional details on each type of impact attached?

Yes ✓ No

(2) **Name of IBP Subdivision** To be used only when the IBP Area is divided into two or more IBP Subdivisions IBP Subdivisions for which there is no suitable name should be given a reference letter (a b c etc ) thus distinguishing them from other IBP Subdivisions in the same IBP Area **This question should only be left blank if the Check Sheet refers to an IBP Area.**

(3) **Map of IBP Area* showing boundaries attached?** Yes/No Check

(4) **Sketch map of IBP Area*** This should show

— the shape of the IBP Area*

— its relation to compass directions

— boundaries common with the boundary of the IBP Area (for IBP Subdivisions only)

— major features of the land form and vegetation (e g peaks rivers woods etc )

— sites of field stations and other permanent habitations

3(1) **Latitude and Long tude** Delete the N or S E or W which does not apply

(2) **Country, State or Province, County** Insert names of administrative areas in which the IBP Area* is situated The following levels are recognised

— National or Territorial embracing the whole contiguous area under one political sovereignty **(Country)**

— Regional or Provincial units intermediate between national and local levels **(State or Province)**

— Local e g **county,** parish commune gemeinde etc

Spaces are provided for IBP Areas* which overlap Province or County boundaries

4(1) **National Category,** e g National Park Strict Nature Reserve etc

(2) **Address of Administration** responsible for the IBP Area* Full postal address

(3) **International Class** The following four classes have been adopted Check under the appropriate class

Class A Included in U N List

Class B Considered for inclusion in U N List but rejected These sites are mentioned in Chapter V of the U N List

Class C Other sites at present protected

Class D Unprotected sites of interest to conservationists and biologists

5(1) **Surface area,** may be inserted in any units but please state units

(2) **Altitude Maximum and Minimum** Please state units used

6(1) **Name of Nearest Climatological Station** As used in publications of national climatological organisations

(2) **Climatological Station on IBP Area* Yes/No** Check

(3) **Distance from edge of IBP Area* if outside** State units

(4) **Direction from IBP Area*** Insert compass direction from centre of IBP Area* Use 16 point compass notation (N NNE NE NNW) or degrees (0° 10° 350°)

(5) **Additional data sheet attached? Yes/No** Check

7(1) **Vegetation**

**Plant Communities** List these by their usual names using Latin names for all species mentioned Space is provided for 20 Communities further Communities should be listed on a separate sheet There is no restriction on the methods by which Communities may be defined so long as the Communities so formed can be easily recognised by local scientists Community Reference Numbers are provided to facilitate cross reference between 7(1) 7(2) and 8

**Vegetation Code** The Formation (and sub formation) to which each Community belongs should be entered These Formations (and sub formations) may be identified in Appendix 1 A key is provided to facilitate identification Enter only the code numbers for each Forma tion (and sub formation) placing one digit in each square

**Area** of each Community should be entered to maximum available accuracy

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17 **Conservation Status**

| | Protection | | | Utilisation | | | Conservation Management | | | Permitted Research | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | none | partial | total | none | controlled | uncontrolled | none | to alter status | to maintain status | experimental | observational | prohibited |
| Flora | | | ✓ | ✓ | | | | | ✓ | | ✓ | |
| Fauna | | ✓ | | | ✓ | | ✓ | | | | ✓ | |
| Non living | | | ✓ | ✓ | | | | | ✓ | | ✓ | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

18 **References**

1 List major biological/geographical references for the IBP Area

Sheet attached? Yes ✓ No

2 List main maps available for the IBP Area

List attached? Yes ✓ No

3 Aerial photographs for the IBP Area available?

For whole area ✓ For part of area None

19 **Other Relevant Information**

Signed Jerry F Franklin (Surveyor)

## GUIDE TO THE CHECK SHEET

by G F Peterken

## PART FOUR

### FIELD INSTRUCTIONS

This part is designed to assist the surveyor to fill in the Check Sheet and thereby facilitate the task of the Data Centre in transferring the contents of each Check Sheet to the computer tape It contains all definitions and instructions necessary for completing the Check Sheet except the classi fications of plant formations and soils which are presented in Appendices 1 and 2 respectively Together with these appendices it can be used in isolation from the remainder of the Guide and is therefore suitable for translation in those countries where it is not possible to translate the entire Guide Previous parts explain the purpose and objectives of the survey (Part 1) the selection of sites (Part 2) and the meaning and purpose of each question on the Check Sheet (Part 3) Following this part are four appendices dealing with the classification of Plant Formations classification of soils the Geocode and an example of a completed Check Sheet

**Incomplete Information**

It is likely that for many IBP Areas* the surveyor will not have enough information to complete every question To a limited extent this does not matter for even incomplete returns will contain valuable information Nevertheless there is a minimum number of sections which must be com pleted before a returned Check Sheet can be accepted as adequate **Sections 1 2 3 4 5 and 7(1) must be completed before it is worth sending in a Check Sheet to the Data Centre**

A returned Check Sheet containing only the bare minimum of information will possess only limited worth In practice it is expected that for most IBP Areas* much more information will be available any ecologist reasonably familiar with an IBP Area* should have no difficulty in answering Sections 6 7(2) 9 10 11 12 and 13 in addition to those listed above The remaining Sections — 8 14 15 16 17 and 18 — ask for more detailed information which may not be readily available Since these later sections largely correspond with the conservation content of the Check Sheet it i hoped that surveyors will make every effort to obtain the additional information necessary to com plete the Check Sheet As the number of unanswered questions increases so does the value of the survey decrease

**IBP Area and IBP Subdivision**

**IBP Area** An IBP Area is a site of class A B C or D as defined below under 4(3)

**IBP Subdivision** An IBP Subdivision is part of an IBP Area It is an area variable in extent which is of interest to conservationists and biologists and which is of such size and uniformity that its features can be meaningfully set out on a single Check Sheet

**Notes on Sections**

In the paragraphs below the numbers correspond with the section (question) numbers on the Check Sheet

General rules

(a) Where quantitative information is requested (e g area) this should be given as accurately as possible Estimates are acceptable in the absence of accurate values

(b) In general only positive statements should be made (i e **presence** of a particular feature) but when a feature is known **with certainty** to be absent this may be stated

1(1) **Name of surveyor**

(2) **Address of surveyor**

(3) **Check Sheet completed on site/from records** Check (i e ✓) one or both as applicable

(4) **Date Check Sheet completed**

2(1) **Name of IBP Area** If the IBP Area is Class A B or C (see 4(3) below) insert the name as it appears in the U N List (A and B) or in national lists of protected sites (B and C) For Class D IBP Areas insert the name by which the IBP Area is generally known If the U N List is not available for Classes A and B fill in the name by which the IBP Area is generally known

---

N B * IBP Areas and IBP Subdivisions

INTERNATIONAL BIOLOGICAL PROGRAMME

SECTION CT CONSERVATION OF TERRESTRIAL BIOLOGICAL COMMUNITIES

**CHECK SHEET (Mark VII) FOR SURVEY OF IBP AREAS***

To be completed with reference to the GUIDE TO THE CHECK SHEET

Serial Number

For Data Centre Use only

1
1 Name of surveyor Jerry F Franklin
2 Address of surveyor Forestry Sciences Laboratory
3200 Jefferson Way
Corvallis, Oregon 97330 U S A
3 Check Sheet completed (a) on site ✓ (b) from records ✓
4 Date Check Sheet completed June 15, 1968

2
1 Name of IBP Area Wildcat Mountain Research Natural Area
2 Name of IBP Subdivision (or serial letter)
3 Map of IBP Area* showing boundaries attached? Yes ✓ No
4 Sketch map of IBP Area* Please mark direction of north the scale and grid numbers where applicable

Map Attached

* For IBP Area read IBP Area and/or IBP Subdivision

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3 **Location of IBP Area***

1 Latitude 44 ° 20′ N/S Longitude 122 ° 06′ E/W

2 Country United States of America

State or Province Oregon County Linn

(State or Province County )

4 **Administration**

**National** 1 Official category Federal Research Natural Area

2 Address of administration U S Forest Service
Willamette National Forest
210 E 11th St
Eugene, Oregon 97401
U S A

**International Class**

3

| Included in U N List | Rejected from U N List | Area with formal conservation status | No formal cons status |
|---|---|---|---|
| (A) | (B) | (C) X | (D) |

5 **Characteristics of IBP Area***

1 Surface area (state units of measurement) 1000 acres

2 Altitude (state units of measurement) Maximum 5353 feet a s l

Minimum 3800 feet a s l

6 **Climate**

Nearest climatological station

1 Name Mckenzie Bridge R S

2 Climatological station on IBP Area*? Yes No ✓

3 If (2) not distance from edge of IBP Area* (state units) 10 miles

4 Direction from IBP Area* South

5 Additional data sheet attached? Yes No ✓

Climatic data from the above-mentioned station not representative of the climate on the IBP Area For relevant data see U S Army Engineer reference listed under 18

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7 **Vegetation and Soil**

1

**Vegetation**

| Community Reference Number | Vegetation Code: Primary Structural Group | Class | Group | Formation | Sub Formation | Plant communities (give usual name using full Latin names of a species where applicable) | Area (state units) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | A | 1 | 7a | | Abies procera / Smilacina sessilifolia | 517 |
| 2 | 1 | A | 1 | 7a | | Abies amabilis-Tsuga mertensiana / Xerophyllum tenax | 95 |
| 3 | 1 | A | 1 | 7a | | Tsuga mertensiana / Xerophyllum tenax | 55 |
| 4 | 1 | A | 1 | 7a | | Pseudotsuga menziesii / Abies amabilis / Chimaphila umbellata | 43 |
| 5 | 1 | B | 2 | 1a | | Alnus sinuata-Athyrium filix femina | 50 |
| 6 | 1 | N | 2 | 2 | e | Pteridium aquilinum / Claytonia lanceolata | 40 |
| 7 | 3 | C | | | | Rock outcrop communities | 200 |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |

Please give information about further communities on a separate sheet

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7 (cont )

2

## Soil

| Community Reference Number | Soil type | Other notes |
|---|---|---|
| 1 | $F_4$ | Brown podzolic within minimal A2 horizon |
| 2 | $F_4$ | " " " " " " |
| 3 | $I_1$ | |
| 4 | $F_4$ | Brown podzolic within minimal A2 horizon |
| 5 | $P_2$ | Poorly drained brown podzolics |
| 6 | $F_4$ | A1-C horizon sequence, meadowsoil |
| 7 | $I_2$ | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |

For Data Centre Use only

8 **Similar Communities in Country (or State)**

| Community Reference Number | Protected | | | | | Protected and Unprotected | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Abundant | Infrequent | None known | Decreasing | Increasing | Abundant | Infrequent | None known | Decreasing | Increasing |
| 1 | | | ✓ | | | | ✓ | | ✓ | |
| 2 | | | ✓ | | | ✓ | | | | |
| 3 | | | ✓ | | | ✓ | | | | |
| 4 | | | ✓ | | | ✓ | | | ✓ | |
| 5 | | | ✓ | | | ✓ | | | | |
| 6 | | | ✓ | | | ✓ | | | ✓ | |
| 7 | | | ✓ | | | ✓ | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
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| 13 | | | | | | | | | | |
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| 16 | | | | | | | | | | |
| 17 | | | | | | | | | | |
| 18 | | | | | | | | | | |
| 19 | | | | | | | | | | |
| 20 | | | | | | | | | | |

For Data Centre Use only

9 **Landscape**

1 General Landscape (give brief description) Crest and upper slopes of a mountain ridge in steep, deeply dissected volcanic mountain range

2 Relief Type

| | Flat | Undulating (0) 200 m | Hilly 200 1000 m | Mountainous > 1000 m | / |
|---|---|---|---|---|---|
| Sharply dissected | | | 100 | | 100 |
| Gently dissected | | | | | |
| Incised | | | | | |
| Skeletonised | | | | | |
| / | | | | | 100 / |

3 Special landscape features (list) extensive area of cliffs, rock outcrops, and talus north and east of Wildcat Mtn. summit Remnants of glacial cirque

10 **Coastline of IBP Area***

1 Protected bays and/or inlets Many ☐ Few ☐ None ☐

2 Substratum / of coast

| Rock | Boulder Beach | Shingle Beach | Sand Beach | Shell Beach | Mud | Coral | Ice |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

3 Physiography / of coast

| Cliffed | Sloping | Flat |
|---|---|---|
| | | |

4 Special Coastal Features (list)

5 Tide Maximum range (state units of measurement)

6 Total length of coastline

Less than 1 km ☐ 1 10 km ☐ Above 10 km ☐

For Data Centre Use only

11 **Freshwater within IBP Area***

1

| | Permanent | Intermittent |
|---|---|---|
| General | | |
| Standing | | |
| Running | ✓ | ✓ |

2 Standing Water

| | Permanent | Intermittent | Unproductive | Productive |
|---|---|---|---|---|
| Swamps | | | | |
| Ponds | | | | |
| Lakes | | | | |

3 Running Water

| | Permanent | Intermittent |
|---|---|---|
| Springs cold | | |
| Springs hot | | |
| Streams | ✓ | |
| Rivers | | |

4 Special freshwater features

12 **Salt and Brackish Water within IBP Area***

| | | | | |
|---|---|---|---|---|
| Salt Lakes | | Lagoon | | |
| Estuaries | | Salt pools | | |

13 **Adjacent Water Bodies (not within IBP Area*)**

1 Fresh ☐ Lake ☐ River ☐ Stream ☐

2 Salt and Brackish

| Estuary | Salt lake | Salt pool | Lagoon | Ocean | | |
|---|---|---|---|---|---|---|
| | | | | | | |

15 **Exceptional Interest of IBP Area*** List items and salient facts (e g botanical ornithological teaching area site of classic research since 1930 )

16(1) **Significant Human Impact. General** Check one line

(2) **Particular** types of significant human impact Types of human impact additional to the 16 types listed should be entered in the vacant rows Where the impact does not operate today but has operated in the past check past Where it does operate now but did not operate before 1900 check Present only Where a present day impact operated before 1900 check both past and present For all types of present impact check off the trend Only check increasing or decreasing if this is certain otherwise check no certain change

(3) **Additional details on each type of impact attached? Yes/No** Check

17 **Conservation Status** Refers to human influence on material objects within the IBP Area* This influence may be partial in space time or manner

Protection (from exploitation) Refers to current legal position regarding deleterious influence of man If practice falls significantly short of theory this fact should be noted in 19

Utilisation Restrained exploitation to take a long term crop The extent and period of utilisation may be legally limited ( Controlled ) or not ( Uncontrolled )

Conservation Management Utilisation with the primary object of maintaining restoring or creating an ecosystem which has some special interest to biologists Status refers to bio logical status which may be equated with vegetation type for the purposes of this survey

Permitted Research Observational research does not interfere with the ecosystem Ex perimental research usually involves interference of some sort

18(1) **List major biological/geographical references for the IBP Area*** Attach list and check

(2) **List main maps available for the IBP Area*** Attach list and check

(3) **Aerial photographs for the IBP Area* available?** Check one space

19 **Other relevant information** Can also be used when there is insufficient space for the answer to another question

**Additional Information**

In a number of sections surveyors are asked to attach additional information when this is available on separate sheets These sections are

2(4) Map of IBP Area*
6(5) Climatological Data
16(3) Significant Human Impact Explanatory notes
18(1) Major biological/geographical references
(2) List of main maps available

**Data Centre**

Completed Check Sheets should be returned to the national organiser or direct to the Data Centre whose address is

IBP/CT Survey
Biological Records Centre
The Nature Conservancy
Monks Wood Experimental Station
Abbots Ripton
Huntingdon England

For Data Centre Use only

14 **Outstanding Floral and Faunal Features**

1 None

2 Fauna

| | Species diversity | Abundance of individuals | Superabundance of individuals | Rare species | Threatened/Relict species | Spp of biogeographical interest | Exceptional Associations | Breeding or Nesting Populations | Migrating Populations | Wintering Populations | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mammalia | | | | | | | | | | | | |
| Aves | | | | | | | | | | | | |
| Reptilia | | | | | | | | | | | | |
| Amphibia | | | | | | | | | | | | |
| Pisces | | | | | | | | | | | | |
| Insecta | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

3 Names of main threatened endemic relict and rare species

| | |
|---|---|
| Sloping | Cliffed coastlines in which no part is inaccessible to land animals |
| Flat | Coastlines which lack cliffs and sloping cliffs |

(4) **Special coastal features** should be listed accordingly to widely terms (e g reefs sand bars )

(5) **Tide Maximum Range** State units

(6) **Total length of coastline** Check appropriate value

11 **Freshwater within IBP Area***

(1) (2) and (3) Check in the spaces the features which are present Surveyors may insert indications of abundance e g many few etc provided it is clear which features are present and which absent

Definitions

| | |
|---|---|
| General | All types of freshwater |
| Standing | Water not flowing continuously in a definite direction |
| Running | Water flowing in a definite direction |
| Swamp | A lake pond or other site of such small depth that it is occupied ± com pletely by emergent vegetation |
| Pond | A body of standing water whose area of open water is less than 10 000 m² |
| Lake | A body of standing water whose area of open water is greater than 10 000 m² |
| Spring | A site at which water is issuing through a natural opening in such quantity as to form an appreciable current A hot spring has an average temperature more than 10°C above the yearly mean for the surrounding air |
| Stream | A watercourse or part of a watercourse whose mean width is less than 5 m |
| River | A watercourse or part of a watercourse whose mean width is greater than 5 m |
| Permanent | Never or very rarely disappears All other situations are regarded as Inter mittent |
| Productive | Eutrophic waters and those with relatively high biological productivity which are morphometrically oligotrophic |
| Unproductive | Other oligotrophic waters and those of relatively low biological productivity |

(4) **Special freshwater features** should be listed according to widely known terms (e g rapids geysers seasonally inundated land )

12 **Salt and Brackish Water within IBP Area*** Check

13 **Adjacent water bodies,** i e those whose margins form part or all of the boundary of the IBP Area* which are therefore not within the IBP Area*

Definitions as follows

| | |
|---|---|
| Freshwater | Salinity generally within the range 15 300 p p m |
| Salt and Brackish water | Salinity above the normal range of freshwater |
| Ocean | Should only be used for the interconnected oceans |
| Salt Lake | A body of standing salt water whose area of open water is greater than 10 000 m² |
| Salt Pool | A body of standing salt or brackish water whose area of open water is less than 10 000 m² |
| Lagoon | Shallow lake formed in association with coral |
| Estuary | Tidal portion of a river mouth |

14(1) **Outstanding Floral and Faunal Features** Check if none known

(2) and (4) Only the presence of outstanding features should be noted by checking the appropriate box No other information is required here we do not want for example the number of bird species present inserted under Aves — species diversity because this is not in itself an indication that this number is outstanding Columns have been left vacant for additional types of outstanding feature and additional taxonomic groups may be added in the vacant rows The vacant rows may also be used to give more precise data for the groups listed e g if the outstanding interest centres on the Carnivora of the Mammalia Carnivora may be inserted in a vacant row Always designate taxonomic groups by their Latin name

(3) and (5) **Names of main threatened, endemic, relict and rare species** List the species by their Latin names Vernacular names in addition are welcome but not obligatory

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4 Flora

| | Species diversity | Abundance of particular species | Rare species | Threatened/relict species | Spp of biogeographical interest | Exceptional associations | Outstanding specimens | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Angiospermae | | | | | | | | | | | |
| trees | | | | | | | | | | | |
| shrubs | | | | | | | | | | | |
| herbs | ✓ | | | | ✓ | | | | | | |
| grass | | | | | | | | | | | |
| Gymnospermae | ✓ | | | | | | | | | | |
| Pteridophyta | | | | | | | | | | | |
| Bryophyta | | | | | | | | | | | |
| Lichens and Algae | | ✓ | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

5 Names of main threatened endemic relict and rare species

15 **Exceptional Interest of IBP Area***

Extensive and fine development of *Abies procera* stands

7(2) **Soil**

**Soil Type** Enter the code number for the soil type which occurs under each Community These can be identified in Appendix 2 Where more than one soil type occurs under one Community either the definition of the Community should be revised or an explanatory note should be added under Other notes

**Other Notes** Sub types present should be mentioned together with short descriptions of significant features e g colour humus content depth

8 **Similar Communities in Country (or State)**

This Section will normally refer to the entire Country but in the case of large countries (Australia Brazil Canada China India U S A U S S R ) it should refer to states or provinces (primary administrative subdivisions) All Communities should be considered here — in exactly the same order as in 7 using the Community Reference Number for cross reference

Insert up to four checks in each row

Protected refers to sites of A B and C (see 4(3) above)

Protected and Unprotected refers to all sites within the Country (or State)

None known The Community does not occur elsewhere in the country/state

Infrequent Other examples of the Community exist in the country/state but the loss of any one of them would be a grave depletion of its type

Abundant Other examples of the Community are sufficiently common and widespread that the loss of any one of them would not be a significant depletion of its type

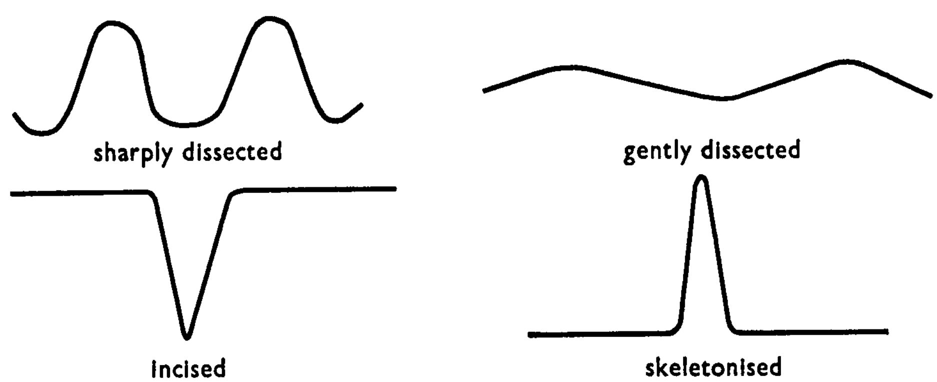
Decreasing/Increasing Insert a check only when the change observed appears to be leading to a permanent change in the status of the Community

9(1) **General Landscape** Describe in less than 50 words Confine description to geomorphological features It is permissible to consider land outside the IBP Area* (see Part 3)

(2) **Relief Type** Check off type(s) present It is possible to consider land outside the IBP Area* (see Part 3)

Altitudinal range divided into four classes of which the lowest is flat in which there is very little variation in altitude

Erosion Types may be illustrated as follows




(3) **Special Landscape Features** should be listed according to widely known terms (e g cliff ice fields dunes recent vulcanism ) Interpret special liberally

10(1) **Protected Bays and Inlets Many/Few/None** Check

(2) **Substratum** Insert approximate percentage value for the length of coast occupied by each type of substratum It is possible for the total to exceed 100% Definitions are as follows

Rock Fixed stable unweathered rock

Beach Mobile or potentially mobile material of which the particle size ranges from very large (boulder) to minute (mud)

(3) **Physiography** Insert approximate percentage value for the length of coast occupied by each type These values should total 100%

Definitions are as follows

Cliffed Wholly or partially vertical with at least some part inaccessible to land animals

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16 **Significant Human Impact**

1 General None in entire IBP Area*

None in part of IBP Area* ✓

Impact on entire IBP Area*

2 Particular

| | Past impact | Present impact | Trend: Increasing | Trend: Decreasing | Trend: No change | Trend: No information |
|---|---|---|---|---|---|---|
| Cultivation | | | | | | |
| Drainage | | | | | | |
| Other soil disturbance | | | | | | |
| Grazing | ✓ | | | | | |
| Selective flora disturbance | | | | | | |
| Logging | ✓ | | | | | |
| Plantation | ✓ | | | | | |
| Hunting | | ✓ | | | ✓ | |
| Removal of predators | | ✓ | | | | ✓ |
| Pesticides | ✓ | | | | | |
| Introductions — plants | ✓ | | | | | |
| Introductions — animals | | | | | | |
| Fire | ✓ | | | | | |
| Permanent habitation | | | | | | |
| Recreation and tourism | | ✓ | ✓ | | | |
| Research | | ✓ | ✓ | | | |
| | | | | | | |
| | | | | | | |

3 Additional details on each type of impact attached?

Yes No ✓

(2) **Name of IBP Subdivision** To be used only when the IBP Area is divided into two or more IBP Subdivisions IBP Subdivisions for which there is no suitable name should be given a reference letter (a b c etc ) thus distinguishing them from other IBP Subdivisions in the same IBP Area **This question should only be left blank if the Check Sheet refers to an IBP Area.**

(3) **Map of IBP Area* showing boundaries attached?** Yes/No Check

(4) **Sketch map of IBP Area*** This should show

— the shape of the IBP Area*

— its relation to compass directions

— boundaries common with the boundary of the IBP Area (for IBP Subdivisions only)

— major features of the land form and vegetation (e g peaks rivers woods etc )

— sites of field stations and other permanent habitations

3(1) **Latitude and Long tude** Delete the N or S E or W which does not apply

(2) **Country, State or Province County** Insert names of administrative areas in which the IBP Area* is situated The following levels are recognised

— National or Territorial embracing the whole contiguous area under one political sovereignty **(Country)**

— Regional or Provincial units intermediate between national and local levels **(State or Province)**

— Local e g **county** parish commune gemeinde etc

Spaces are provided for IBP Areas* which overlap Province or County boundaries

4(1) **National Category,** e g National Park Strict Nature Reserve etc

(2) **Address of Administration** responsible for the IBP Area* Full postal address

(3) **International Class** The following four classes have been adopted Check under the appropriate class

Class A Included in U N List

Class B Considered for inclusion in U N List but rejected These sites are mentioned in Chapter V of the U N List

Class C Other sites at present protected

Class D Unprotected sites of interest to conservationists and biologists

5(1) **Surface area,** may be inserted in any units but please state units

(2) **Altitude Maximum and Minimum** Please state units used

6(1) **Name of Nearest Climatological Station** As used in publications of national climatological organisations

(2) **Climatological Station on IBP Area* Yes/No** Check

(3) **Distance from edge of IBP Area* if outside** State units

(4) **Direction from IBP Area*** Insert compass direction from centre of IBP Area* Use 16 point compass notation (N NNE NE NNW) or degrees (0° 10° 350°)

(5) **Additional data sheet attached? Yes/No** Check

7(1) **Vegetation**

**Plant Communities** List these by their usual names using Latin names for all species mentioned Space is provided for 20 Communities further Communities should be listed on a separate sheet There is no restriction on the methods by which Communities may be defined so long as the Communities so formed can be easily recognised by local scientists Community Reference Numbers are provided to facilitate cross reference between 7(1) 7(2) and 8

**Vegetation Code** The Formation (and sub formation) to which each Community belongs should be entered These Formations (and sub formations) may be identified in Appendix 1 A key is provided to facilitate identification Enter only the code numbers for each Forma tion (and sub formation) placing one digit in each square

**Area** of each Community should be entered to maximum available accuracy

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17 **Conservation Status**

| | Protection | | | Utilisation | | | Conservation Management | | | Permitted Research | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | none | partial | total | none | controlled | uncontrolled | none | to alter status | to maintain status | experimental | observational | prohibited |
| Flora | | | ✓ | ✓ | | | | | ✓ | | ✓ | |
| Fauna | | ✓ | | | ✓ | | | | ✓ | | ✓ | |
| Non living | ✓ | | | ✓ | | | | | ✓ | | ✓ | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

18 **References**

1 List major biological/geographical references for the IBP Area

Sheet attached? Yes ✓ No

2 List main maps available for the IBP Area

List attached? Yes ✓ No

3 Aerial photographs for the IBP Area available?

For whole area ✓ For part of area None

19 **Other Relevant Information**

Signed Jerry F Franklin (Surveyor)

## GUIDE TO THE CHECK SHEET

by G F Peterken

## PART FOUR

## FIELD INSTRUCTIONS

This part is designed to assist the surveyor to fill in the Check Sheet and thereby facilitate the task of the Data Centre in transferring the contents of each Check Sheet to the computer tape It contains all definitions and instructions necessary for completing the Check Sheet except the classifications of plant formations and soils which are presented in Appendices 1 and 2 respectively Together with these appendices it can be used in isolation from the remainder of the Guide and is therefore suitable for translation in those countries where it is not possible to translate the entire Guide Previous parts explain the purpose and objectives of the survey (Part 1) the selection of sites (Part 2) and the meaning and purpose of each question on the Check Sheet (Part 3) Following this part are four appendices dealing with the classification of Plant Formations classification of soils the Geocode and an example of a completed Check Sheet

### Incomplete Information

It is likely that for many IBP Areas* the surveyor will not have enough information to complete every question To a limited extent this does not matter for even incomplete returns will contain valuable information Nevertheless there is a minimum number of sections which must be completed before a returned Check Sheet can be accepted as adequate **Sections 1, 2, 3 4 5 and 7(1) must be completed before it is worth sending in a Check Sheet to the Data Centre**

A returned Check Sheet containing only the bare minimum of information will possess only limited worth In practice it is expected that for most IBP Areas* much more information will be available any ecologist reasonably familiar with an IBP Area* should have no difficulty in answering Sections 6 7(2) 9 10 11 12 and 13 in addition to those listed above The remaining Sections — 8 14 15 16 17 and 18 — ask for more detailed information which may not be readily available Since these later sections largely correspond with the conservation content of the Check Sheet it i hoped that surveyors will make every effort to obtain the additional information necessary to complete the Check Sheet As the number of unanswered questions increases so does the value of the survey decrease

### IBP Area and IBP Subdivision

**IBP Area** An IBP Area is a site of class A B C or D as defined below under 4(3)

**IBP Subdivision** An IBP Subdivision is part of an IBP Area It is an area variable in extent which is of interest to conservationists and biologists and which is of such size and uniformity that its features can be meaningfully set out on a single Check Sheet

### Notes on Sections

In the paragraphs below the numbers correspond with the section (question) numbers on the Check Sheet

General rules

(a) Where quantitative information is requested (e g area) this should be given as accurately as possible Estimates are acceptable in the absence of accurate values

(b) In general only positive statements should be made (i e **presence** of a particular feature) but when a feature is known **with certainty** to be absent this may be stated

1(1) **Name of surveyor**

(2) **Address of surveyor**

(3) **Check Sheet completed on site/from records** Check (i e ✓) one or both as applicable

(4) **Date Check Sheet completed**

2(1) **Name of IBP Area** If the IBP Area is Class A B or C (see 4(3) below) insert the name as it appears in the U N List (A and B) or in national lists of protected sites (B and C) For Class D IBP Areas insert the name by which the IBP Area is generally known If the U N List is not available for Classes A and B fill in the name by which the IBP Area is generally known

---

N B * IBP Areas and IBP Subdivisions

18(1)

U S Army Corps of Engineers North Pacific Division

1956 Snow hydrology Summary report of the snow investigations U S Army Corps of Engineers 437 pp , illus

Peck, D L , Griggs A B , Schlicker, H G , et al

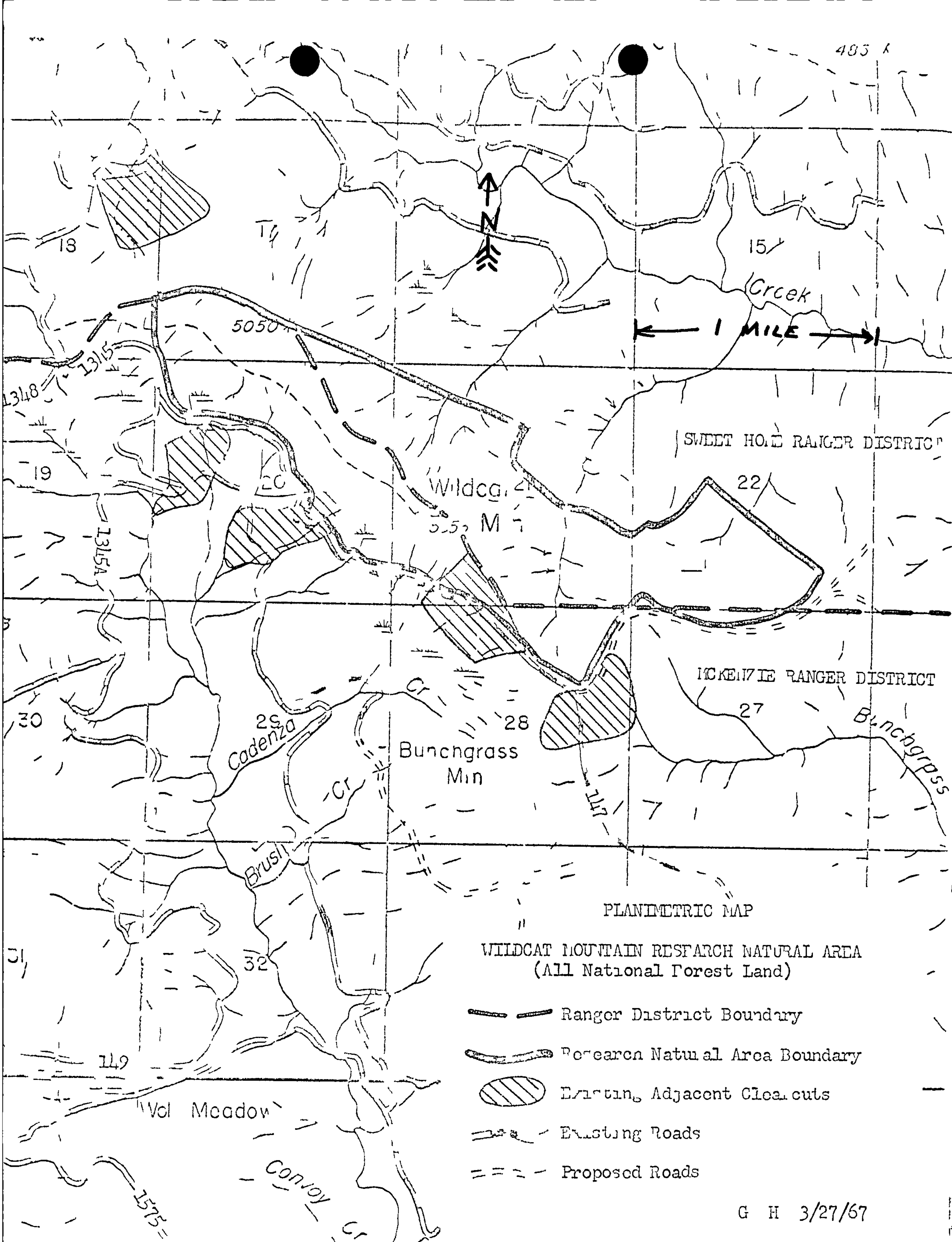
1964 Geology of the central and northern parts of the Western Cascade Range in Oregon U S Geol Survey Prof Pap 449, 56 pp

18(2)

Topography - Echo Mountain, Oregon, 15' quandrangle, scale 1 62,500, 80' contour interval issued 1955 by the U S Geological Survey

Geology - Reconnaissance Geologic Map and Sections of the Western Cascade Range Scale 1 250 000 Plate 1 in Peck, Griggs, and Schlicker (1964) cited above

Forest Types - Type map for Wildcat Mountain R N A , Scale 2 in = 1 mi On file at U S Forest Service, Pacific NW Forest and Range Experiment Station, Portland, Oregon



18
15
Creek
1 MILE
5050
1315
1348
19
1345A
SWEET HOME RANGER DISTRICT
22
Wildcat Mtn
McKENZIE RANGER DISTRICT
27
Bunchgrass
30
29
Cadenza Cr
28
Bunchgrass Mtn
Brush Cr
32
149
Vol Meadow
Conjoy Cr
1575
PLANIMETRIC MAP
WILDCAT MOUNTAIN RESEARCH NATURAL AREA
(All National Forest Land)
Ranger District Boundary
Research Natural Area Boundary
Existing Adjacent Clearcuts
Existing Roads
Proposed Roads
G H 3/27/67

Wildcat Mountain NATURAL AREA

(Name)

1 000 Acres

STATE Oregon COUNTY Linn

AGENCY/OWNER U S Forest Service

ADMINISTRATIVE UNIT Williamette National Forest

PRIMARY FOREST TYPE

SAF No 205 MOUNTAIN HEMLOCK SUBALPINE FIR 95

(Species) (Acres)

OTHER IMPORTANT VEGETATION

| (Species) | (Acres) |
|---|---|
| Old growth noble fir (NO SAF TYPE) | 517 |
| SAF 224 WESTERN HEMLOCK | 55 |
| SAF 221 SITKA ALDER | 50 |

ELEVATION 3800-5353 FEET

TOPOGRAPHY MODERATE TO STEEP SLOPES

FOR INFORMATION CONTACT Director Pacific Northwest Forest Experiment Station 809 NE 6th Avenue P O Box 3141 Portland Oregon 97208

1522770

# WILDCAT MOUNTAIN RESEARCH NATURAL AREA[1/]

Stands of noble fir and associated species on mountain slopes and ridgetops in the Western Cascade Range of Oregon

The Wildcat Mountain Research Natural Area was established on March 18, 1968, to preserve prime examples of noble fir (*Abies procera*) stands as they occur on mountain ridges in the Western Cascades of Oregon The 405 ha (1,000 acre) tract is located in Linn County, Oregon and is administered by the McKenzie Bridge Ranger District (McKenzie Bridge, Oregon), Willamette National Forest The tract occupies portions of Sections 17, 20, 21, 22, 27, and 28, T 14 S , R 6 E , Willamette meridian (fig WM-1) The southern boundary is marked by Forest Road 147 and the dividing ridge between Browder and Bunchgrass Creeks (fig WM-1) The northern boundary is based on various natural features used either directly or as control points It lies at 44°20' N latitude and 122°06' W longitude

## Access and Accommodations

It is easiest to approach the vicinity from either the north (Albany and Sweet Home) using U S Highway 20 or from the south (Eugene) using U S Highway 126 From U S Highway 20 turn south just west of Tombstone Summit onto Forest Road 1345 and follow it to Forest Road 147 and the natural area From U S Highway 126 turn north onto Forest Road 1645 (about 14 km or 9 miles east of McKenzie Bridge Ranger Station) The natural area can be reached via this and Forest Road 1345 or via Forest Road 147 which leaves Forest Road 1645 about 2 4 km (1 5 miles) north of U S Highway 126

Forest Road 147 provides access to most of the southern edge of the natural area and the abandoned Wildcat Mountain trail traverses the western half, terminating at the summit of the mountain

## Environment

The Wildcat Mountain Research Natural Area extends latitudinally along the summit ridge of Wildcat Mountain onto the north slope of Bunchgrass Mountain (fig WM-1) Elevations range from about 1,160 m (3,800 ft ) in the bottom of a drainage in Section 22 to 1,632 (5,353 ft ) at the summit of Wildcat Mountain Several distinctive topographic units can be recognized (1) the southwest face of Wildcat Mountain which has moderate (20 to 40 percent slopes at its base and increasingly steeper (50 to 70 percent) gradients near the summit, (2) the north face of Wildcat Mountain which is largely occupied by steep or precipitous (50 to over 100 percent) slopes and frequent rock outcrops, and (3) two drainages on the north slope of Bunchgrass Mountain and associated ridges which have steep (30 to 80 percent) but generally not precipitous slopes

---

1/ Description prepared by Dr J F Franklin and Dr C T Dyrness, U S Forest Service, Forestry Sciences Laboratory, Corvallis, Oregon

The natural area lies within a geologically older (Eocene to Miocene) part of the Cascade Range known as the Western Cascades A current geologic map indicates the tract is located on "volcanic rocks of the High Cascade Range" which were intruded in the Pliocene and Pleistocene, i e the formation commonly known as the High Cascade Andesites (Peck et al 1964) However, recent studies indicate that, " these areas of 'High Cascade' rocks which have been mapped within the Western Cascade Province are not to be associated in time or in place of origin with High Cascade volcanism " (Taylor 1968) Topographically the natural area is certainly consistent with the deeply-eroded character of the Western Cascades and it lies several kilometers west of the recognized boundary (approximately the McKenzie River) between the Western and High Cascades (Taylor 1968) William's (1957) geologic mapping recognizes this contact and places Wildcat Mountain in Eocene to Miocene volcanic rocks of the Western Cascades

The dominant rock type is andesite Volcanic tuffs and breccias and, possibly, intrusive plugs and dikes also occur in the area Peck et al (1964) have provided some data on the lithology and petrography of the volcanic bedrock Residual materials are covered with aeolian deposits of volcanic ash except where the ash has been removed by erosion The source and age of the ash deposits are unknown but there are many possible originating vents in adjacent parts of the High Cascades (Williams 1957, Taylor 1968)

The wet, cool climate of the natural area is typical of subalpine areas in the Cascade Range Precipitation is heaviest during the winter months (November through March), only 4 to 5 percent occurs during the summer (June through August) About half of the precipitation occurs as snow and accumulates in winter snowpacks which reach maximum depths of 2 to 3 m (70 to 120 in ) between February and March The peak of snowmelt typically occurs in May and is completed by June or early July There are no nearby climatic stations which provide useful climatic indices for the natural area However, headquarters of the U S Army Corps of Engineers' Willamette Basin Snow Laboratory was located in the pass between Squaw and Wildcat Mountains, about 1 km (0 5 mile) west of the natural area Between 1947 and 1951 this laboratory collected many data on general climate, snow hydrology, streamflow, etc , in the Blue River drainage The following data are average values computed for this drainage (U S Army Corps of Engineers North Pacific Division 1956)

| | | |
|---|---|---|
| Mean annual temperature | 7 2°C | (45 0°F ) |
| Mean January temperature | 0 0°C | (32 0°F ) |
| Mean July temperature | 16 7°C | (62 0°F ) |
| Average annual precipitation | 3,188 mm | (125 5 in ) |
| June through August precipitation | 127 mm | ( 5 0 in ) |
| Snowfall (water equivalent) | 174 cm | ( 68 5 in ) |

Since the mean elevation for the basin under study is 1,045 m (3,430 ft ) temperatures are lower on the natural area and precipitation is higher, an isohyetal map suggests 3,810 to 4,065 mm (150 to 160 in ) of annual precipitation on the natural area (U S Army Corps of Engineers North Pacific Division 1956) The numerous data collected at the Willamette Basin Snow Laboratory are summarized in "Snow Hydrology Summary Report of the Snow Investigations" (U S Army Corps of Engineers North Pacific Division 1956) and are on file at the division office in Portland, Oregon

Soils in the area are poorly-developed Brown Podzolics In some locations it is difficult to discern any profile development Generally, however, the surface 15 to 30 cm (6 to 12 in ) of soil is a weakly expressed B2ir horizon comprised of dark brown, very friable loam or sandy loam with weak subangular blocky structure This soil material can be described as "fluffy" and is always of very low bulk density Soil texture usually shows little variation throughout the profile Stone content increases with depth and often reaches 50 to 60 percent by volume at 45 to 60 cm (17 71 to 23 62 in ) Although andesite fragments are sometimes common throughout the profile these soils appear derived primarily from aeolian deposits of volcanic ash Forest floor thickness ranges from 4 to 8 cm (1 5 to 3 in ) and the organic layer is occasionally underlain by a very thin, discontinuous A2 horizon

Biota

Approximately 288 ha (710 acres) of the Wildcat Mountain Research Natural Area are forested A detailed breakdown of this area by National Forest inventory type, S A F cover Type (Society of American Foresters 1954), composition, and age class is provided in Table WM-1 Areas of S A F cover types can be summarized as follows [2/]

| No | Name | Area |
|---|---|---|
| 226 | Pacific Silver Fir-Hemlock (noble fir-dominated) | 209 ha (517 acres) |
| 226 | Pacific Silver Fir-Hemlock (Pacific silver fir-dominated) | 38 ha ( 95 acres) |
| 205 | Mountain Hemlock-Subalpine Fir | 22 ha ( 55 acres) |
| 230 | Douglas Fir-Western Hemlock | 17 ha ( 43 acres) |

There are 117 ha (289 acres) of nonforested lands within the natural area, which include rocky cliffs, meadows of various types, and brushfields Küchler (1964) types represented include Silver Fir-Douglas Fir Forest (3) and Fir-Hemlock Forest (4) Most of the natural area lies within the *Abies amabilis* Zone, the *Tsuga mertensiana* Zone is represented at higher elevations (Franklin and Dyrness 1969)

The most important and nearly ubiquitous tree species in the natural area is noble fir Pure, 130-year-old stands located in the southwestern quarter and 300-year-old stands in the eastern third of the natural area provide excellent examples of this species development Pacific silver fir (*Abies amabilis*), Douglas-fir (*Pseudotsuga menziesii*), and mountain hemlock (*Tsuga mertensiana*) are common associates Pacific silver fir is absent from the overstory in some of the pure noble fir stands but is present everywhere as seedlings and saplings, in a few stands at highest elevations Pacific silver fir and mountain hemlock are the only species present Douglas-fir is most abundant in the drainage in Section 22 and is nearly absent at higher elevations Some of the 130-year-old stands contain residual 450-year-old Douglas-fir specimens which survived the destruction of the previous stand, young, 130-year-old Douglas-firs in such stands are generally subordinate in the crown canopy to dominant noble firs

---

2/ Assignment of some forest stands in this area to S A F cover types was, in part, arbitrary due to inadequacies in the type definitions (Society of American Foresters 1954) Mixtures of Pacific silver fir and mountain hemlock were assigned to Types 226 or 205 based on the relative importance of the two species All areas dominated by noble fir or a mixture of Douglas-fir and noble fir were assigned to Type 226

Table WM-1 --Area of forest types in the Wildcat Mountain Research Natural Area[1]

| Forest Service Inventory Type[2] | Major Species[3] | S A F Type | Age[4] Class (years) | Area (Ha ) | Acres) |
|---|---|---|---|---|---|
| Cutover | NF, DF | 226 | 40 | 2 8 | 7 |
| FM 1 | MH, PSF | 205 | 30 | 4 0 | 10 |
| FM 1 | PSF, MH | 226 | 20 | 4 0 | 10 |
| FM 1 | NF | 226 | 30 | 4 0 | 10 |
| FM 2 | PSF | 226 | 70 | 2 0 | 5 |
| FM 3 | PSF, MH | 226 | 120 | 12 2 | 30 |
| FM 3 | MH, PSF | 205 | 140 | 18 2 | 45 |
| FM 3 | NF | 226 | 70 | 4 0 | 10 |
| FM 4 | NF | 226 | 120 | 8 1 | 20 |
| FM 4 | NF, DF | 226 | 120 | 72 9 | 180 |
| FM 4 | NF, DF | 226 | 300 | 48 6 | 120 |
| FM 4 | NF, PSF | 226 | 300 | 36 4 | 90 |
| FM 4 | NF, PSF, MH | 226 | 350 | 28 4 | 70 |
| FM 4 | PSF, MH, NF | 226 | 350 | 20 2 | 50 |
| D 1 | DF | 230 | 95 | 1 2 | 3 |
| D 4 | DF, NF | 226 | 120 | 4 0 | 10 |
| D 4 | DF, NF, WH | 230 | 180 | 16 2 | 40 |
| TOTAL | | | | 287 6 | 710 |

1/ Based on 1960 inventory of the Willamette National Forest

2/ Alphabetic symbols refer to forest type FM, true fir-mountain hemlock, and D, Douglas-fir Numeric symbols refer to size class 1, seedlings and saplings, 0 to 5 in d b h , 2, pole timber, 5 to 11 in d b h , 3, small sawtimber, 11 to 21 in d b h , and 4, large sawtimber, 21 in and larger d b h

3/ In approximate order of importance Abbreviations are NF, noble fir, DF, Douglas-fir, MH, mountain hemlock, PSF, Pacific silver fir, and WH, western hemlock

4/ Estimated age at time of 1960 inventory

Other tree species present within the natural area are western white pine (*Pinus monticola*), Alaska-cedar (*Chamaecyparis nootkatensis*), and western hemlock (*Tsuga heterophylla*) The pine is scattered throughout the area, but much of it is presently dead or dying from attacks by bark beetles and white pine blister rust Alaska-cedar is generally found on rocky habitats along the ridgetops and around some meadow areas Western hemlock is essentially confined to lower elevations

Mensurational data have been collected only from the younger forest stands Dominant noble fir in the highly productive southwestern part of the natural area average 75 to 100 cm (30 to 40 in ) d b h and 50 to 55 m (160 to 180 ft ) tall Ring counts on roadside stumps indicate a range in age from 120 to 137 years, these data substantiate the age class recognized in the 1960 inventory Douglas-fir of the same age in these stands average 15 to 30 cm (6 to 12 in ) smaller in diameter and 2 to 5 m (5 to 15 ft ) shorter than the dominant noble firs The scattered old-growth Douglas-firs are commonly 125 to 150 cm (50 to 60 in ) d b h and about 450 years old Dominant Pacific silver fir and mountain hemlock stands growing on poorer sites average 30 to 60 cm (12 to 24 in ) d b h and 30 to 35 m (100 to 120 ft ) tall at 130 years Trees found in stands over 130 years of age are, of course, larger in size given comparable site conditions Maximum diameters observed to date are 186 7 cm (73 5 in ) at b h for noble fir and 91 4 cm (36 0 in ) b h for Pacific silver fir

Based on size class distributions, successional trends apparently favor gradual replacement of most forest tree species by Pacific silver fir The degree to which successional processes have advanced varies greatly, especially with stand age, but the trend in compositional changes is generally clear For example, Pacific silver fir seedlings and saplings are abundant in many of the young (130-year-old), pure noble fir stands but there are relatively few specimens of any species in intermediate size classes In older stands, Pacific silver fir commonly dominates both seedling and larger, intermediate size classes (fig WM-3) Pacific silver fir seedlings and saplings are also much more abundant than those of mountain hemlock in mixed stands of these species In general, noble fir is failing to reproduce within closed forest stands, however, seedlings are abundant on the forest floor after a good seed year and may persist for several years before dying Mountain hemlock and Douglas-fir also appear ineffectual in reproducing themselves in forest stands

At least four major forest communities can be recognized within the natural area based on the limited sampling done thus far *Abies procera/Clintonia uniflora*, *Abies procera/Achlys triphylla*, *Tsuga mertensiana-Abies amabilis/Xerophyllum tenax*, and *Abies amabilis/Vaccinium membranaceum-Xerophyllum tenax* 3/

The *Abies procera/Clintonia uniflora* community is found on productive, relatively mesic sites It is characterized by a herb-rich understory which averages 40 to 45 percent canopy coverage, in some dense stands the coverage is much less (fig WM-3) Typical species include *Achlys triphylla*, *Anemone deltoidea*, *Chimaphila menziesii* and *umbellata*, *Clintonia uniflora*, *Cornus canadensis*, *Galium oreganum*, *Pyrola picta* and *secunda*, *Pteridium aquilinum*, *Rubus lasiococcus*, *Smilacina sessilifolia*, *Tiarella unifoliata*, and *Viola glabella* and *sempervirens* *Cornus*, *Smilacina*, and *Clintonia* usually have the highest coverage *Vaccinium membranaceum* has high constancy but its coverage is relatively low (1 to 15 percent)

3/ These are vegetation units which have been recognized in a classification of forest communities in the Western Cascades of Oregon Details are available from Dr C T Dyrness, U S Forest Service, Forestry Sciences Laboratory, Corvallis, Oregon

*Abies procera/Achlys triphylla* communities are found on somewhat poorer sites, e g , areas of shallower soil *Acer circinatum* is usually a conspicuous shrubby element in stands of this type *Vaccinium membranaceum* is also present but has low coverage The herbaceous layer can be relatively well developed and typically includes *Achlys triphylla, Pyrola secunda, Pteridium aquilinum, Smilacina sessilifolia, Galium oreganum,* and *Viola glabella* and *sempervirens* The *Achlys* and *Smilacina* normally have the highest herbaceous coverage

The *Tsuga mertensiana-Abies amabilis/Xerophyllum tenax* community is typical of the poorest forested habitats, i e , sites with the shortest, coolest growing seasons and shallow soils Only two species are important in the understory--*Xerophyllum tenax* and *Vaccinium membranaceum* The liliaceous *Xerophyllum* completely dominates with canopy coverage of up to 90 percent (fig WM-3)

A fourth forest community, the *Abies amabilis/Vaccinium membranaceum-Xerophyllum tenax* is at least sporadically represented in the natural area It is intermediate in character between the *Tsuga-Abies/Xerophyllum* and the *Abies/Achlys* types with significant coverage of *Vaccinium membranaceum, Xerophyllum tenax* and several herbs

There are also a variety of nonforested communities in the Wildcat Mountain Research Natural Area These include (1) communities on logged and burned forest land, (2) meadows of various types, (3) shrub communities, and (4) communities associated with rock outcrops and cliffs Small portions of areas clearcut and broadcast burned in 1952 (in Section 20) and 1967 (in Sections 21 and 28) were incorporated into the natural area The seral communities present on these areas are typical of early stages in secondary succession on forest habitats Shrubs (e g , *Ceanothus velutinus*) dominate on the older (more advanced) clearcut and herbs on the other Natural regeneration of conifers is appearing in both

The meadow communities in the natural area can largely be related to the Wet Meadow, Mesic Meadow, and Subalpine Xeric Meadow types recognized by Hickman (1968) in comparable portions of the Western Cascades The Wet Meadow type is generally found on gentle slopes where a relatively deep, organic soil has developed, it is relatively rare in the natural area, occurring most frequently adjacent to *Alnus sinuata* thickets Typical dominants are *Veratrum viride, Senecio triangularis,* and *Valeriana sitchensis* The Mesic Meadow type occupies habitats where moisture is typically adequate until midsummer Dominants are *Rubus parviflorus, Pteridium aquilinum,* and *Rudbeckia occidentalis* There are many associated herbaceous perennials, e g , *Erigeron aliceae, Lupinus latifolius, Polygonum phytolaccaefolium, Cirsium centaurea,* and *Vicia americana* var *truncata,* and occasional ephemeral annuals, e g , *Gayophytum humile* This type of meadow is probably the most extensive within the natural area In some locations, invasion of trees, especially noble fir, is taking place, in others, there is no evidence for such successional changes, and the meadow community appears stable Subalpine Xeric Meadows occur on sites with shallow, rocky soils where moisture becomes critical relatively early in the growing season Representative species are *Gilia aggregata, Gayophytum diffusum* var *parviflorum, Orthocarpus imbricatus, Polygonum douglasii, Navarretia divaricata, Microsteris gracilis, Collinsia parviflora, Cerastium arvense,* and *Rumex acetosella*

Wet sites adjacent to the meadows and forest, steep, north-facing slopes on Wildcat Mountain, and talus associated with rock outcrops are occupied by shrub communities *Alnus sinuata* is the typical dominant on wetter substrates and steep north slopes forming dense thickets Deep winter snow accumulations and extensive snow creep cause strong bowing of the 3 to 5 m (10 to 16 ft ) tall *Alnus* stems In a nearby area, the occurrence of these stands has been related to high soil water tables due to a nearly impervious subsoil[4] while in other regions they are associated with recurrent avalanches, both factors are probably operative on the natural area *Acer circinatum* dominates the shrub communities occupying relatively dry talus, these intergrade, in some cases, with *Alnus sinuata* communities which may be found on moister portions of the same talus patch Both types of shrub communities appear to be stable community types as there is generally no evidence of encroachment by tree species

The communities found on rock outcrops and cliffs have not been examined The species present undoubtedly include many of those listed by Hickman (1968) for the Outcrop Ridge and Vertical Outcrop habitats recognized in his floristic study of the Western Cascades The Outcrop Ridge habitat is found on south- and west-facing slopes, where mass wasting of small fragments has produced small outcrops of barely exposed parent rock eroded parallel to the general slope of the area Many species root in weathered cracks or pockets of finer material, including *Delphinium menziesii* var *pyramidale*, *Castilleja hispida*, *Penstemon procerus* var *brachyanthus*, *Sedum stenopetalum* and *divergens*, *Eriophyllum lanatum*, *Arctostaphylos nevadensis*, *Comandra umbellata*, *Lomatium martindalei*, *Sanicula graveolens*, *Eriogonum compositum*, *Juniperus communis*, *Erigeron foliosus* var *confinis*, *Arenaria capillaris* var *americana* *Erysimum asperum*, and *Phacelia heterophylla* Species such as *Saxifraga bronchialis* var *vespertina* and *Penstemon rupicola* are typical of the exposed Vertical Outcrop habitat

Many common Western Cascade animals occur within the natural area, including blacktail deer (*Odocoileus hemionus columbianus*), Douglas-squirrel (*Tamasciurus douglasii*), coyote (*Canis latrans*), black bear (*Ursus americanus*), bobcat (*Lynx rufus*), pocket gopher (*Thomomys talpoides*), whitefooted deer mouse (*Peromyscus maniculatus*), mountain beaver (*Aplondontia rufa rufa*), and showshoe hare (*Lepus americanus*)

The only specialized habitats known to occur on the natural area, which have not already been mentioned, are the live stream and streamside areas

History of Disturbance

Within the core of the natural area there has been some human disturbance Minor disturbance was associated with construction and maintenance of the Wildcat Mountain trail and fire lookout A small forest opening was created at the mountain summit when the lookout was built The building was burned in about 1966 and the cleared area now has dense tree regeneration Sheep grazing was frequently practiced in mountain meadows in this part of the Cascade Range into the 1930's It has undoubtedly influenced the character of the various meadows found within the natural area

Most human disturbance is along the southern margin of the area although it is considered minor, this area will probably also be the focus of any future problems Two small areas (fig WM-1) totalling about 4 ha (10 acres) were clearcut prior to natural area establishment Some mortality (mostly windthrow) is associated with the margins of these clearcuts and of Forest Road 147, particularly immediately northwest of the Wildcat-Bunchgrasss Mountain saddle Some damage from road construction (sidecast dirt and rock, e g ) also occurred in this area

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4/ Unpublished soil survey data from the H J Andrews Experimental Forest on file at U S Forest Service, Forestry Sciences Laboratory, Corvallis, Oregon

Natural dist ances appe o be minor within the natural area since the bulk o the stands were established 130 years or more ago The scattering of younger stands suggests some minor wildfires have occurred in the last 50 years Dwarf mistletoe is present in noble fir in at least some of the area and there also appear to be small scattered pockets of root rot

Research

A number of research projects are already in progress at Wildcat Mountain Research Natural Area

1 Cone production by noble fir has been observed an y since 1961 (Franklin 1968) and that by mountain hemlock and Pacific silver fir since 1967 5/ This s w nue at least through 1972

2 Tot o uality of annual tree seedfall has been under study si ce 1968 will continue at least through 1972 6/ Seedtraps are located within a pure noble fir stand at about 1,340 m (4,400 ft ) in the southwestern port of the natural area and a mixed mountain hemlock-Pacific silver fir stand at about 1,430 m (4,700 ft the north slope of Bunchgrass Mounta n (fig WM-3)

3 Vegetation-soil plots (10) have been pled within the natural area as part of a study of t forest communities and their environmental relationships in the c ntral we tern Cascades of Oregon These are being incorporated into the resulting classification 7/

4 Numerous collectio s of soil fungi ha been made within the natural area by Forest Ser and Orego State U iversity mycologists 8/

5 Stem analyses of noble fir and associated species have been made of specimens cut immediately adjacent to the natural area Both the least and most productive sites are represented in these samples The data is presently being analyzed (DeMars, Herman and Bell 1970, Herman and DeMars 1970)

This natural area is considered an adjunct to the H J Andrews Experimental Forest located 8 km (5 miles) southwest, providing additional representation of high-elevation true fir forest The possibility exists of using comparable forest areas on the experimental forest for work involving destructive sampling or manipulation and using the natural area as a control site The H J Andrews Experimental Forest (including Wildcat Mountain Research Natural Area) is also an inten study site for the U S International Biological Program's Coniferous Forest Biome Analysis of Ecosystems project It is expected that two plot locations to be used in this ecosystem research will be located within stands in the natural area

The natural area provides a number of special research opportunities besides those possible in connection with already active research projects These include research on (1) the two small watersheds which occupy the eastern half of the area, (2) subalpine stands of varying age, composition, and productivity, including some of pure noble fir, (3) mountain meadows typical of those found in the western Cascades, and (4) succession on small, recently cutover tracts incorporated within the natural area

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5/ Research by Dr Jerry F Franklin, U S Forest Service, Forestry Sciences Laborator Corvallis, Oregon

6/ See footnote 5

7/ Res arch by Dr C T Dyrness, U S Forest Service, Forestry S es L oratory, Corvallis, Oregon

/ arch by Dr James M Trappe, U S Forest Service, Forestry Sciences L atory, Corvallis, Oregon

9/ Research by Mr Fra cis R Herman, U S Forest Service, Forestry Sciences Laboratory, Corvallis, Oregon

Maps and Aerial Photographs

Special maps applicable to the natural area are Topography--15' Echo Mountain, Oregon quadrangle, scale 1 62,500, issued by the U S Geological Survey in 1955, and geology--Reconnaissance Geologic .ap and Sections of the Western Cascade Range Oregon, North of Latitude 43°N , scale 1 250,000 (Pecl et al 1964), Geologic Map of the Central Part of the High Cascade Range, Oregon (Williams 1957), and Geologic Map of Oregon West of the 121st Meridian, scale 1 500,000 (Peck 1961) Either the District Ranger (McKenzie Bridge Ranger District) or Forest Supervisor (Willamette National Forest, Eugene, Oregon) can provide details on the most recent aerial photo coverage and forest type maps for the area

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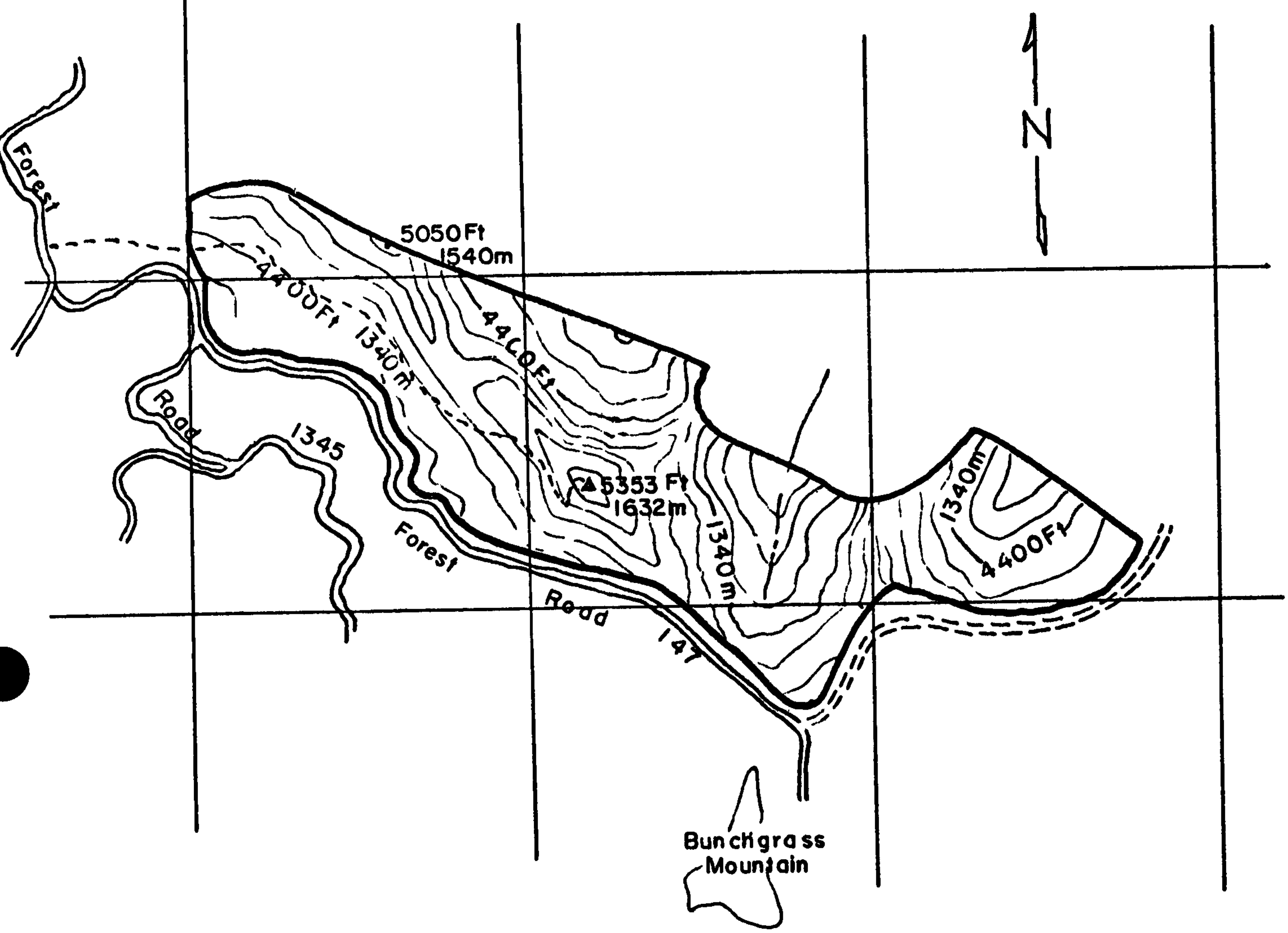
Figure Captions

Figure WM-1 --Wildcat Mountain Research Natural Area, Linn County, Oregon (approximate scale 2 in equals 1 mile, contour interval 160 ft or 49 m )

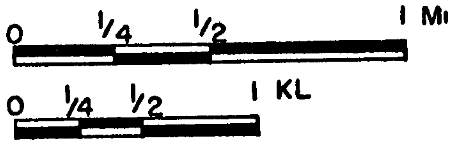
Figure WM-2 --Forest types and age classes in the Wildcat Mountain Research Natural Area (Data source 1960 inventory, Willamette National Forest )

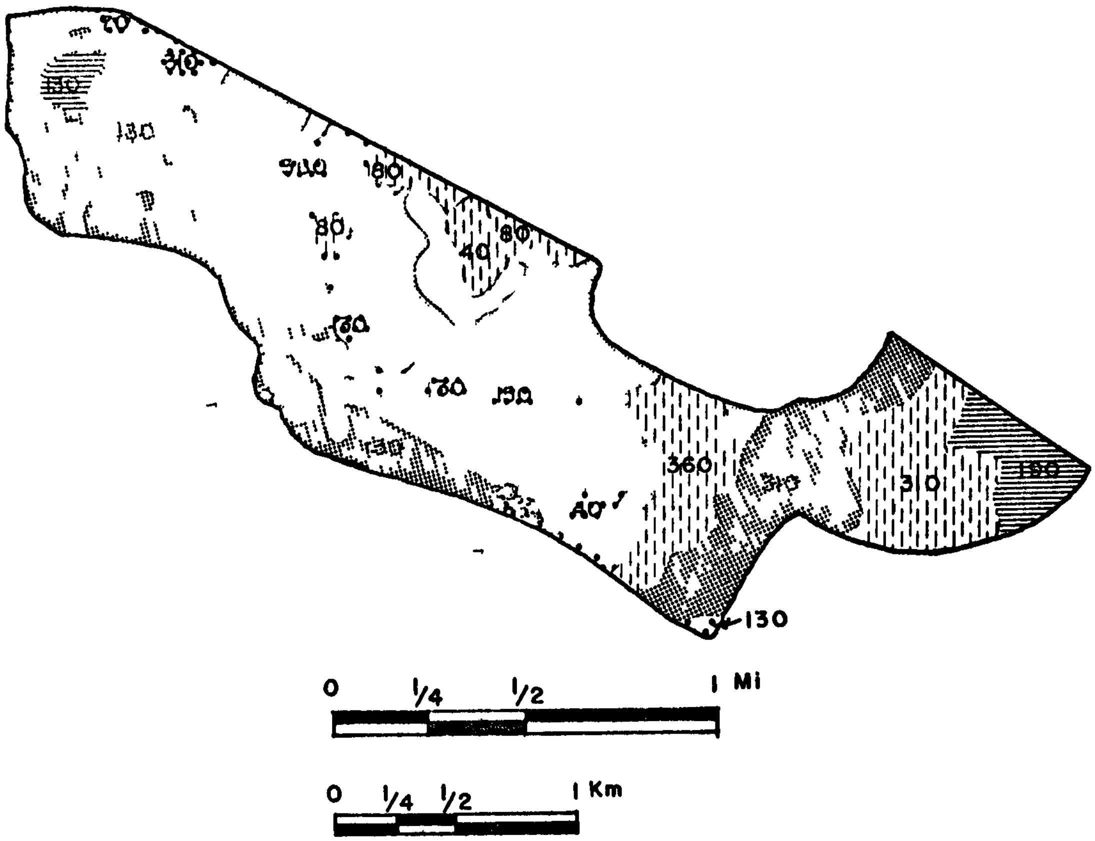
Figure WM-3 --Forest communities of Wildcat Mountain Research Natural Area Upper left Community of *Tsuga mertensiana-Abies amabilis/Xerophyllum tenax*, the approximately 130-year-old trees average 30 to 60 cm (12 to 24 in ) d b h Upper right Nearly pure stand of noble fir growing along Wildcat Mountain trail, these approximately 130-year-old trees average 75 cm (30 in ) d b h and 45 m (150 ft ) tall Lower left Older stand (approximately 180 years) of noble fir showing abundant seedlings and saplings of Pacific silver fir, the probable climax species Lower right Collecting contents of seedtrap in stand of mountain hemlock and Pacific silver fir as part of long-term study of tree seeding habits on the natural area




## LEGEND

- BOUNDARY, WILDCAT MOUNTAIN RESEARCH NATURAL AREA
- SECTION LINE
- STREAM
- ROAD
- PROPOSED ROAD
- TRAIL






LEGEND

Noble fir-dominated forest with Pacific silver fir

Noble fir-dominated forest with Douglas-fir

Mixed forest of Pacific silver fir and Mountain hemlock

Mixed forest of Douglas-fir and Noble fir

Rocky areas

Moist meadows and brushfields

Clearcut forested areas