Land Use / Land Cover ca. 1990

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Mapping LULC ca. 1990 in the WRB

The map at right represents land use/land cover in the WRB circa 1990 using 65 legend classes in five categories: built features, agriculture, natural and native vegetation, water and physiographic features, and unknown. We use the term “land use” for features of the built environment such as roads, railroads, residential, and commercial structures. The term “land cover” is used for features such as forests, grasslands, rivers and streams. For modeling and data interpretation, the Willamette Valley Ecoregion (WVE) is used to distinguish the valley or Lowland portion of the basin from the Upland areas (pp. 48-49). This map and its legend serve as reference points for conditions in depicting the past and evaluating the alternative futures.

Mapping land use/land cover requires an abstraction of what actually exists in the landscape. The map represents each legend class as a single land use or land cover with definitive boundaries. However, any given location in the landscape may actually contain more than one land use/land cover with boundaries that are not distinct. To determine land use/land cover representation and level of detail for the map, the PNW-ERC considered both the needs of its researchers and the accuracy of available data.

The land use/land cover patterns that appear ca. 1990 are the result of both natural and cultural influences. Since the mid 19th century, EuroAmerican settlement of the Willamette Valley has played a major role in establishing the patterns seen in Map 24. Settlers were attracted to the Willamette Valley’s mild climate, fertile soils, and abundant natural resources. The locations of early settlements were determined primarily by environmental factors, kinship affiliation and farming suitability. People settled near major rivers for transportation, on hill slopes for safety from recurrent valley floods and access to fuel and building materials, and in open areas for livestock forage and easier clearing of the land.

Establishment of communities and transportation networks as well as clearing of forests and draining of wet prairies for commercial scale agriculture have resulted in significant changes in the landscape. Much of the land cover seen in the Presettlement Vegetation ca. 1851 Map (p. 39) had been converted to land use ca. 1990. Figure 94 shows the extent of this conversion in the WVE. The land cover types listed on the horizontal axis are ca. 1851, with the colored bar above each 1851 type representing conditions ca. 1990. A notable example is an 80% conversion of the land cover area ca. 1850 in wet and dry prairie to built and agricultural land use ca. 1990.

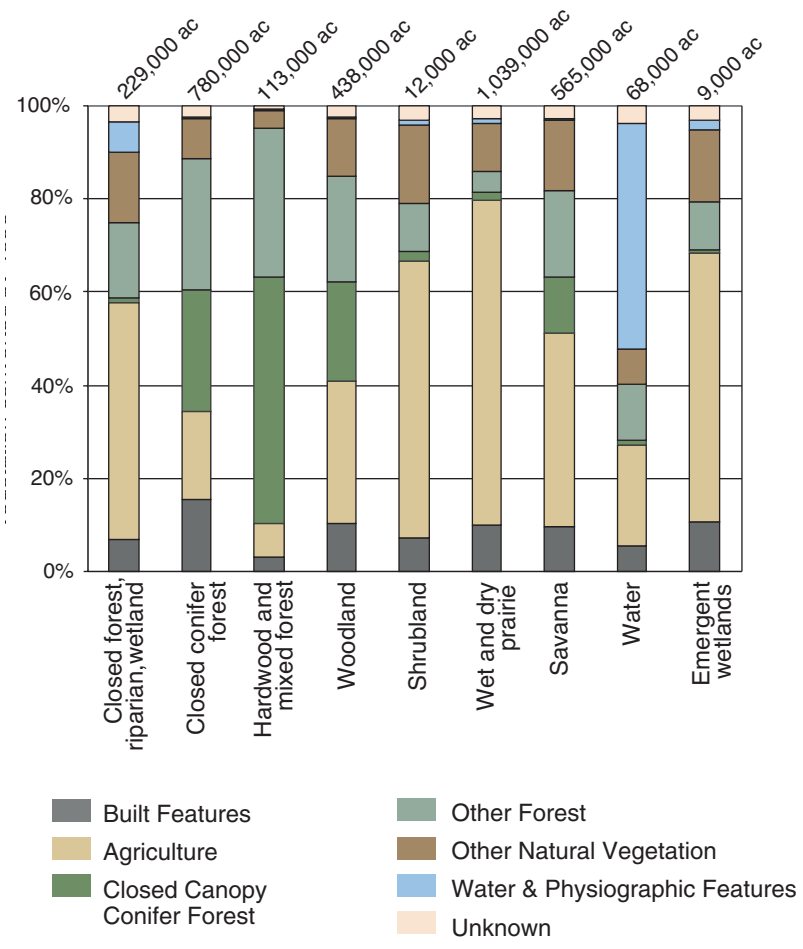
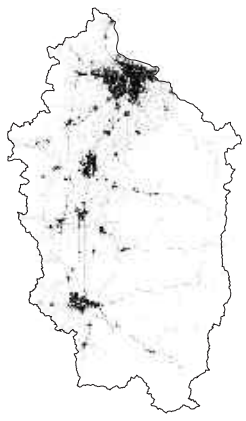


Figure 94. *Conversion of land cover from ca. 1851 to ca. 1990 within the Willamette Valley Ecoregion (WVE). Labels on the horizontal axis represent land cover classes ca. 1851; the bars above represent conditions ca. 1990. Each bar represents the percentages of the 1851 class that were converted to the various ca. 1990 classes with the sum of the segments totaling 100%. Numbers at the top of each bar represent the total number of acres of each ca. 1851 land cover in WVE (rounded to the nearest thousand). Note: 2.47 acres equal 1 hectare.*

Built features

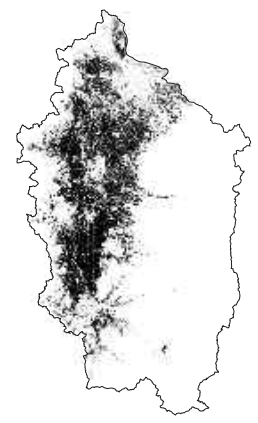
- Residential 0 - 4 DU/ac
- Residential 4 - 9 DU/ac
- Residential 9 - 16 DU/ac
- Residential > 16 DU/ac
- Commercial
- Commercial/Industrial
- Industrial
- Residential & commercial
- Rural structures
- Railroad
- Primary roads
- Secondary roads
- Light duty roads



Built (black)

Agriculture

- Hybrid poplar
- Grass seed rotation
- Irrigated annual rotation
- Grains
- Nursery
- Berries & vineyards
- Double cropping
- Hops
- Mint
- Radish seed
- Sugar beet seed
- Row crop
- Grass
- Burned grass
- Field crop
- Hayfield
- Late field crops
- Pasture
- Bare/fallow
- Irrigated perennial
- Turfgrass
- Urban tree overstory
- Orchard
- Christmas trees
- Conifer Woodlot



Agriculture (black)

Natural & native vegetation

- Upland Forest open
- Upland Forest semi-closed mixed
- Forest closed hardwood
- Forest closed mixed
- Upland Forest semi- closed conifer
- Conifers 0 - 20 yrs.
- Forest closed conifer 21 - 40 yrs.
- Forest closed conifer 41 - 60 yrs.
- Forest closed conifer 61 - 80 yrs.
- Forest closed conifer 81 - 200 yrs.
- Forest closed conifer older than 200 yrs.
- Upland Forest semi-closed hardwood
- Natural grassland
- Natural shrub
- Flooded/marsh
- Oak Savanna
- Wet shrub
- Wet prairie

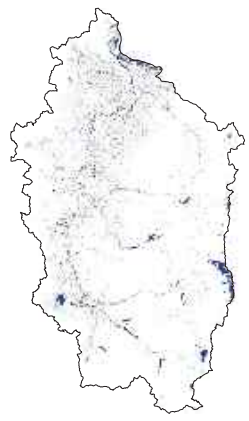
Natural and native vegetation (black)

Water & physiographic features

- Main channel non-vegetated
- Stream orders 5 - 7
- Permanent lentic water
- Topographic shadow
- Snow
- Barren

Unknown

- Urban non-vegetated unknown
- Rural non-vegetated unknown
- Unknown



Water (blue) and Unknown (black)

Map 24. LULC ca. 1990

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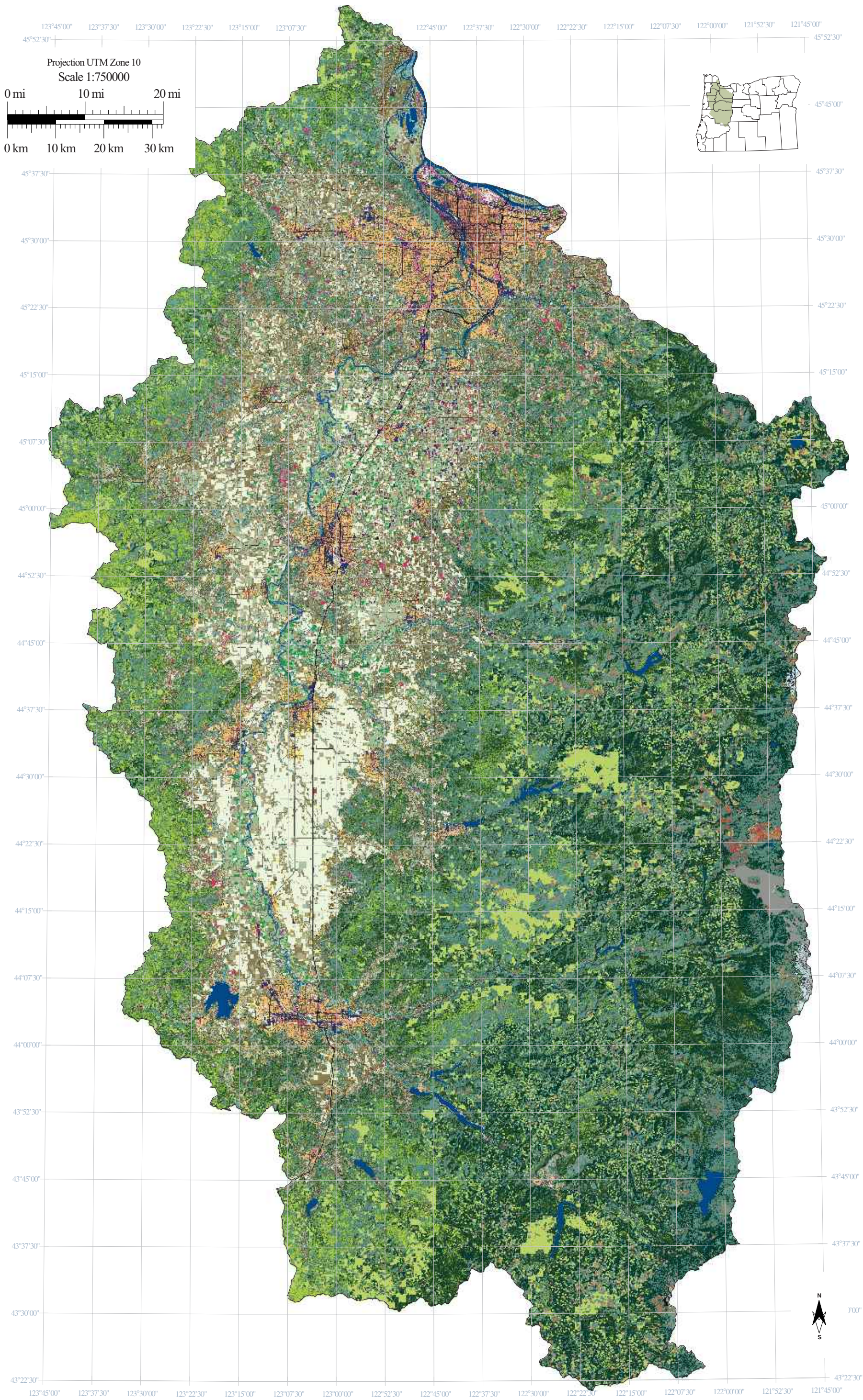
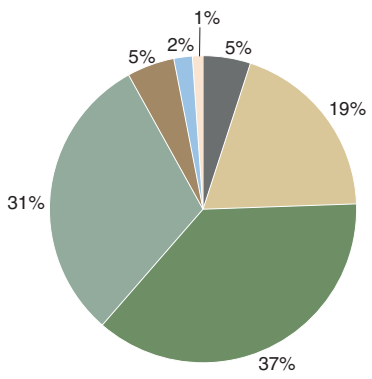


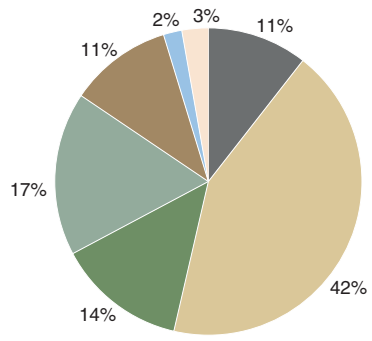
Land Use / Land Cover ca. 1990

The distribution of land cover ca. 1990 seen in Figure 95 shows that the majority of agriculture and built features occur in the valley portion of the basin.



Legend Category	Acres
Built Features	366,000
Agriculture	1,424,000
Closed Conifer Forest	2,725,000
Other Forest	2,238,000
Non Forest Natural Vegetation	372,000
Water & Physiographic Features	131,000
Unknown	90,000
Total Acres in WRB	**7,346,000**

a) Willamette River Basin



Legend Category	Acres
Built Features	348,000
Agriculture	1,394,000
Closed Conifer Forest	447,000
Other Forest	555,000
Non Forest Natural Vegetation	359,000
Water & Physiographic Features	63,000
Unknown	88,000
Total Acres in WVE	**3,254,000**

b) Willamette Valley Ecoregion

Figure 95. *Land cover distribution within the Willamette River Basin (a) and the Willamette Valley Ecoregion (b). Note: In this figure, 'Urban Tree Overstory' is tabulated in the 'Other Forest' category.*

Data Used in Compiling Land Use/Land Cover ca. 1990

Map 24 comprises 16 discrete, gridded map data layers which have been assembled in a specific sequential order. Each data layer (map) is composed of picture elements, or pixels, that represent an area of ground 30 meters by 30 meters (0.25 acre). The LULC ca. 1990 map contains 33 million of these pixels, also called grid cells. The data used in creating the map were obtained from multiple sources, collected for various purposes from 1985-1995, and contain varying degrees of accuracy.

The foundation of the map's data comes from Landsat satellite thematic mapper (TM) images. These data are collected through remote sensors on Landsat orbiting at an altitude of 705 kilometers on a 16-day cycle. The data are collected in digital form, transmitted to ground stations and sent to facilities for image processing. The upland portion of the basin was mapped using a single-date 1988 TM data set, while the valley portion was derived from a multi-season data set consisting of 5 images from 1992 (March 19th, May 6th, June 7th, July 25th, and August 26th) to represent one full growing season.[97]

The TM sensor records data in 7 spectral bands which capture visible, infrared, and thermal wavelengths. Individual bands highlight characteristics such as vegetative chlorophyll absorption, soil moisture content, and light reflection. The bands are used individually or in combination to differentiate and classify a wide variety of land cover types.

The TM imagery captures some land cover types better than others, depending on the spectral properties of the feature and the homogeneity of the land surface. Because the satellite sensor records surface reflection of light waves, the uppermost object tends to dominate the data signal. This means that TM may capture the overstory of a forest but fail to detect understory or ground surface conditions. Likewise, overhanging vegetation can obscure narrow linear features such as streams or minor roads. In addition, objects smaller than the spectral resolution of the sensor (25 m) are lost because of merging with their surroundings.

By comparing predicted land cover classes with independently gathered sources of actual ground conditions, accuracy can be calculated for a classified image derived from satellite data (Table 25). Land cover types such as water and snow have unique spectral signals, and this contributes to a high accuracy. The river seen in the aerial photograph (Fig. 96b) is easily distinguished as water in the classified satellite image (Fig. 96a). Other land cover types, such as natural grassland, hay, and pasture, are more difficult to differentiate and thus have a lower accuracy. These accuracy descriptions are part of an independent study comparing satellite and aerial photo derived land use/ land cover characterizations in the WRB.[104]

Data derived from satellite imagery represent land cover rather than land use. For example, the sensor can detect rooftops, but cannot distinguish the use of the building. To determine land use (residential, commercial, industrial, or recreational) and land ownership (public or private), additional geospatial data were combined with the TM land cover information.

Table 25. *Accuracy of land use / land cover legend categories derived from Landsat Thematic Mapper satellite images.*

LEGEND CATEGORY	USER'S ACCURACY in WRB
Snow	100%
Water	100%
Radish Seed	100%
Burned Grass	88%
Hops	85%
Row Crop	75%
Bare/ Fallow	72%
Double Cropping	67%
Mint	67%
Field Crop	53%
Grass	53%
Sugar Beet Seed	50%
Closed Conifer > 200 yrs	80%
Closed Conifer 81-200 yrs	74%
Closed Conifer 61-80 yrs	0%[a]
Closed Conifer 41-60 yrs	38%
Closed Conifer 21-40 yrs	75%
Conifer 0-20 yrs	0%[a]

[a] *This table is based on a test showing a 65% accuracy overall in predicting the 6 conifer age classes represented.*

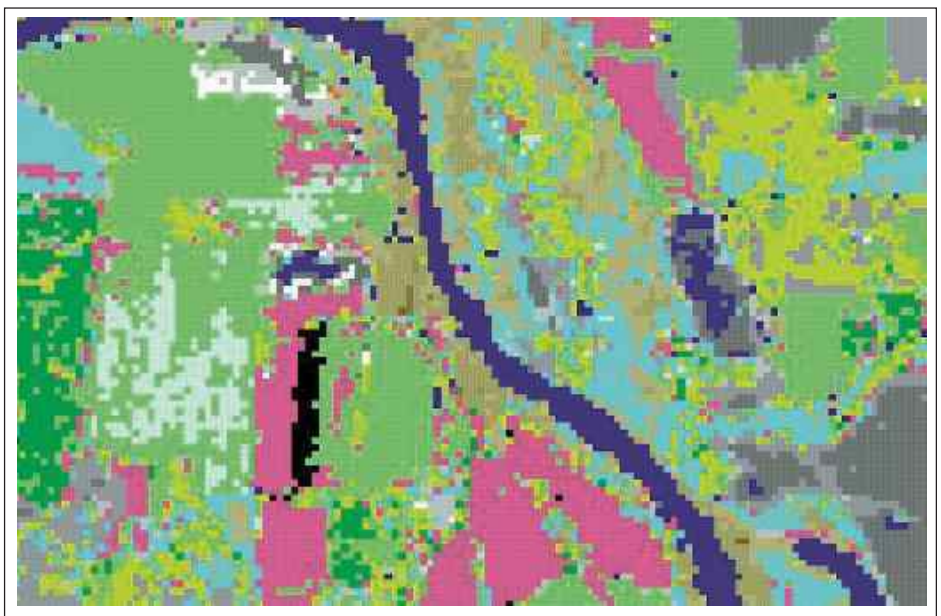


Figure 96. *a) Classified satellite image (above) and b) aerial photograph (below) of land cover from Linn/Benton counties.*

Figure 96. *Comparison of satellite image and air photo from Linn/Benton Counties. These images show some of the challenges in classifying TM land cover data. Some features, like water and woody vegetation, are distinct in the classified land use image (a) while others, such as narrow roads seen in the aerial photograph (b), are not. A single agricultural crop in different states of growth, harvest, or irrigation will reflect different spectral signatures back to the satellite, and conversely, two different land covers, like field crop and natural grassland, may have similar spectral signals. These levels of uncertainty are quantified in the accuracy for each legend category (Table 25) and show the benefit of having satellite images from different times of the year, as well as additional independent data sources to help define valley land use and cover type.*

The legend categories for Map 24 were determined with user accuracy ratings and include classes needed for representing current conditions (LULC ca. 1990) and those needed for depicting landscape characteristics in the alternative futures maps (pp. 87, 89, 91). Where necessary, TM data were augmented or refined with other data sources. These sources included aerial photographs, roads data from the Oregon Department of Transportation (ODOT), USGS topographic quadrangle maps, tax assessor parcel data, and 1990 US Census data. Within UGBs county tax assessor data were used to refine land use classifications.

Built Features

As seen in the LULC ca. 1990 map legend (p. 79), built features include urban, rural, and transportation structures. The term "urban" is used for areas within UGBs: all other areas are considered rural. The UGB has greatly shaped Oregon's population growth patterns since its adoption ("General Land Use Zoning" pp. 72-75). The WRB contains 69 UGBs, only 5 of which are outside of the Willamette Valley Ecoregion. Urban services such as water and sewer lines do not extend into rural residential areas. Typically, each rural residence establishes its own well and septic system.

In urban areas, digital data from tax assessor parcel records were used to classify structures as residential, commercial, or industrial. For Yamhill and Columbia counties, where digital tax assessor parcel data were not available, TM data were used to depict developed areas. For parcels in the residential category, population and household size data from the 1990 U.S. Census were applied to calculate gross residential density as dwelling units (DU) per acre of land.

In rural areas, built structures were mapped by extracting data from digital USGS 7.5' topographic quadrangle maps. These structures and their uses were not categorized to the same level of detail as those in urban areas.

ODOT data were used to locate interstate highways, principal arterials, minor arterials, major urban collectors, and railroads. Minor local roads were added in urban areas where tax assessor parcel data identified a public right-of-way.

Agriculture

TM data serve as the foundation for the agriculture categories. The set of 5 TM scenes from March through August 1992 provides data for an entire growing season. This makes it possible to identify agricultural fields that are used for production of multiple crops over the season. The agricultural data were refined with aerial photographs, USDA farm records, county statistics, and field checks.[93]

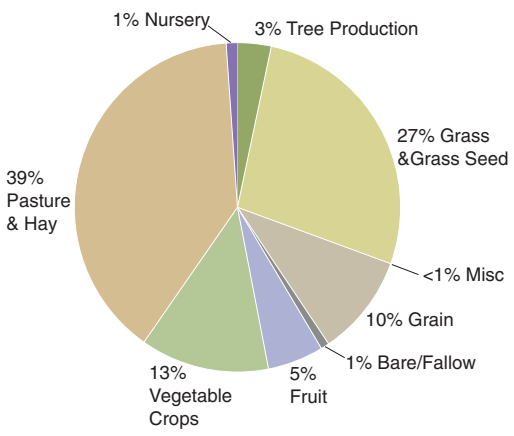


Figure 97. *Percentage of WRB agricultural acres in various categories of production. Numbers are based on 1,406,000 total agricultural acres and aggregation of agricultural categories from LULC ca.1990 map.*

Oregon's leading agricultural commodities circa 1990 were cattle, greenhouse products, hay, and grass seed. The percentage of WRB agricultural land used for production of various crop types is shown in Figure 97. The figure is based on the 1,406,000 acres defined by land use/land cover as WRB land in agricultural production circa 1990 and includes both private and public lands. Approximately 85% of Oregon's farm products are sold outside of the state.[105] Further discussion of the crops and cropping systems can be seen in the agriculture section (pp. 102-103).

Natural and Native Vegetation

Map 24 shows that the vegetation in the WRB differs greatly between the Uplands and the Lowlands (WVE), due in part to the differences in topography, soils, and climate. However, because the Uplands and the Lowlands were mapped separately each with a different focus, there are some legend categories that appear only in the Lowlands, and others only in the Uplands.[106] For example the data used in the Uplands, which focused on forest cover,[95] did not include natural grassland, natural shrub, flooded marsh, or wet prairie classes. For the most part these vegetation types do not occur in the Uplands. Where open areas do occur, e.g., alpine meadows, they were classified under "upland forest open." Similarly, open and semi-closed forest categories were not included in the Lowlands; any Lowland areas with open or semi-closed forest were included in the "natural shrub" legend category.

The majority of the forest classes were derived from TM data. However, for disturbances in forested areas such as recent clearcuts or major fires the satellite image results varied depending on the remaining ground layer. In order to define the legend category "Conifers aged 0-20 years," forest disturbance information gathered from 1972-1988 was used.[94] Figure 98 shows the proportion of forest types in the basin ca. 1990.

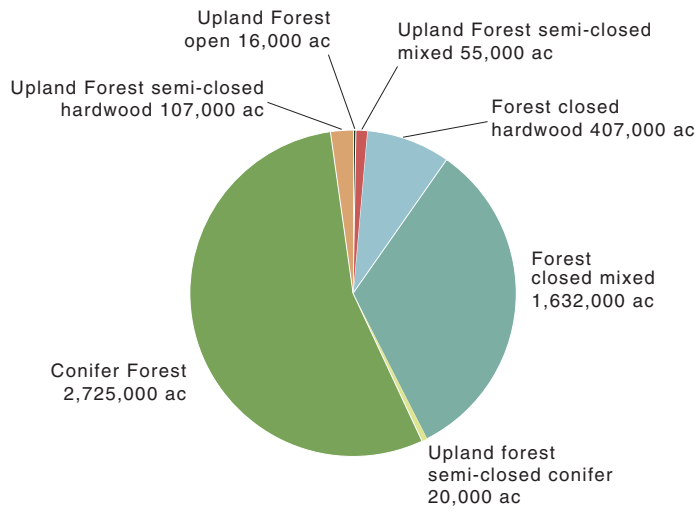


Figure 98. *Acres of forest type as a proportion of total forest acres in the Willamette Basin ca. 1990. These data were derived from PNW-ERC TM analyses. Figures are rounded to the nearest 1000. Note: 2.47 acres equal 1 hectare.*

Relatively natural vegetative communities have been reduced to about 10% of their previous extent of the early 1800s.[52] Many of the once-extensive wetlands have been tiled, drained, or filled to graze livestock, grow crops, or build roads, houses, and industry. Natural vegetation in an agricultural field, such as a clump of trees, was classified as natural rather than agricultural to facilitate restoration opportunities modeled in the Conservation Scenario (pp. 90-91). The conifer, deciduous, and mixed forests, flooded marsh, and natural shrub legend categories were classified in this way, but natural grassland was not due to its low confidence rating.

All categories in the "Natural and Native Vegetation" section of the legend were derived from TM data except for Oak Savanna and Wet Shrub, which cannot be reliably distinguished from that source. Very little to no oak savanna remains in the valley today.[106] Even where there are large, open grown oaks, the understory has typically been altered from the native grassland of pre-EuroAmerican settlement (p. 39).

Water Features

The water features in the basin were mapped using three principal sources. Large rivers and lakes were mapped using TM and 1990 Census TIGER data; small streams were mapped using USGS maps. These sources were further refined with digital elevation models, USGS topographic quadrangles, 1994-1995 digital orthophoto quadrangles, aerial photographs, and 54 field checked points (see p. 156). The 54 points were checked with a Global Positioning System (GPS) unit to verify the location of road and stream intersections. Because of its 30x30 meter pixel size, the composite Map 24 does not show the smaller streams, but they can be seen in the stream network map (pp. 16-17) and the entire stream network was used for aquatic and riparian aspects of modeling the alternative futures.

Unknown

The Unknown class includes areas with insufficient data to allow classification within the defined land use/land cover categories. An example of this is the rural non-vegetated unknown category. The urban non-vegetated unknown category includes areas where the tax assessor parcel data were undefined or ambiguous.