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Willamette Valley Land Use

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Willamette Valley Land Use Change

Author contact information

Wynn W. Cudmore, Ph.D., Principal Investigator
Northwest Center for Sustainable Resources
Chemeketa Community College
P.O. Box 14007
Salem, OR 97309
E-mail: wynn.cudmore@chemeketa.edu
Phone: 503-399-6514

Willamette Valley Land Use Change – Module Description

This module is an expansion of an existing laboratory that uses aerial photographs to evaluate land use change at the local level (See: Environmental Science III, pp. 115-126 – *The Use of Aerial Photography to Evaluate Land Use Changes*.) In this activity students examine various images (available in print and on the web) and prepare a detailed analysis of land use changes in the Willamette Valley, Oregon. Using these images, students describe observed and inferred changes in ecosystem elements such as water quality, land use, wildlife habitat, forest type and riparian vegetation. Similar images of future conditions illustrate the effects of different policy decisions implemented today. The activity requires students to synthesize a number of important concepts and thus, is an excellent capstone activity for an environmental science course. While the activity uses imagery that is specific to western Oregon, the concepts introduced are universal. Thus, the activity could be implemented at any location. Alternatively, with access to local imagery the activity could be used as a template for a land use change exercise at any location in the United States. Resources are provided that direct faculty to some of this imagery.

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Willamette Valley Land Use Change

Introduction

The evaluation of human impacts on the environment is an important element of natural resource management and the resolution of environmental issues. Although you may be quite familiar with local impacts such as emissions from a nearby factory or impaired water quality in a local stream, impacts on broader scales of time and space may be less familiar. In general, human life spans and attention spans are too short to fully appreciate the extent of changes in the landscape over time. A better understanding of the rate and trajectory of land use change is vital to the interpretation of environmental trends and the management of our natural resources. An examination of present conditions and their comparison with our best estimates of past and future conditions provides you with an opportunity to explore this concept.

New technologies are now available that provide us with the necessary tools to illustrate land use changes on broad scales of time and space. The following activity has been developed to illustrate changes in the same landscape over a relatively long (in human terms, at least) period of time. You will then predict the environmental impacts of these changes. Resulting future landscapes based on several different management policies are then evaluated.

Objectives

Upon successful completion of this activity, students should be able to:

1. Evaluate computer-generated imagery of landscapes to determine environmental changes and the inferred impacts of those changes.

2. Evaluate possible future landscapes and project the impacts of various environmental policies.

Background

The Willamette Valley ecoregion occupies the lowlands of the Willamette River Basin (WRB) located in the northwest section of Oregon (Fig. 1). The WRB is defined as all lands that drain into the Willamette River, a major north-flowing tributary of the Columbia River. The watershed occupies an area of approximately 11,500 square miles. The WRB is bound by the Cascade Range to the east and the Coast Range to the west and extends from 40 miles south of present-day Eugene to 30 miles north of Portland (Fig. 2).

Figure 1. Willamette Valley location map

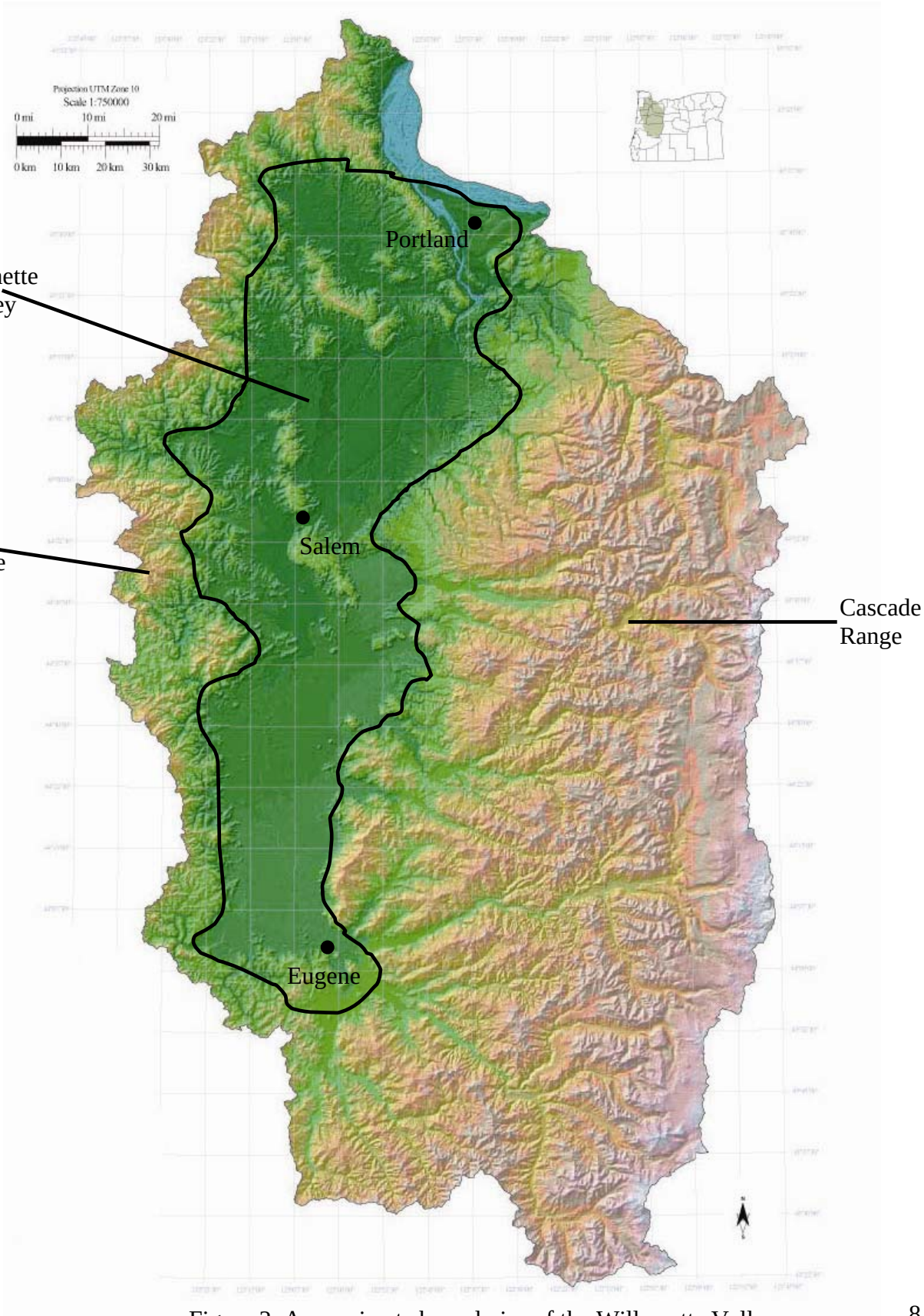


Figure 2. Approximate boundaries of the Willamette Valley within the Willamette River Basin.

For the first Euro-American pioneers to cross the Oregon Trail, the Willamette Valley was seen as a "Garden of Eden" at the end of a long and perilous journey. From their accounts we know that the valley was dominated by tall grasses and deep, fertile soils. When the first pioneers arrived they found not a deep, impenetrable forest but rather a park-like landscape of open meadows dotted with large oak trees. Although unknown to the early settlers, this ecosystem was not natural but rather one that had been carefully managed by Native Americans of the area - the Kalapuya tribe - for hundreds of years. The Kalapuyas periodically burned the valley to promote the growth of plants and animals that were essential to their culture and diet.

Stable and easily accessible populations of deer, waterfowl, grasshoppers and a variety of early successional plants were all promoted as a result of the burning. Foremost among these was camas lily, the staple of the Kalapuya diet. While most of the coastal tribes such as the Chinook tribe of the Columbia River and the Coast Salish of Puget Sound relied heavily on salmon as their main food source, the Kalapuyas apparently relied more heavily on plants as a food source. Perhaps for this reason, lower population densities were supported. It has been estimated that at their peak the Kalapuyas numbered about 13,500 or approximately 50 per square mile.

In the absence of fire, successional changes result in the disappearance of camas and the appearance of later successional stages dominated by Garry oak on dry sites and a mixture of cottonwood, alder, big-leaf maple, grand fir and Douglas-fir on wetter sites along rivers and streams and on north slopes. Geographical and climatic factors made lightning strikes and natural fires a rarity, therefore the Kalapuyas would set their own fires. Fires were set on alternate sides of the Willamette River to assure that while one area was being regenerated the other could be used for home sites. Early explorers of the Willamette Valley including English botanist David Douglas in 1826 commented in their journals about the "burned over nature" of the land. By burning the Willamette Valley periodically the Kalapuyas altered the natural ecosystem in such a way that made it more suitable for their needs. The intersection of this prairie ecosystem with the forested ecosystem of the foothills of the Coast Range to the west and the Cascades Range to the east provided ideal habitat for deer and elk which were also important sources of food. Native grasses would proliferate in burned areas when the fall rains came. These native grasses attracted waterfowl such as geese, ducks, swans and other species which would graze on the fresh grasses. These concentrations of waterfowl made hunting much easier. The grassy meadows also supported large populations of grasshoppers which were collected, baked and eaten as a supplemental food source.

Fires also enhanced production of another important food source — acorns. In the absence of fire, Garry oak would grow in dense stands in which individual trees are in competition with each other and other species. By virtue of their thick bark, mature Garry oak trees are relatively resistant to quick, ground fires typical of this ecosystem. Therefore, in an environment of periodic fires, large Garry oaks are unaffected while their competitors, including scrub oaks of the same species, were removed. This results in a landscape dotted by large, sprawling, open-grown oaks referred to as "savannah oaks", a name derived from the similarity with vegetation in savannah biomes such as the Serengeti Plains of Africa. Such open-grown oaks are often prolific producers of acorns.

Although it is clear from the journal of David Douglas that he regarded the Kalapuyas as "inferior savages", from what we know of their culture, these people had a deep awareness of their environment and the ways to alter it for their benefit. Like so many other Native Americans, contact with Euro-Americans led to the demise of the Kalapuyas. A number of factors contributed to their decline. Exposure to European diseases first took their toll. Diseases for which the Kalapuyas had no immunity such as smallpox, venereal disease and malaria were all brought in by European settlers. In addition, starvation resulted from the disruption of their food gathering culture. Periodic burning of the valley followed by the gathering of food were simply not compatible with the European system based on permanent agriculture and grazing livestock. By the mid-1840's the demise of the Kalapuyas was nearly complete — only 300 remained when Daniel Lee, nephew of Jason Lee, established the Methodist Mission in the mid-Willamette Valley.

With the decline of the Kalapuya culture, areas of the Willamette Valley that were not put into cultivation by European settlers reverted to natural successional changes. Oak reproduction and the growth of scrub oaks which had been minimal due to the periodic fires of the Kalapuya, began anew. Today the vegetation of the Willamette Valley is dominated by introduced grasses grown for animal feed and grass seed. On the uncultivated knolls of the valley such as those on Baskett Slough National Wildlife Refuge a plant community dominated by Garry oak and a mixture of native and introduced grasses can be seen. Two distinct age classes of Garry oak can be identified. The large diameter, sprawling **savannah oaks** are remnants of those that were present during the reign of the Kalapuyas. Core samples from these trees indicate that their average age is 293 years. The smaller diameter, straight-trunked, **forest grown oaks** appear in dense stands on these knolls. They represent those trees that were able to reproduce as the fires of the Kalapuyas were extinguished. They average about 100 years. Age classes between these two extremes are virtually non-existent.

Historical Vegetation Changes in the Willamette Valley

As you consider changes in land use, you may find it useful to know what changes in general have occurred in the Willamette Valley since European settlement. From 1851 to 1865 the federal land survey agency, known as the General Land Office (GLO) mapped the Willamette Valley in preparation for settlement. The Valley was subdivided into square mile sections and the topography, soils and vegetation were described in the surveyors' notes for each section. The estimates of land cover for 1851 were derived from these early surveys; 1990 estimates were derived from Landsat satellite thematic mapper images (Table 1).

Table 1. Estimates of Land Cover for the Willamette Valley, Oregon in 1851 and 1990

Land Cover	1851 % of area	1990 % of area	Percent gain (+) or loss (-)
Development	0.0	10.7	+
Agriculture	0.0	33.5	+
Natural grass	18.9	0.6	-97.0
Natural shrub	13.3	7.6	-43.0
Hardwood forest	5.4	6.5	+20.9
Mixed forest	3.7	15.5	+322.1
Conifer forest	36.6	23.3	-36.2
Savanna	13.0	0.0	-100.0
Wetland	7.9	0.4	-94.5
Water	1.3	1.6	+20.5

The most significant changes in Willamette Valley vegetation over this time frame are the conversion of natural prairies, shrublands and savanna into agricultural and developed land. Today, prairies and savannas are among the rarest plant communities in the Willamette Valley. Also, most of the once-extensive wetlands were tiled, drained or filled for the production of hay, grain and cattle grazing and later, for roads, houses and industry.

Procedure

Below are two procedures for student use in analysis in the WRB: (1) changes occurring from 1851 to 1990), and (2) prediction of the impact based on future scenarios.

Historical vs. Modern Comparison

1. Carefully examine the projected image - a comparison of the same view across the Willamette Valley in western Oregon at two different times - 1851 (top) and 1990 (bottom). The view is looking east across the valley floor just north of present-day Eugene. The 1851 image is a computer simulation based on the records of the General Land Office; the 1990 image is based on satellite imagery and aerial photography.

2. Complete the table on the following pages for each of the characteristics listed by comparing the two images and describing:

    - CHANGES: Observed or inferred changes or differences between the two images
    - IMPACTS: Predicted impacts (observed or inferred) of those changes

Characteristic	Changes	Impacts
Willamette River	From: To:	
Wetlands	From: To:	
Riparian Vegetation	From: To:	
Urbanization	From: To:	
Agriculture	From: To:	

Characteristic	Changes	Impacts
Native Prairie/Savanna	From: To:	
Water Quality	From: To:	
Forests	From: To:	
Fish and Wildlife Habitat	From: To:	

Future Scenarios

Now that we know "where we have been" with respect to land use changes in the Willamette Valley, it may be interesting to project "where we'll be" in the future. The characteristics of the Willamette Valley in the future will be determined both by the changes that have already taken place as well as the land uses choices we make today. The attached images illustrate the consequences of three possible policy choices after several decades of implementation.

Each of the three scenarios (described in detail below) illustrates the landscape as it would appear in 2050 and assumes a population of 3.9 million people, approximately double the 1990 figure.

Plan Trend 2050 (Status quo)

This scenario assumes that current land use plans for the region will be fully implemented and that current land use laws will remain essentially intact. Oregon's land use planning system was established in 1973 and is considered a national model. Every city and county is required to have a comprehensive land use plan. Local zoning and planning are done by local officials but state regulators have the power to write and enforce rules. Regulations and decisions are guided by 19 statewide planning goals including the protection of agricultural and forest lands, maintaining water and air quality and meeting the housing needs of its citizens. These goals were established to prevent the type of urban sprawl that had accompanied population growth in other parts of the United States. They are designed to protect Oregon's natural resources and to guide development in such a way that a high quality of life is maintained in the state. Urban sprawl is controlled by establishing "urban growth boundaries" (UGB's) which create an orderly and efficient transition from rural to urban land use by designating areas for future urban development. Every city must establish a UGB that delineates this area.

Under this scenario the management of federal forested lands in the region would continue to be dictated by the Northwest Forest Plan which uses ecosystem management as its guiding philosophy. Planning is conducted at the watershed level, old growth forests are protected as "late successional reserves" and streams and adjacent areas are protected as "riparian reserves". On state and private lands riparian buffers are established at 70 – 100 feet on all streams.

Recent trends in population growth, water and land use are assumed to continue on their current trajectories for this scenario. This plan shows 93% of the population living within urban growth boundaries by 2050 and UGB's have been expanded to accommodate this larger population.

Development 2050 (Economic emphasis)

This scenario emphasizes short-term economic gain in the establishment of land use policy. It assumes that land use laws will be relaxed to better accommodate development interests resulting in fewer restrictions on where development can occur. A recent successful effort, for example, requires the state to either compensate landowners for decreased property values due to land use laws or to exempt that property from the land use regulation. Under the Development 2050 scenario both urban and rural residential land use increase with existing agricultural and forest lands making way for this expansion. Development is allowed in riparian zones, on prime agricultural soils and in wetlands smaller than 5 acres. Riparian buffers are established at 150 feet on all large streams on federal forest lands, but are not required for streams on state or private lands. Timber harvest levels are based on average annual cutting rates for 1973-1995.

Conservation 2050 (Environmental protection emphasis)

This scenario prioritizes ecological services in land use policy. The protection of aquatic and terrestrial native habitats is paired with resource conservation and ecological restoration efforts. The result is an overall increase in the extent and quality of natural habitat as compared to 1990 levels as well as other future scenarios. Urban growth boundary expansion is somewhat greater than that of the Plan Trend 2050 scenario due to the protection of riparian vegetation within UGB's. On federal forests, tree harvest is limited to harvesting young stands on a 60-year rotation and most federally managed forest lands are in reserves. On state and private forests, longer rotations are implemented resulting in significantly more late successional forests. All national wildlife refuge lands currently leased for agriculture are converted to natural habitat. Riparian buffers are established at 300 feet on all streams on federal forest lands, 200 feet on all state lands and 100 feet on all private lands.

Carefully examine each of these images and predict the impacts to the ecosystem characteristics listed in the previous table. Summarize your predictions in the space provided below:

1. Plan Trend 2050

2. Development 2050

3. Conservation 2050

Which of these scenarios would you support and why?

Notes to Instructors

This activity is designed to summarize the topic of "land use" but it also ties in a number of environmental science topics. It may be used as a stand alone activity or as a follow-up to the NCSR laboratory entitled "The Use of Aerial Photography to Evaluate Land Use Changes" (See: *Environmental Science III*, pp. 115-126). While the activity uses imagery that is specific to western Oregon, the concepts introduced are universal. Thus, the activity could be implemented at any location. Alternatively, the activity could be used as a template for a land use change exercise at any location in the United States. Resources are provided that direct faculty to some of this imagery.

The images and descriptions used in this activity were developed by the Pacific Northwest Ecosystem Research Consortium (PNW-ERC), a regional research consortium involving researchers at Oregon State University, the University of Oregon, the University of Washington and the Environmental Protection Agency. The objectives of the consortium are to:

1. create a regional context for interpreting trajectories of landscape and ecosystem change
2. identify and understand critical ecological processes
3. develop approaches for evaluating outcomes of alternative future land and water use, management and policy

The Willamette River Basin Planning Atlas supports these objectives by compiling analyzing, and representing the best available information about critical natural and cultural factors influencing land and water use decisions.

I project several images taken from Hulse, et al., 2002 (copied here) and allow approximately one hour for students to evaluate and complete the attached tables. This may be done individually or in small groups. Images are projected in the following order:

1. 1851 (Pre-EuroAmerican Scenario) vs. 1990 (Land Use/Land Cover) Comparison (p. 82)
2. Map 29. Pre-EuroAmerican Scenario and Map 30. 1990 Land Use/Land Cover (p. 94) (OPTIONAL)
3. Future Scenario images (Plan Trend 2050, Development 2050, Conservation 2050) (p. 82)
4. Maps 31, 32 and 33 Future Scenario comparison maps (p. 95) (OPTIONAL)
5. Maps 25, 26, 27 and 28 Individual Future Scenario maps (pp. 87, 89, 91, 93) (OPTIONAL)

Maps 25 through 33 described above are basin-wide, color-coded depictions of land use at a 1:750000 scale. They are available for each of the 5 land use scenarios described in this activity (1851, 1990, 2050 – Plan Trend, Development and Conservation Scenarios).

NOTE: Images are available at the end of this module.

The activity is based on the evaluation of a series of images that depict changes in land use over time. These changes are evaluated over a relatively large area (over 11,000 square miles if basin-wide maps are used) and over a relatively long time frame (200 years) that includes both the past and the future. As a result, students are able to consider changes that extend well beyond their own personal experiences. Ideally, images such as those described in this activity for western Oregon would be available for all regions of the country. Students could then evaluate changes in a region with which they have some intimate familiarity. However, it is unlikely that resources will be dedicated any time soon to efforts similar to this one for all regions of the country. If such efforts have been completed for your area, I would encourage you to use them. In their absence however, the images described in this activity may be used. Although the details and timing of the changes illustrated in this imagery may differ from those in your region, the major concepts illustrated here are common ones across the country.

The availability of similar imagery will probably determine whether or not instructors will adapt the activity for their location. Images and descriptions for some other regions of the country may be found in Sisk, T.D. 1998 cited at the end of this document. Some background information should be prepared by the instructor prior to the activity. This provides students with a better context for the observed changes. Also, questions and tables will need to be customized for another location.

Note that it is not necessary in this activity to identify land use changes as either "good" or "bad". These value judgments are probably best left to students as they evaluate the observed changes in the context of their own value system. Student feedback on this issue may provide for interesting discussion after the activity is completed.

Assessment

Student assessment for this activity is an individual effort and is based on how well students evaluate the projected images. The entire activity is worth 20 points – 15 points for the historical vs. modern comparison and 5 points for the evaluation of future scenarios. Suggested responses are included below. Instructors will need to customize their expectations of responses based on student preparation. Since I usually conduct this activity towards the end of a 3-term sequence of environmental science courses, comprehensive answers are expected. Less complete answers may be expected from students with less background.

Below is a key to historical vs. modern comparison in the first part of this activity. Some potential responses by students are included. Percentages in parentheses represent estimated percent cover for each land use based on information reported in Hulse, et al., 2002.

Characteristic	Changes	Impacts
Willamette River	From: Braided, highly complex river system with oxbows, back channels, sloughs, etc.; highly interactive with its floodplain To: Channelized river lacking above complexity	▸ Some river habitats eliminated for aquatic species (e.g., salmon spawning and rearing habitat) ▸ Changes in flow patterns and proneness to flooding ▸ Greater potential for impacts on human structures
Wetlands	From: Extensive wetlands of many types associated with Willamette River (7.9%) To: Most wetlands replaced with agriculture or urban lands due to filling, draining, diking and tiling (0.4%)	▸ Loss of water quality improvement function of wetlands (e.g., filtration, absorption) ▸ Loss of wetland habitat ▸ Increased proneness to flooding due to decreased water retention ▸ More land made available for agriculture and urban use
Riparian Vegetation	From: Extensive riparian vegetation along river To: Only a narrow band of vegetation remains; conifers mostly removed	▸ Loss of habitat for riparian species ▸ Increased water temperature with impacts on aquatic species ▸ Impaired water quality due to loss of filtering function of riparian vegetation

Urbanization	From: None - some Native American settlements (0%) To: Cities, towns and rural residential development now occupies significant percentage of the landscape (10.7%)	▸ Loss of natural habitats (riparian, wetland, prairie, savanna) ▸ Urban pollutants (air, water, soil) ▸ Energy consumption and CO_2 production ▸ Human population increases consumption ▸ Greater potential for flooding impacts on human structures
Agriculture	From: None (0%) To: Major land use for this area - grass seed, nursery stock, pasture, orchards (33.5%)	▸ Habitat loss/edge creation ▸ Runoff of agrochemicals impacting water quality ▸ Air pollution ▸ Fossil fuel consumption ▸ Agricultural commodity production
Native Prairie/Savanna	From: Major habitat represented To: Minimal	▸ Habitat loss resulting in decline of native prairie/savanna species
Water Quality	From: High quality (inferred) - low temperature, high O_2, low turbidity, etc. To: Poor quality	▸ Decline of susceptible aquatic species ▸ Increasingly difficult and expensive to produce clean water for human uses
Forests	From: *Upland* - savanna-like forests with Garry oaks scattered among grasslands due to natural and human-set fires *Riparian* - extensive cottonwood/maple/conifer forests along rivers	▸ Loss of prairie/savanna habitats ▸ See “Riparian Vegetation”

	To: *Upland* - dense oak forests due to fires suppression *Riparian* - large areas replaced with other land uses	
Fish and Wildlife Habitat	From: Extensive availability of a wide range of terrestrial and aquatic habitats To: Decreased availability of natural habitats (some to near zero)	▸ Loss of natural biodiversity at genetic, species and ecosystem level ▸ Extinction of some endemic species ▸ Increase in number of threatened and endangered species

Below is a key to the "Future Scenarios" part of the activity.

1. Plan Trend 2050

No major structural changes occur in the Willamette River but water quality issues increase with an expanding urban population (expanding UGB's) and no significant increase in riparian vegetation. Upland forests remain essentially unchanged. Some conversion of agricultural lands to urban/residential uses along the edges of the 1990 UGB's has occurred. However, there is no significant loss of agricultural lands in this scenario due to the implementation of Oregon's land use laws which protect most agricultural lands from development. There will be an increase in water demand due to population increases and economic growth.

2. Development 2050

The Willamette River mainstem channel complexity decreases due to river straightening efforts. Other changes and impacts are driven primarily by a relaxation of current land use laws with resulting expansion of urban and rural residential areas. Significant expansion of urban growth boundaries allows for "less confined" urban development and expanded rural residential land use. Forest and agricultural lands are the land types being converted. Consequently, agricultural land use declines in this scenario. Relaxation of riparian buffer requirements results in greater stress on water quality and a decline in riparian habitat availability for wildlife. Increased demands on water due to population increases and land conversion result in increased stress on aquatic species such as salmon.

3. Conservation 2050

The complexity of the Willamette River channel increases due to restoration efforts resulting in more extensive floodplain forests on flood-prone lands. Urban growth boundaries expand beyond 1990 locations but most population increase is accommodated by increased density within existing UGB's. Protection of riparian vegetation within UGB's has a positive impact on water quality. Total agricultural land decreases significantly (12% decrease) due to an increase in riparian vegetation and especially due to re-vegetation along water quality-limited streams. Expanded riparian zones improve water quality and increase habitat for both terrestrial and aquatic species. Forest management and ecological restoration in uplands increases the amount of oak savannah with a resulting increase in habitat availability for wildlife.

Resources

All images described in this activity were originally published in the following document and are used with permission:

Hulse, D., S. Gregory and J. Baker (eds.). 2002. Willamette River Basin Planning Atlas - Trajectories of Environmental and Ecological Change. Oregon State University Press, Corvallis, OR. 178 pp.

http://www.fsl.orst.edu/pnwerc/wrb/Atlas_web_compressed/PDFtoc.html

The following resources provide a broad context for the study of land use change:

Dale, V.H., et al. 2000. Ecological principles and guidelines for managing the use of land. Ecological Applications 10(3):639-670.

Foley, J.A. 2005. Global consequences of land use. Science 309 (22 July 2005):570-574.

www.sciencemag.org

Loveland, T.R., and H.L. Hutcheson. 1995. Monitoring changes in landscapes from satellite imagery. Pages 468-473 *in* E.T. LaRoe, et al. (eds.) Our living resources: a report to the nation on the distribution, abundance and health of U.S. plants, animals and ecosystems. U.S. Dept. of the Interior, National Biological Service, Washington, D.C. 530 pp.

Sisk, T.D. (ed.). 1998. Perspectives on the land use history of North America: a context for understanding our changing environment. U.S. Geological Survey, Biological Resources Division, Biological Sciences report USGS/BRD/BSR 1998-0003 (Revised September 1999). 104 pp.

http://biology.usgs.gov/luhna/cover.html

In addition to providing an excellent introduction to land use change, this publication includes some imagery that documents land use change at a number of locations in the United States. The following are included:

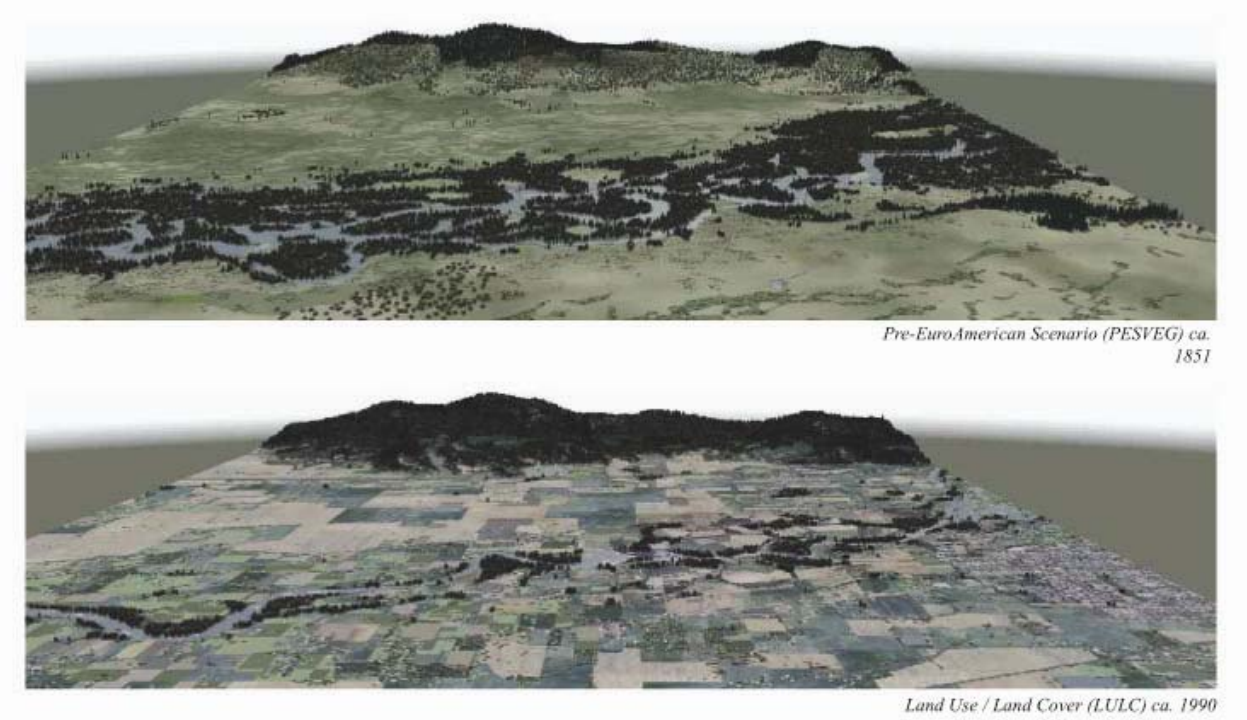
Baltimore/Washington, D.C.
Great Lakes Area
Upper Mississippi River
Colorado Plateau
Greater Yellowstone Area
Palouse Region
Northeastern Forests

While none of the images are as detailed as those described here for the Willamette Valley in Oregon, instructors in these areas will find them to be a valuable resource. For those who wish

to build this activity around imagery that is available for their own location, this is a good place to start.

Images

1. 1851 (Pre-EuroAmerican Scenario) vs. 1990 (Land Use/Land Cover) Comparison (p. 82)

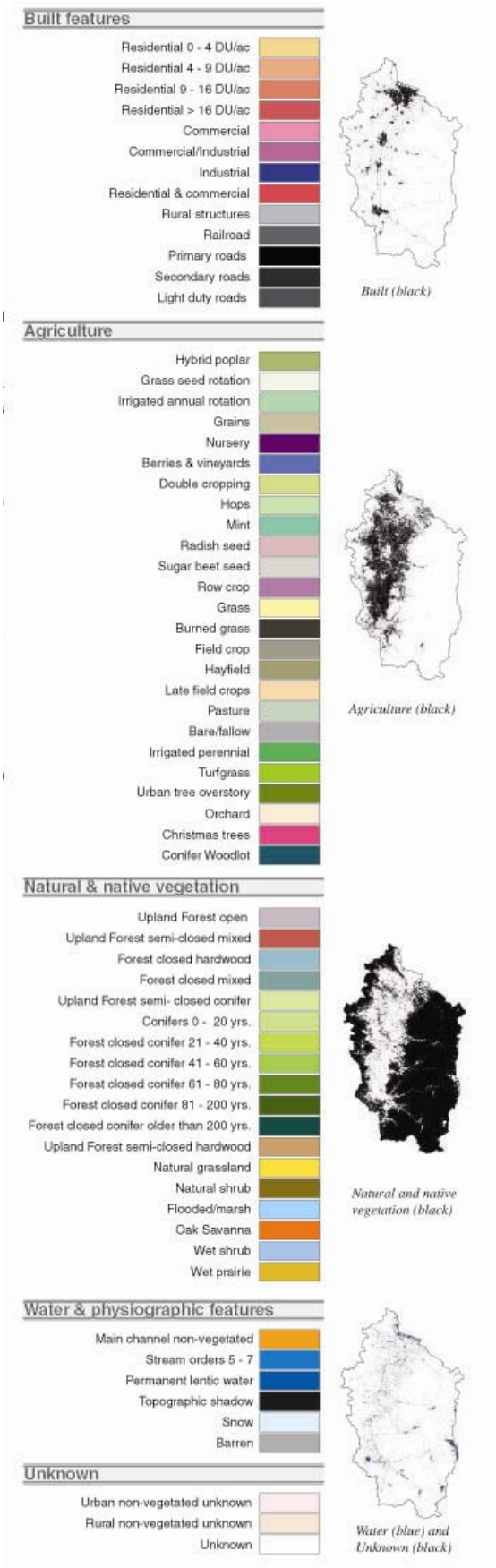


Pre-EuroAmerican Scenario (PESVEG) ca. 1851

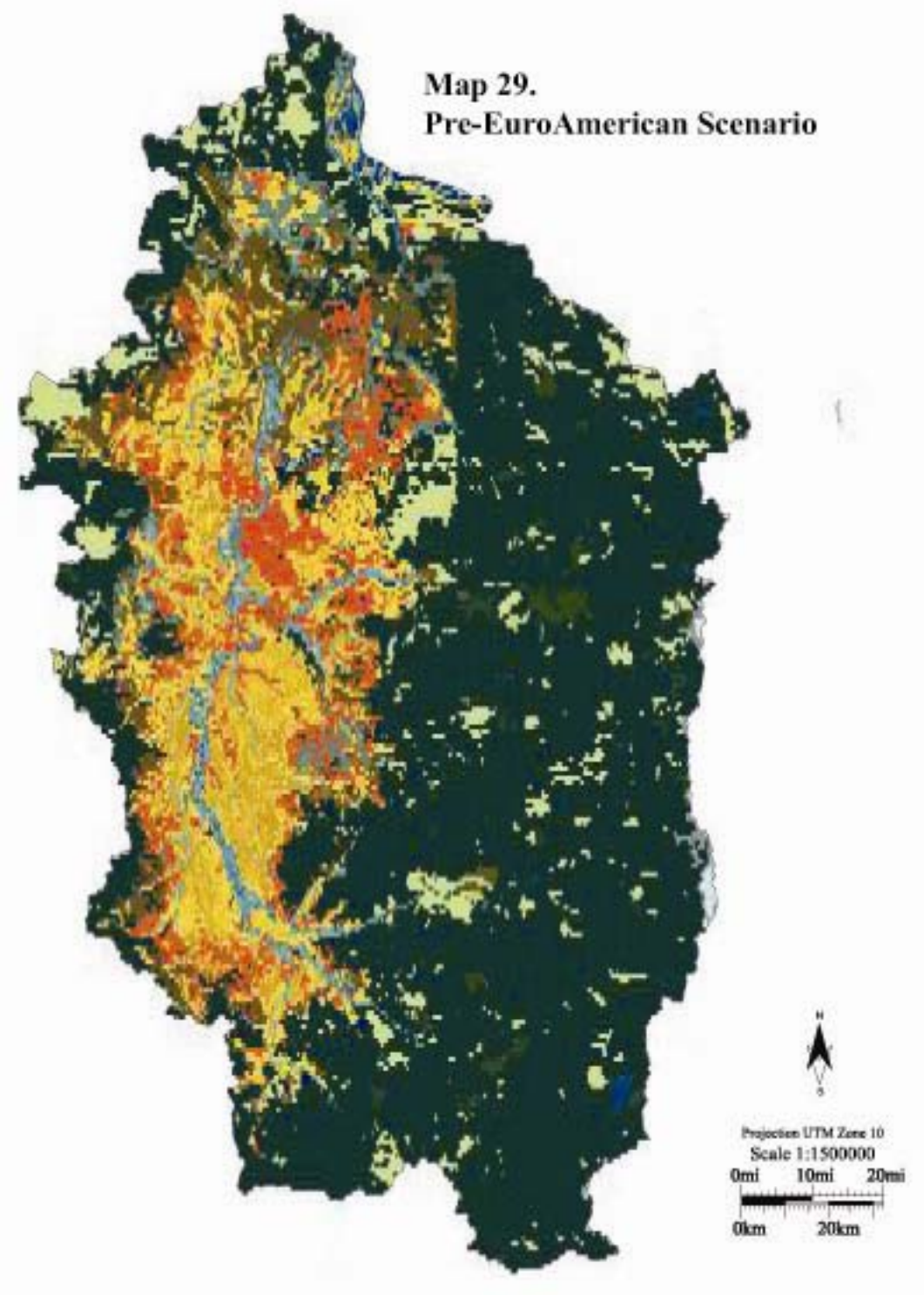
Land Use / Land Cover (LULC) ca. 1990

Map Legend

This legend applies to all maps on the pages that follow.

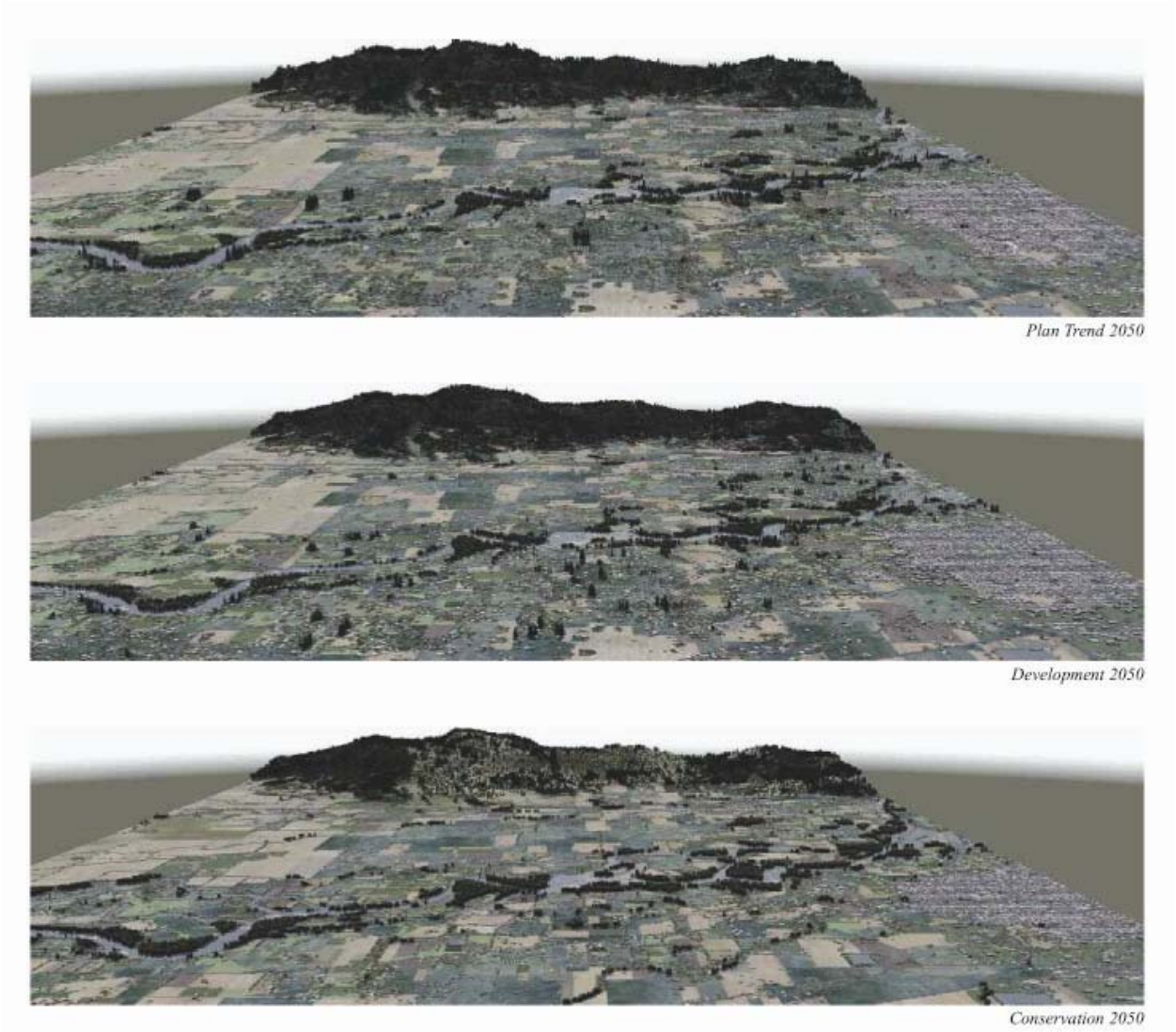


2. Map 29. Pre-EuroAmerican Scenario



3. Map 30. 1990 Land Use/Land Cover (p. 94)

4. Future Scenario images (Plan Trend 2050, Development 2050, Conservation 2050) (p. 82)

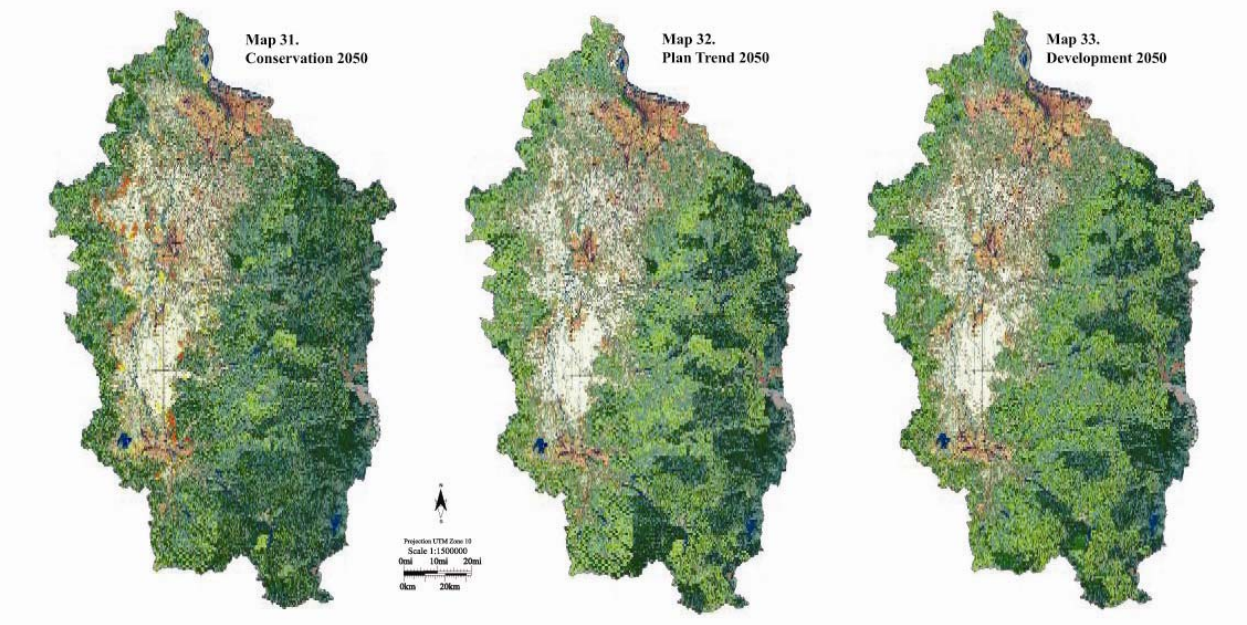


Plan Trend 2050

Development 2050

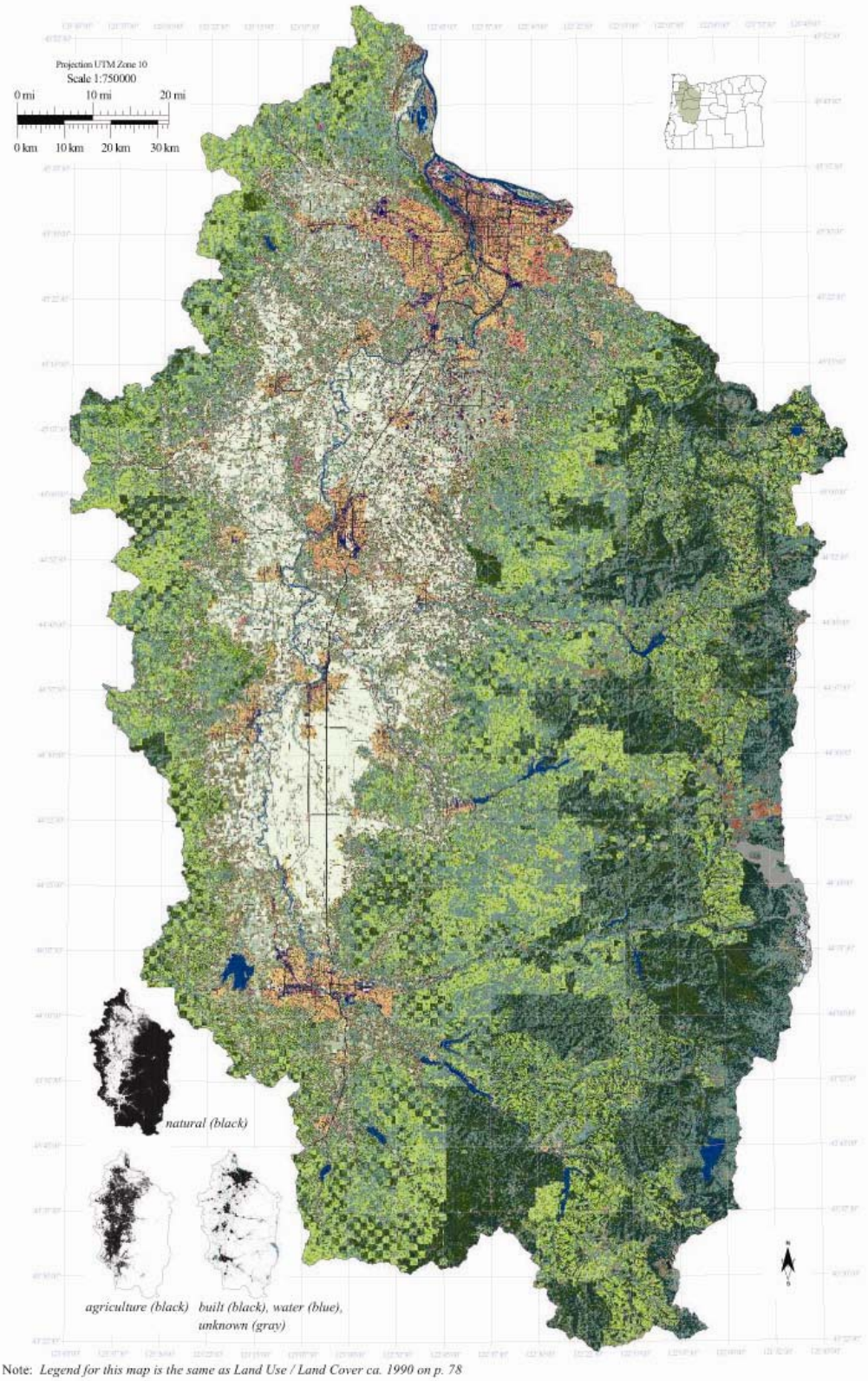
Conservation 2050

5. Maps 31, 32 and 33 Future Scenario comparison maps (p. 95)



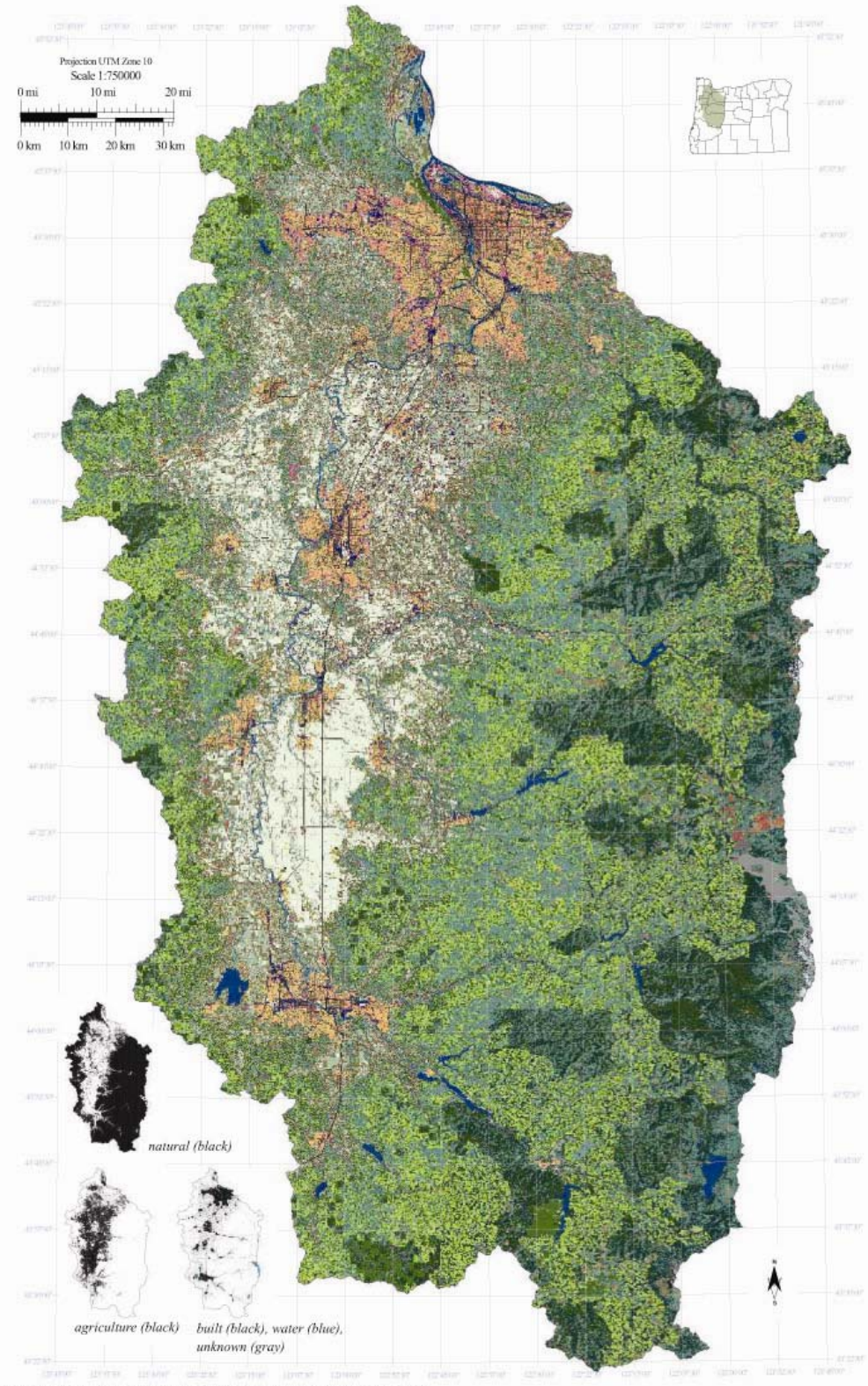
6. Maps 25, 26, 27 and 28 Individual Future Scenario maps (pp. 87, 89, 91. 93)

Map 25. Plan Trend 2050



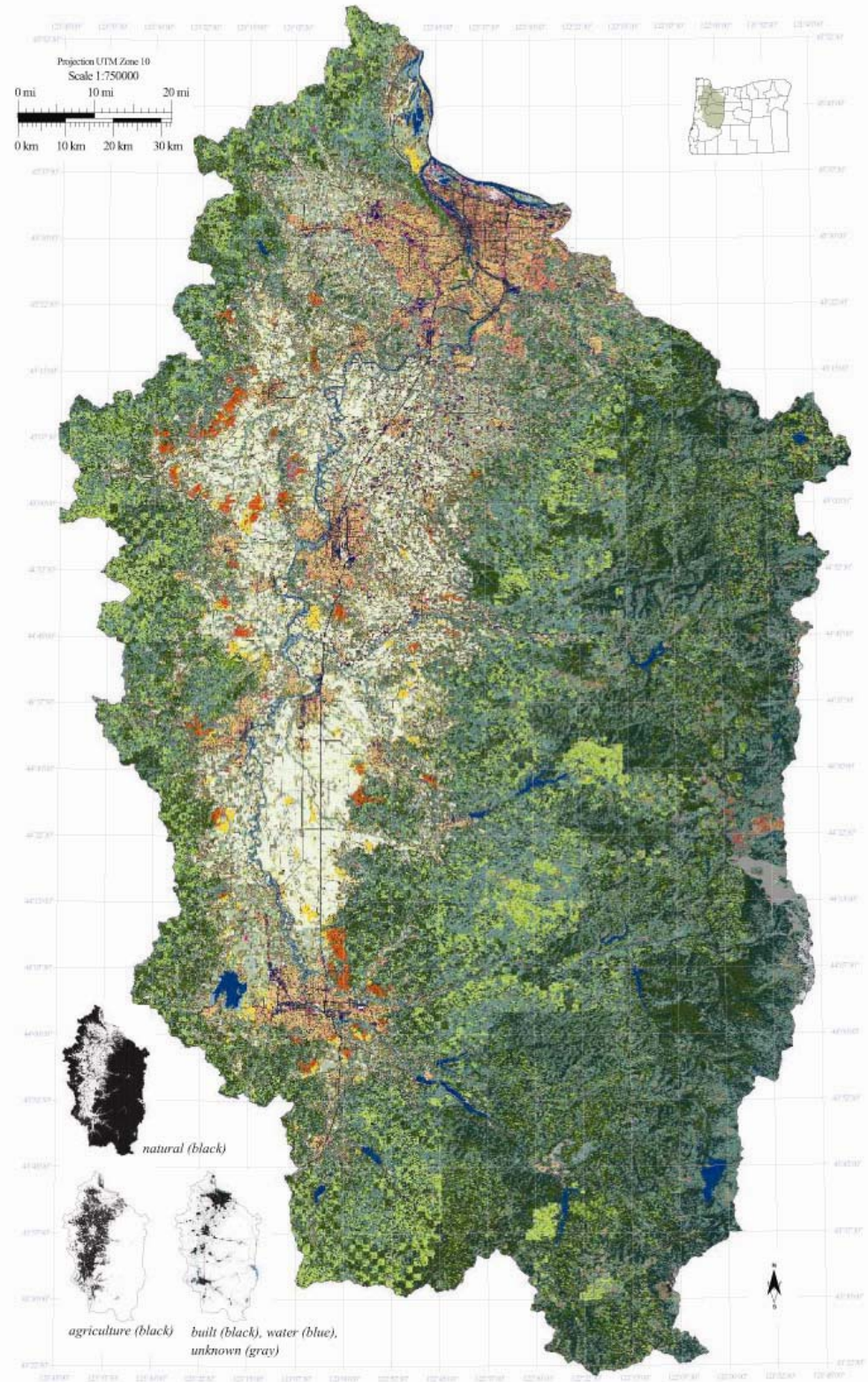
Note: *Legend for this map is the same as Land Use / Land Cover ca. 1990 on p. 78*

Map 26. Development 2050



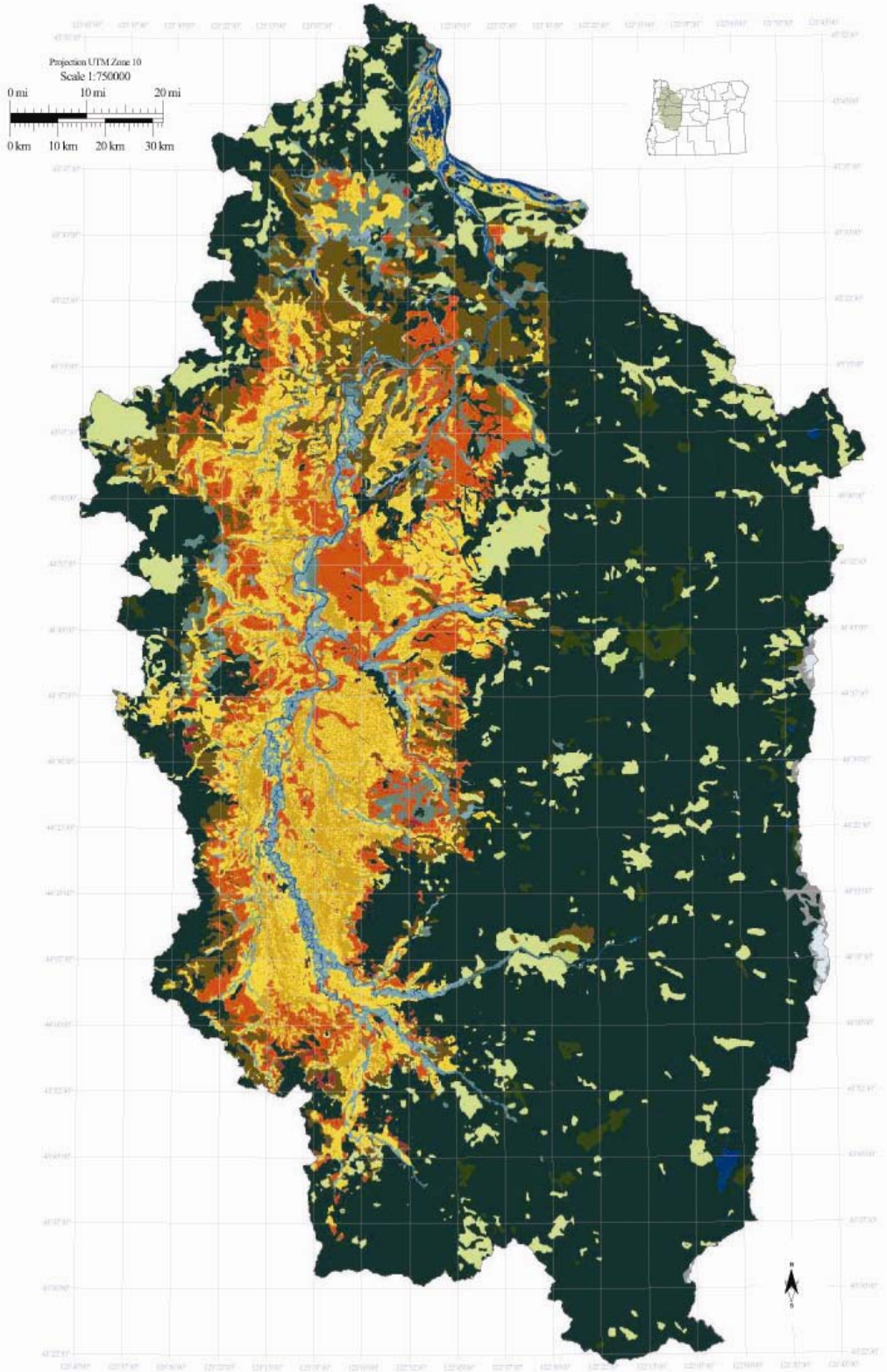
Note: *Legend for this map is the same as Land Use / Land Cover ca. 1990 on p. 78*

Map 27. Conservation 2050



Note: *Legend for this map is the same as Land Use / Land Cover ca. 1990 on p. 78*

Map 28. Pre-EuroAmerican Scenario



Note: *Legend for this map is the same as Land Use / Land Cover ca. 1990 on p. 78*