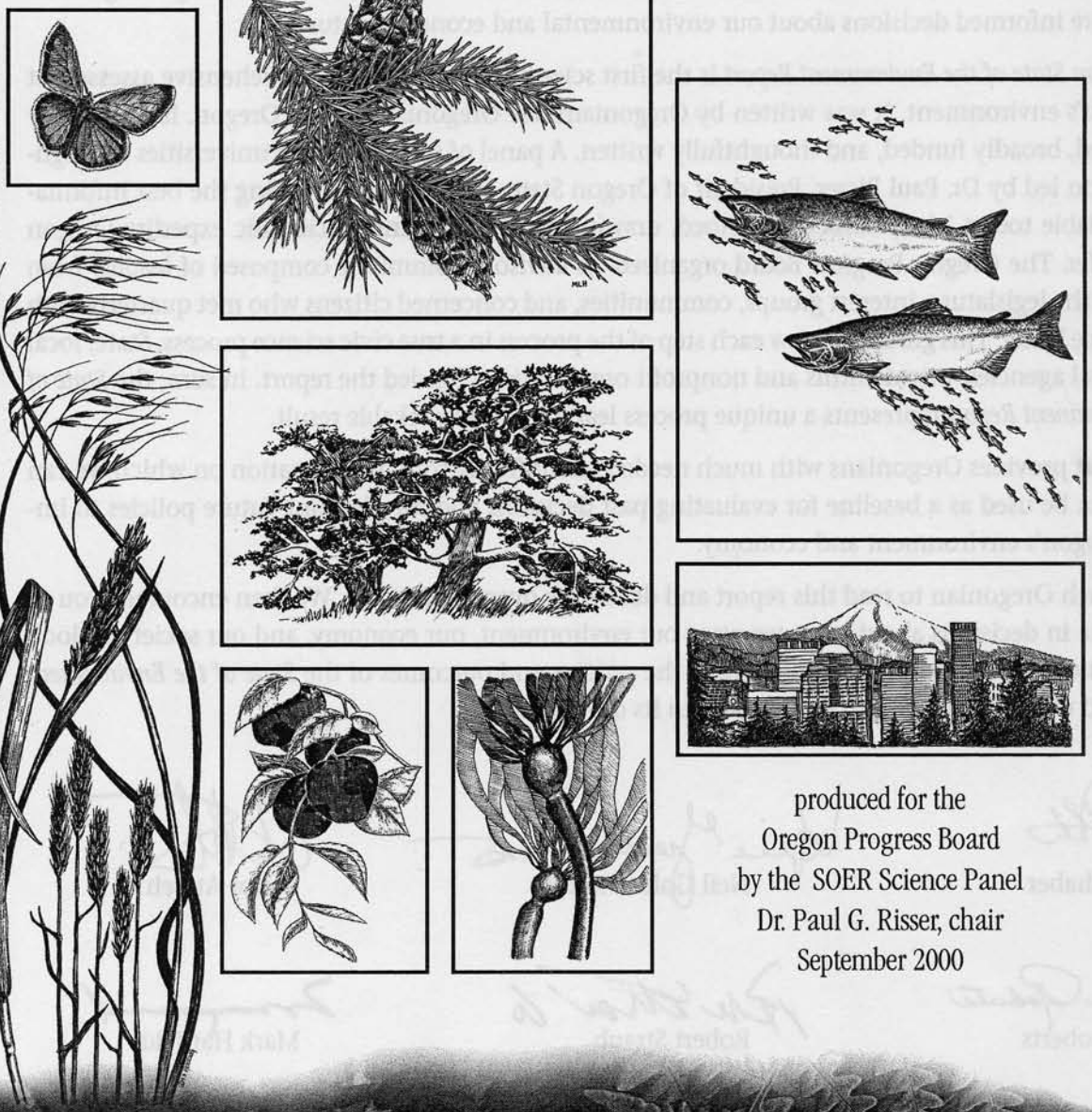
OREGON STATE OF THE ENVIRONMENT REPORT 2000

Statewide Summary



produced for the
Oregon Progress Board
by the SOER Science Panel
Dr. Paul G. Risser, chair
September 2000

A Word from Oregon's Governors...

Dear Oregonians,

Oregon's environment is precious to us all. As Oregon's Governors we each have been committed to protecting Oregon's environment as we seek to improve our economic and social well being.

A spirit of civic engagement and environmental stewardship that defined the Oregon Mystique a generation ago continues to attract new residents to our state. Yet the achievements of the past are not enough to forestall the problems of the future. We have learned that there are limits to Oregon's natural abundance. In places throughout the state, we have seen salmon runs dwindle, forest health decline, and farmers struggle to keep pace with a changing economy. We face limits to our water supply and limits to the amount of waste our land and waters can assimilate. We know that creating an environmentally sound future is a task for all Oregonians.

All too often decisions about how to manage the environment have been characterized by polarizing debates and a lack of credible scientific information. The *Oregon State of the Environment Report* is intended to provide Oregonians with scientifically reviewed information about current conditions and trends across the state and future risks to the environment. This information can help Oregonians make more informed decisions about our environmental and economic future.

The *Oregon State of the Environment Report* is the first scientifically credible, comprehensive assessment of Oregon's environment. It was written by Oregonians, for Oregonians, about Oregon. It was widely considered, broadly funded, and thoughtfully written. A panel of scientists from universities throughout Oregon led by Dr. Paul Risser, President of Oregon State, wrote the report using the best information available today. Many associates helped, drawing on the substantial scientific expertise Oregon has to offer. The Oregon Progress Board organized an advisory committee composed of leaders from business, the legislature, interest groups, communities, and concerned citizens who met quarterly with the Science Panel. This group oversaw each step of the process in a true civic science process. State, local and federal agencies, private firms and nonprofit organizations funded the report. In sum, the *State of the Environment Report* represents a unique process leading to a remarkable result.

This report provides Oregonians with much needed scientifically sound information on which we can rely. It can be used as a baseline for evaluating past decisions and for planning future policies to improve Oregon's environment and economy.

We ask each Oregonian to read this report and deliberate over what it says. We then encourage you to participate in decisions about what we want our environment, our economy, and our society to look and function like in the future. We applaud the process and outcomes of the *State of the Environment Report* and thank all those who participated in its development.

Sincerely,

John Kitzhaber

Neil Goldschmidt

Victor Atiyeh

Barbara Roberts

Robert Straub

Mark Hatfield

Executive Summary

The state has made great strides in resolving critical environmental problems of the past, and now faces new challenges.

In response to environmental problems during the 1960s and '70s, Oregon became a leader in the nation in land-use planning, reduction of waste, and land protection. The quality of life made possible by a healthy environment continues to attract new people and industry to Oregon. On average since 1990, Oregon has added more than 50,000 new residents per year. This brings new pressures to the state's environment.

Overall, the Science Panel found that Oregon has made great strides in resolving some of the critical problems of the past. Oregon's land use laws have limited the loss of forest and farm land. Coastal zone management has helped to reverse the loss of estuarine habitats. Forest practices rules have contributed to protection of forest streams. Recent changes in federal land management emphasize protection of biodiversity on federal forests and range lands.

Yet, the panel found that the State still faces environmental challenges that existing policies and programs may not be sufficient to address, including:

- Inadequate water supplies
- Poor water quality, especially in urban and agricultural areas
- Loss of wetlands
- Degraded riparian areas
- Depleted fish stocks
- Invasions of exotics
- Diminished biodiversity
- Waste and toxic releases

Many of Oregon's key environmental problems are concentrated in the lowlands where most Oregonians live and work.

With few exceptions, these problems are most critical in the lowlands of the major river basins—historically the wetlands, woodlands, and grasslands—that Oregonians have intensively developed for homes, cities, farms, and ranches. These lands are mostly privately owned, and the actions involved come from people and industries going about the ordinary business of life.

Oregon's current environmental problems reflect the cumulative effects of many small, diffuse, individual decisions and actions.

Aquatic ecosystems, which integrate many diverse activities, are most impacted and most at risk. Developing policies and programs to address these cumulative effects is one of the greatest challenges for Oregonians.

The greatest opportunity for improving Oregon's environment in this generation occurs on lands that Oregonians control: on state, county, and private lands.

Much of what potentially can be achieved on federal lands is already reflected in new policies and plans for managing forest and range lands. Private lands have become increasingly important to solving many of Oregon's environmental problems for this generation.

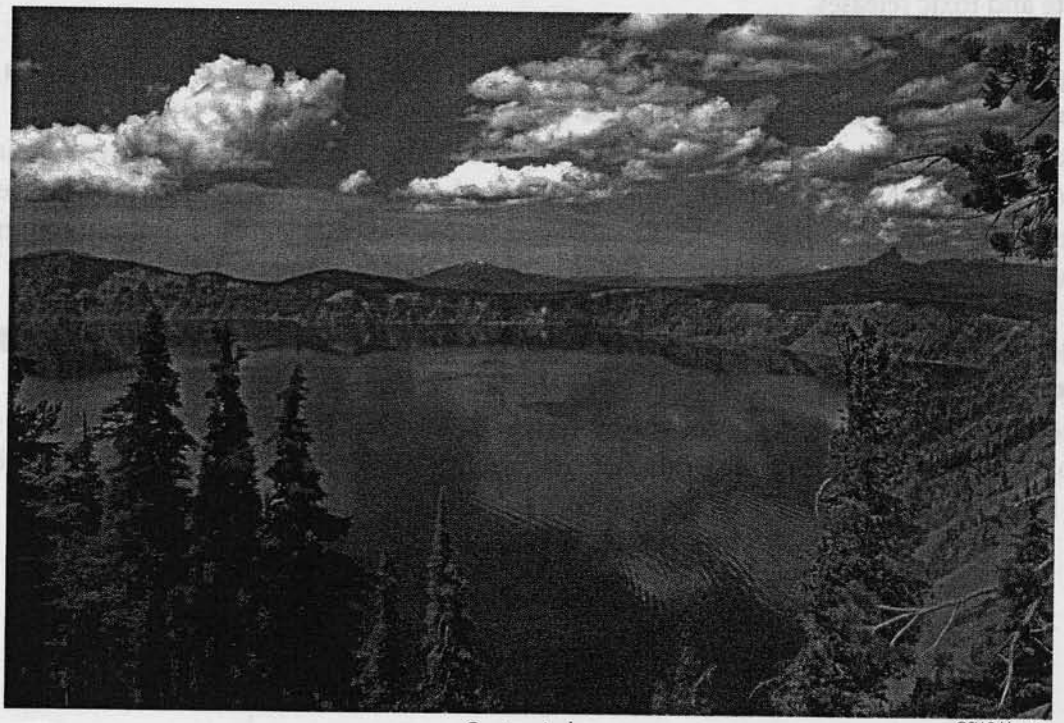
The current challenge on federal lands is to take action based on plans that are now in place or in the process of development.

Federal lands have gone through great change in management in recent years. Implementation of these changes rests with federal managers as well as their citizen partners and neighbors in every Oregon community.

The State's existing environmental data collection and management system must be improved to effectively measure ecological conditions, trends or risks.

Measuring ecological conditions, trends, and risks is fundamentally different from the problems Oregon's environmental programs were initially established to address. Resolving them will require new approaches as described in this report, which are aimed at sustaining the health of naturally functioning landscapes and the productive capacity of the environment.

Science's role is to help us understand the health of Oregon's environment — democracy's role is to determine Oregon's future.



Crater Lake

OSU Publications

Section I. Introduction

The purpose of the State of the Environment Report *is to describe the health of the environment in terms of natural structure and function, and how the environment contributes to a sustainable production of goods and services.*

The people of Oregon care deeply about the environmental quality of their state. They treasure its natural beauty and they depend upon its natural resources for the basics of life as well as a vital part of the state's economy. To continue to enjoy and use natural resources, Oregon citizens want to know that their environmental wealth will last into the future. They understand that the future of Oregon will be shaped by the health of its environment.

If Oregonians are to understand the whole picture of their environment, they need a summary of the status and trends of key natural resources across and within various regions of the state. From such a summary, it should be possible to gain a general understanding of the health of Oregon's environment. This evaluation will also identify where Oregon has been successful in maintaining high environmental quality, and where there are threats to the environment. Specifically, the purpose of the *State of the Environment Report* is to describe the health of the environment in terms of natural structure and function, and how the environment contributes to a sustainable production of goods and services.

The report, however, is not an exhaustive list of environmental issues in Oregon. Constraints of space and time have forced authors to limit their analyses. Nor is the report a compendium of threats to the environment so the reader should not search for discussion of every possible negative environmental impact. This is an analysis of the status and trends, both positive and negative, of the state's most important environmental resources, and an assessment of their current health.

This brief *Statewide Summary* synthesizes the much longer *State of the Environment Report*, which contains a more complete discussion of the resources and ecoregions of Oregon. Both the full report and this summary report were prepared at the request of the Oregon Progress Board by a volunteer panel of scientists under the leadership of Dr. Paul Risser, president of Oregon State University. The full report contains chapters individually authored by Science Panel members, each with different areas of expertise and styles of analysis. Data available for analyzing each resource varied considerably as well. The report's conclusions are, therefore, the result of both analysis of existing data and best professional scientific judgement. All of the individual chapters in the full *State of the Environment Report*, as well as the entire *Statewide Summary*, have been peer reviewed.

The *State of the Environment Report* is significant for four reasons:

First, for the first time Oregonians have an integrated scientific evaluation of the health of the major environmental resources across the state. The environment is a complex and interrelated system, so it is important to evaluate it by considering all the major components simultaneously.

Lynn Ketchum, OSU EESC

Healthy ecosystems have naturally functioning landscapes.

Second, the descriptions of various parts of the environment tell us why we should care about these natural resources. These values that we care about include considerations of natural processes, the goods and services provided to humans, and whether or not the status of natural resources meets the expectations of the law.

Third, the report describes a series of indicators that collectively provide a baseline for understanding the health of Oregon's environment. In the future, these indicators can be used for anticipating and evaluating the consequences of making specific decisions that affect Oregon's environmental quality.

Fourth, the report does not declare how healthy the environment should be. Such choices are not for a science panel to decide, but rather must be made by the people of Oregon as they decide how to manage their natural systems. This report sets the stage from which these decisions can be made with considerations of the total environment rather than one element at a time. By identifying the key natural resources, describing current conditions, and developing measurements that indicate trends, the report provides a scientific basis for understanding the status of Oregon's environment.

Findings

In response to environmental problems during the 1960s and '70s, Oregon became a leader in the nation in land-use planning, reduction of waste, and land protection. The quality of life made possible by a healthy environment continues to attract new people and industry to Oregon. On average since 1990, Oregon has added more than 50,000 new residents per year. This brings new pressures to the state's environment.

Overall, the Science Panel found that Oregon has succeeded in resolving some of the critical problems of the past. Oregon's land use laws have limited the loss of forest and farm land. Coastal zone management has helped to reverse the loss of estuarine habitats. Forest practices rules have contributed to protection of forest streams. Recent changes in federal land management emphasize protection of biodiversity on federal forests and range lands. Yet, the panel also found that Oregonians now face a new set of environmental challenges that existing policies and programs may not be sufficient to address.

Many of Oregon's key environmental problems are concentrated in the lowlands where most Oregonians live and work. Aquatic ecosystems, which integrate many diverse activities, are most impacted and most at risk. Water quality in many

lowland areas is poor throughout much of the year, and the structure and function of many riparian areas have been significantly altered from historical conditions. Further, many of these problems may not improve under existing policies and programs. Much of what potentially can be achieved on public lands is already reflected in new federal and state policies. Developing programs to address the cumulative effects on private lands is one of the greatest challenges Oregonians face. Resolving these problems will require improvements to the State's existing environmental data management system and new approaches aimed at sustaining the health of naturally functioning landscapes and the productive capacity of the environment.

Context

Over the last 150 years, Oregonians have significantly altered their environment, converting Oregon's grasslands, wetlands, and woodlands to ranches, farms, and cities–using its forests to build the state and the nation, and its range lands to graze livestock for meat and wool (Figures 1 and 2). Its streams and

Figure 1. Historical Land Use/Land Cover

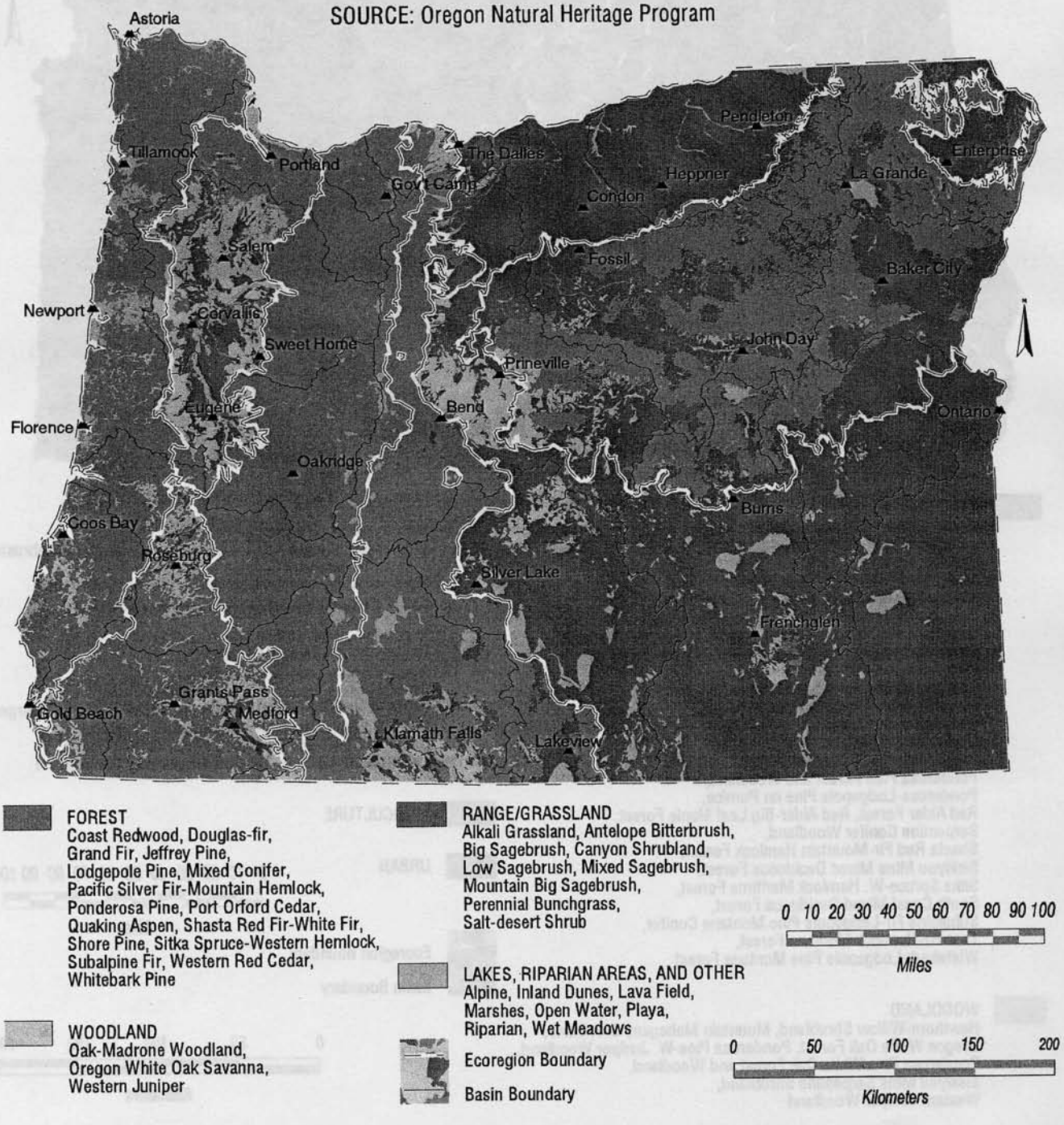
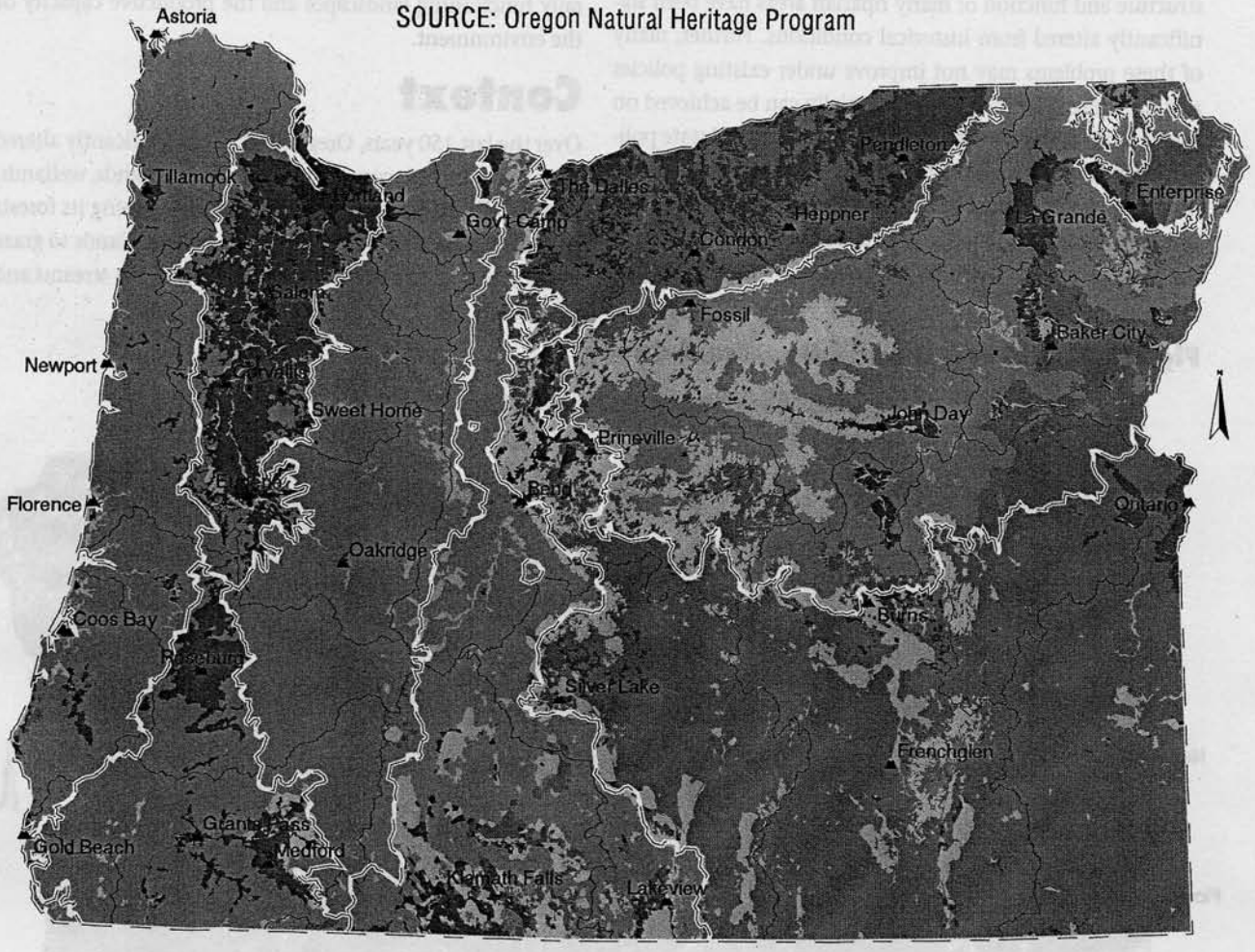


Figure 2. Current Land Use/Land Cover



FOREST
Aspen Groves, Coastal Lodgepole Forest,
Douglas Fir Dominant-Mixed Conifer Forest,
Douglas Fir-Mixed Deciduous Forest,
Douglas Fir-Port Orford Cedar Forest,
Douglas Fir-W. Hemlock-W. Red Cedar Forest,
Douglas Fir-White Fir/Tanoak-Madrone Mixed Forest,
Douglas Fir/White Oak Forest, Forest-Grassland Mosaic,
Grass-Shrub-Sapling or Regenerating Young Forest,
Jeffrey Pine Forest and Woodland,
Lodgepole Pine Forest and Woodland,
Mixed Conifer/Mixed Deciduous Forest,
Mountain Hemlock Montane Forest,
Northeast Oreg Mixed Conifer Forest,
Ponderosa Pine Dominant Mixed Conifer Forest,
Ponderosa Pine Forest and Woodland,
Ponderosa-Lodgepole Pine on Pumice,
Red Alder Forest, Red Alder-Big Leaf Maple Forest,
Serpentine Conifer Woodland,
Shasta Red Fir-Mountain Hemlock Forest,
Siskiyou Mtns Mixed Deciduous Forest,
Sitka Spruce-W. Hemlock Maritime Forest,
South Coast Mixed Deciduous Forest,
Subalpine Fir-Lodgepole Pine Montane Conifer,
True Fir-Hemlock Montane Forest,
Whitebark-Lodgepole Pine Montane Forest

WOODLAND
Hawthorn-Willow Shrubland, Mountain Mahogany Shrubland,
Oregon White Oak Forest, Ponderosa Pine-W. Juniper Woodland,
Ponderosa Pine/White Oak Forest and Woodland,
Siskiyou Mtns Serpentine Shrubland,
Western Juniper Woodland

RANGE/GRASSLAND
Big Sagebrush Shrubland,
Bitterbrush-Big Sagebrush Shrubland, Low-Dwarf Sagebrush,
Manzanita Dominant Shrubland, Modified Grassland,
Northeast Oreg Canyon Grassland, Sagebrush Steppe,
Salt Desert Scrub Shrubland, Subalpine Grassland

LAKES, RIPARIAN AREAS, AND OTHER
Alkali Playa, Alpine Fell-Snowfields,
Coastal Dunes, Coastal Strand, Exposed Tidal Flat,
Lava Flow, NWI Estuarine Emergent, NWI Palustrine Emergent,
NWI Palustrine Forest, NWI Palustrine Shrubland,
Open Water, Palustrine Emergent, Palustrine Forest,
Palustrine Shrubland, Subalpine Parkland, Wet Meadow

AGRICULTURE

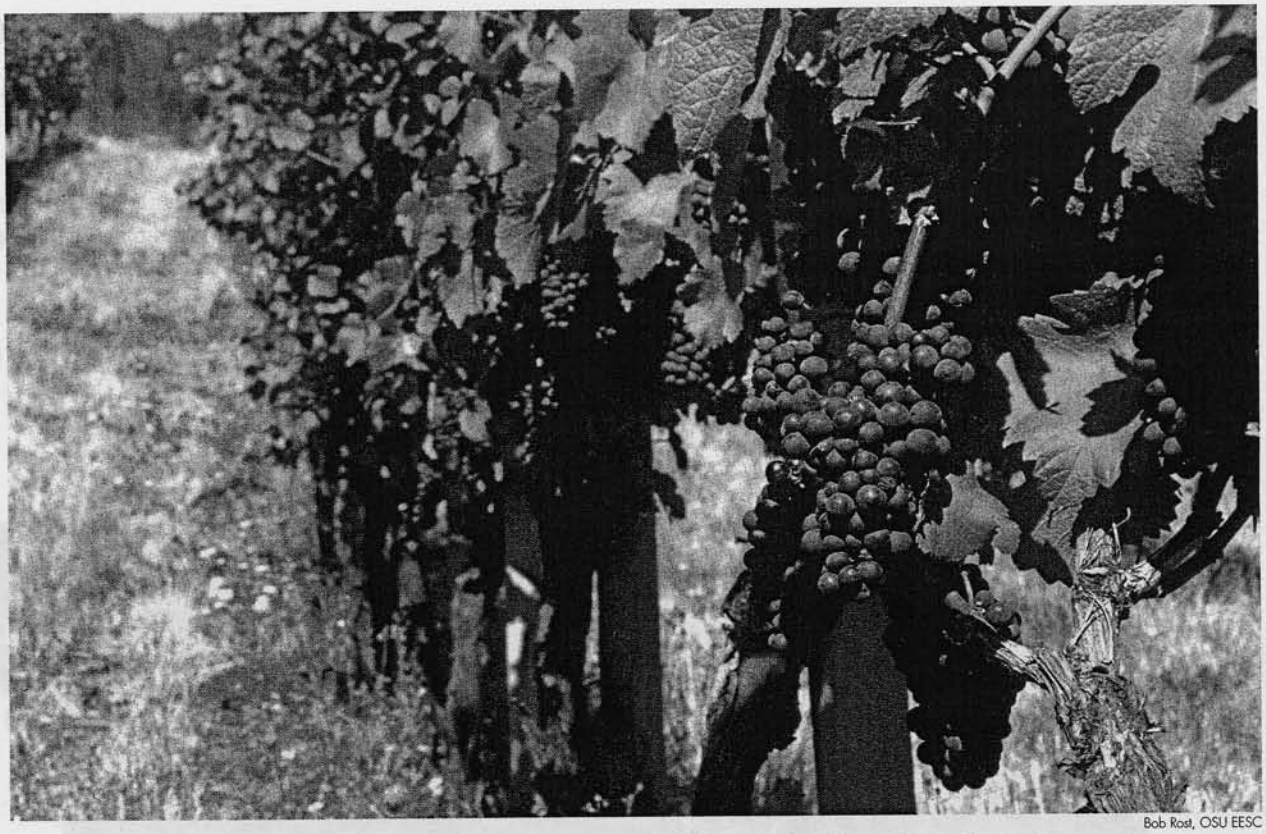
URBAN

0 10 20 30 40 50 60 70 80 90 100
Miles

Ecoregion Boundary

Basin Boundary

0 50 100 150 200
Kilometers



Bob Rost, OSU EESC

Healthy ecosystems provide a sustainable supply of goods and services.

rivers have been harnessed as sources of water, energy, and transport, and as a way to dispose of residues and pollutants. Altering the environment enabled a growing population to settle across the state and natural resources were developed as a key component of the economy. Along with development of the state's natural resources came unanticipated costs and questions of long-term productivity.

Early in Oregon's history, people saw the abundance of natural resources as something ready to be harvested, vast riches to be cut, plowed, or caught. Yet the intensity of harvest outpaced the land's natural ability to replenish, and as early as the 1920s, wheatlands in the Columbia Plateau were losing topsoil, grasslands in eastern Oregon were grazed bare, and the once-booming salmon industry was in decline.

In response, the State's resource management focused on improving the environment to produce more goods more reliably. Fast-growing trees, grasses, and fish supplanted native species in an attempt to provide predictable results from a managed environment. Rivers were harnessed to drain flooded valleys, irrigate the dry lands, and bring electric power to cities and industry. Such improvements paved the way for a dramatic increase in population and economic development.

By the 1960s it was clear that parts of Oregon's environment were not healthy. Attention turned to the Willamette Valley, where increasing volumes of pollutants from growing industries and urban development poured into rivers, outpacing government efforts at sewage treatment. Oregon's political leaders responded with a series of landmark initiatives to clean up Oregon's waterways and limit urban sprawl. Led by Governor Tom McCall, Oregon became a leader in protecting water quality, green way preservation, land-use planning, protection of agricultural land, and recycling. Also, in cleaning up the Willamette River, the State demonstrated that environmental quality need not be sacrificed for economic growth.

With passage of the Forest Practices Act in 1971, Oregon became the first state in the nation to regulate practices on private forestland. This law required protection of streambanks, provision of shade, and limits on sedimentation into streams. Additional legislation protected riparian areas on federal forests. Now, thirty years later, we can see the results in good water quality in most forested areas of the state.

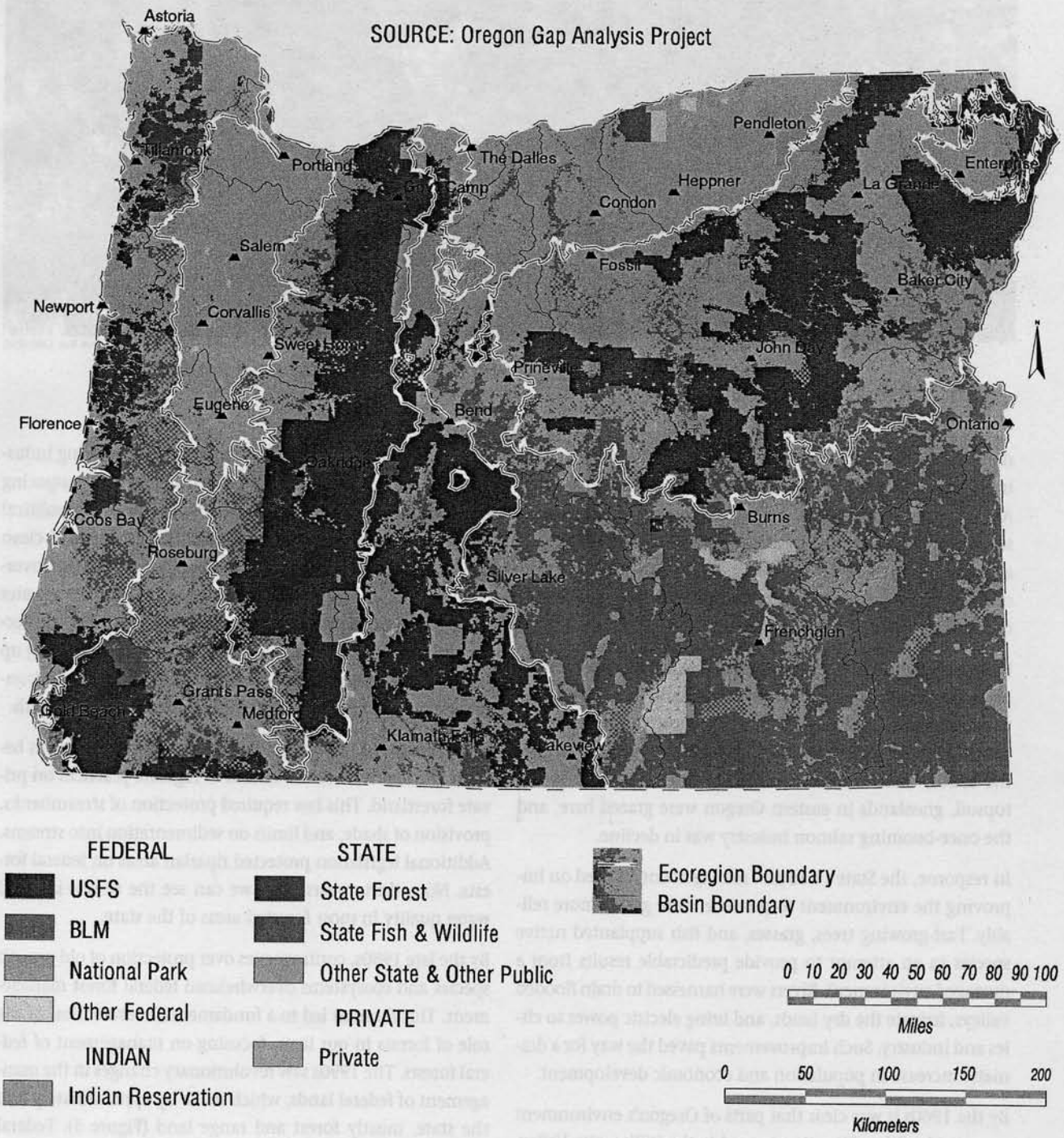
By the late 1980s, controversies over protection of old growth species and ecosystems overwhelmed federal forest management. This ferment led to a fundamental reevaluation of the role of forests in our lives, focusing on management of federal forests. The 1990s saw revolutionary changes in the management of federal lands, which make up approximately half the state, mostly forest and range land (Figure 3). Federal

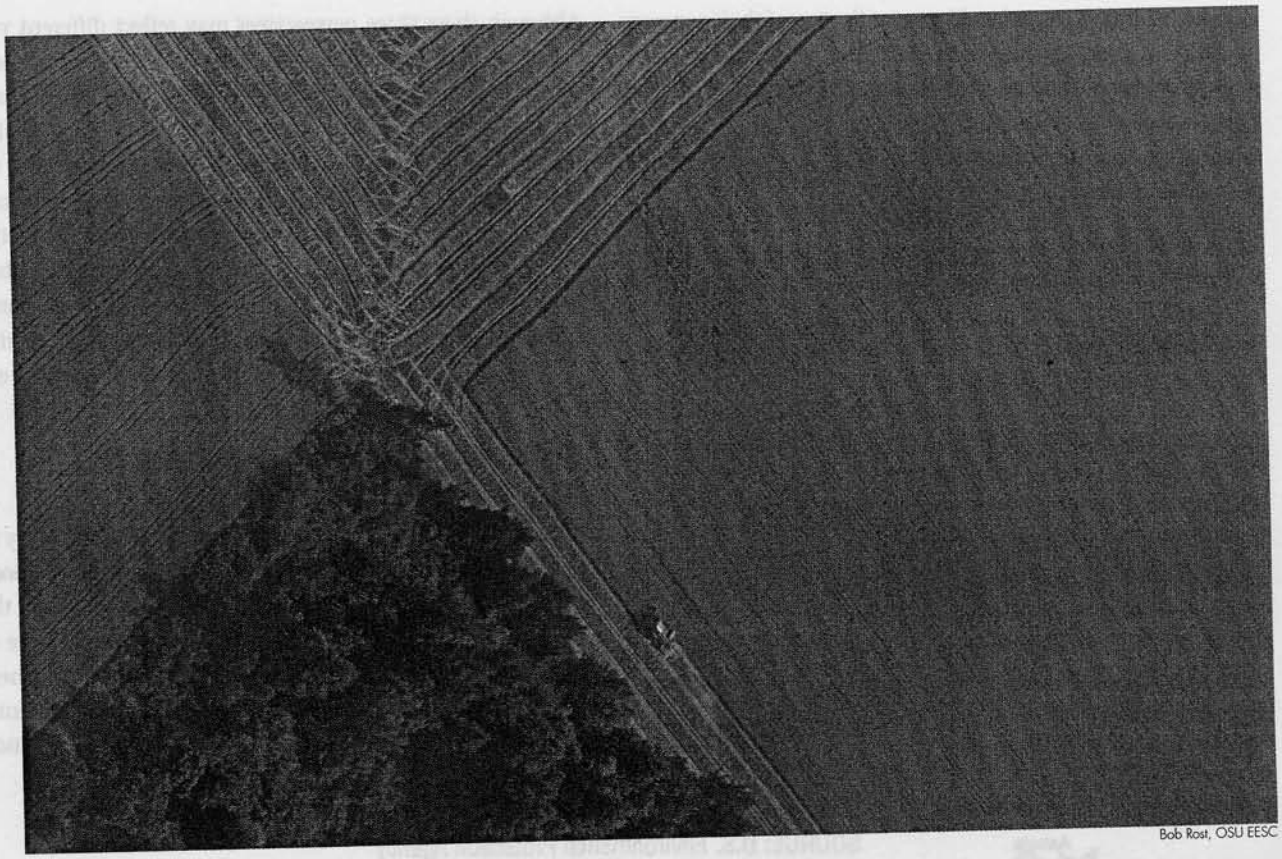
managers reduced the timber harvest on federal lands by 80% in less than a decade and refocused management onto protection of biodiversity, especially old growth species and fish stocks. In addition, evolving plans for federal range lands call for management that restores the natural processes, especially disturbance processes to these lands.

Today, the protection of streams, watersheds, and biodiversity has become a high priority statewide.

- The Oregon Department of Forestry is in the process of designing and implementing plans that place a higher priority on protecting streams and watersheds, and the biodiversity they contain, while producing a lower but more sustainable timber harvest level.
- The Oregon Department of Environmental Quality is in the process of establishing total maximum daily loads of contaminants for all streams and rivers in Oregon that are listed as water quality impaired.

Figure 3. Land Ownership





Bob Rost, OSU EESC

Healthy ecosystems meet the goals and requirements of environmental laws.

- The Oregon Department of Agriculture is in the early stages of developing and beginning to implement agricultural water quality management area plans for river basins across the state under a law known as Senate Bill 1010.
- METRO, the metropolitan Portland planning authority, has begun implementing stream buffers on new developments in the Portland area.
- The Oregon Plan for Salmon and Watersheds calls for state agencies to redirect their practices to protect salmon and watersheds in all their actions and for Oregonians in all walks of life to take personal responsibility for the recovery of salmon.

Three perspectives on environmental health:

- *maintenance of natural ecosystem processes*
- *sustainable production of goods and services for human use*
- *compliance with environmental laws*

Yet, questions remain about the state of Oregon's environment. Not a month goes by without a spate of articles in the media on problems in Oregon's environment, be it haze in the Columbia Gorge, toxic waste in the lower Willamette River, or rapid development along the Deschutes River. In addition, expected population growth has Oregonians worried about what the future holds.

Methods Used to Evaluate Oregon's Environment

It is in this context that the *State of the Environment Report* was produced, specifically to describe the conditions and trends of Oregon's environment, identify areas at risk, and suggest environmental indicators to help track environmental progress in the state. The Science Panel was supported by over fifty scientists and specialists from academia, state and federal agencies, and private organizations from across Oregon. All were volunteers. In addition, the Science Panel met quarterly with a committee of Oregon business, environmental, and agency representatives to share progress and obtain advice on what grew to be a very broad-based scientific assessment.

In a place as diverse as Oregon, there are myriad possible environmental components that could be analyzed. The project started by asking a broad group of citizens, conservationists, business people, and civic leaders what they thought were currently the most important environmental issues in Oregon.

They ranked water-related issues at the top of their concerns, and the focus of the report reflects that emphasis. They also were concerned about their forests, rangelands, air, and marine environments, and the effects of agriculture and cities on Oregon's environment. The Science Panel attempted to address all these resources and issues.

People value different aspects of the environment, and therefore they have different perspectives on what it means to have a healthy environment. The Science Panel recognized these different values and assessed the health of the environment from three perspectives:

1. *maintenance of natural ecosystem processes*—healthy ecosystems have naturally functioning landscapes much as they would before intensive land use and land conversion by humans;
2. *sustainable production of goods and services for human use*—healthy ecosystems can consistently provide goods and services that people desire; and
3. *compliance with environmental laws*—healthy ecosystems meet the technical requirements and overall goals of environmental laws.

Although these three perspectives may reflect different values of society, they work together to provide a more complete picture of what makes the environment healthy and keeps it productive. It is important to note that assessing the health of naturally functioning landscapes does not suggest that we can or should return our landscapes to predevelopment conditions. It simply provides a means to measure the risk to the environment. The further our landscapes are from undisturbed conditions, the greater the risk that important natural functions may be disturbed or lost, that the long-term productive capacity of the environmental may be reduced, and that environmental laws may not be met.

Selection of Environmental Regions for Analysis

Because Oregon is a large and diverse state, it was necessary to take a closer look at places where environmental conditions are relatively homogeneous. The Science Panel selected the well-established heirarchical system of ecoregions (Figure 4) used by the U.S. Environmental Protection Agency. These ecoregions are based on similarity of several environmental variables such as geology, vegetation, and average precipitation

Figure 4. Ecoregions

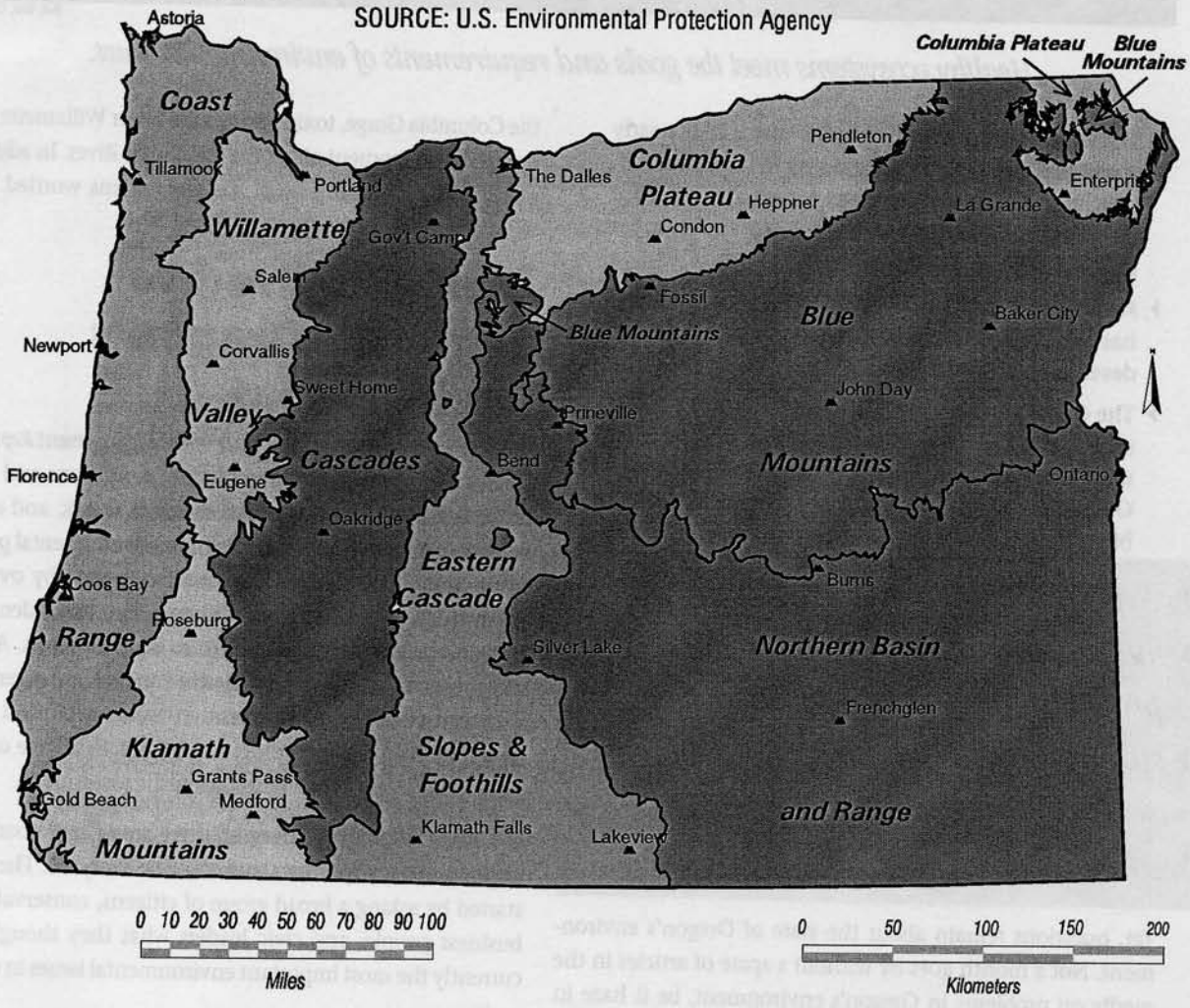
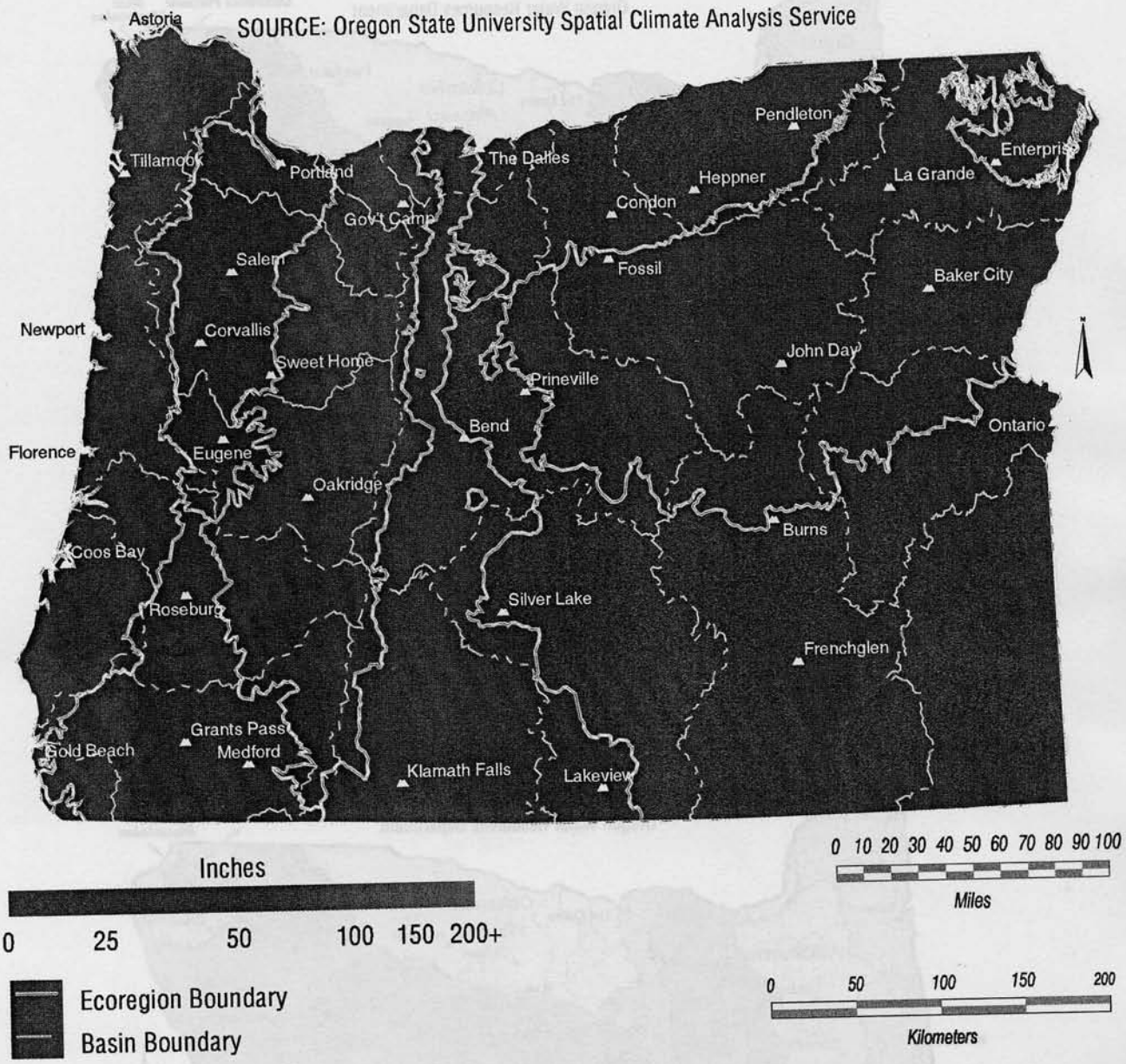


Figure 5. Mean Annual Precipitation



(Figure 5). Under the Oregon Plan for Salmon and Watersheds, the State uses drainage basins to organize areas of analysis. Both approaches use characteristics of the landscape, rather than political borders, to define study areas, and each approach provides a different perspective on the complexities of the environment. Figure 6 illustrates the overlap between ecoregions and drainage basins. The state can be divided also by county (Figure 7), and county boundaries do not match the boundaries of either ecoregions or watersheds. The socio-economic analysis of this report is done mainly by county.

An ecoregion approach can provide insights into terrestrial issues such as land use/land cover, whereas a watershed approach highlights gravity-driven issues such as water quality and quantity. Both are important. Using more than one approach to analyze landscapes allows a more complete picture of Oregon's environment to emerge. The Science Panel used preexisting ecoregion data to establish vegetation patterns, and adapted watershed-based data on water quality and quantity and other aspects of aquatic health.

These multiple approaches provide a summary of environmental conditions and trends in each ecoregion so the reader can understand differences throughout the state, and so every Oregonian can learn more about the environmental status of his or her own region.

Figure 6. Ecoregions and Drainage Basins

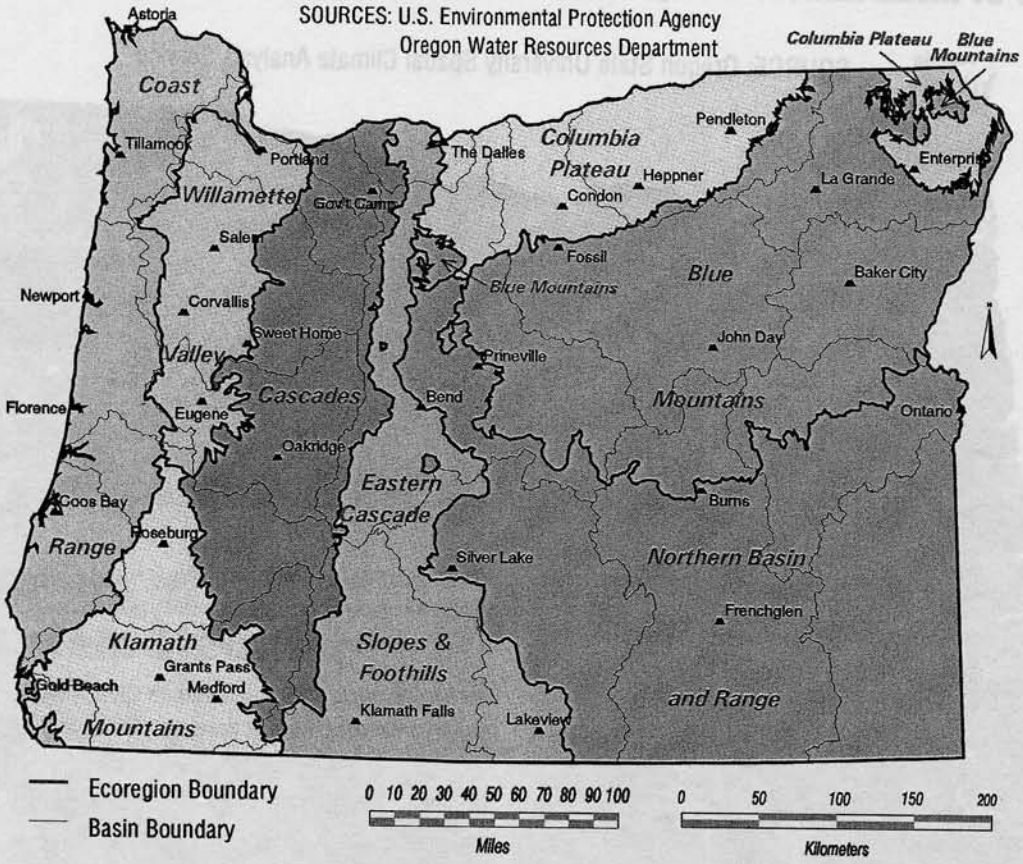
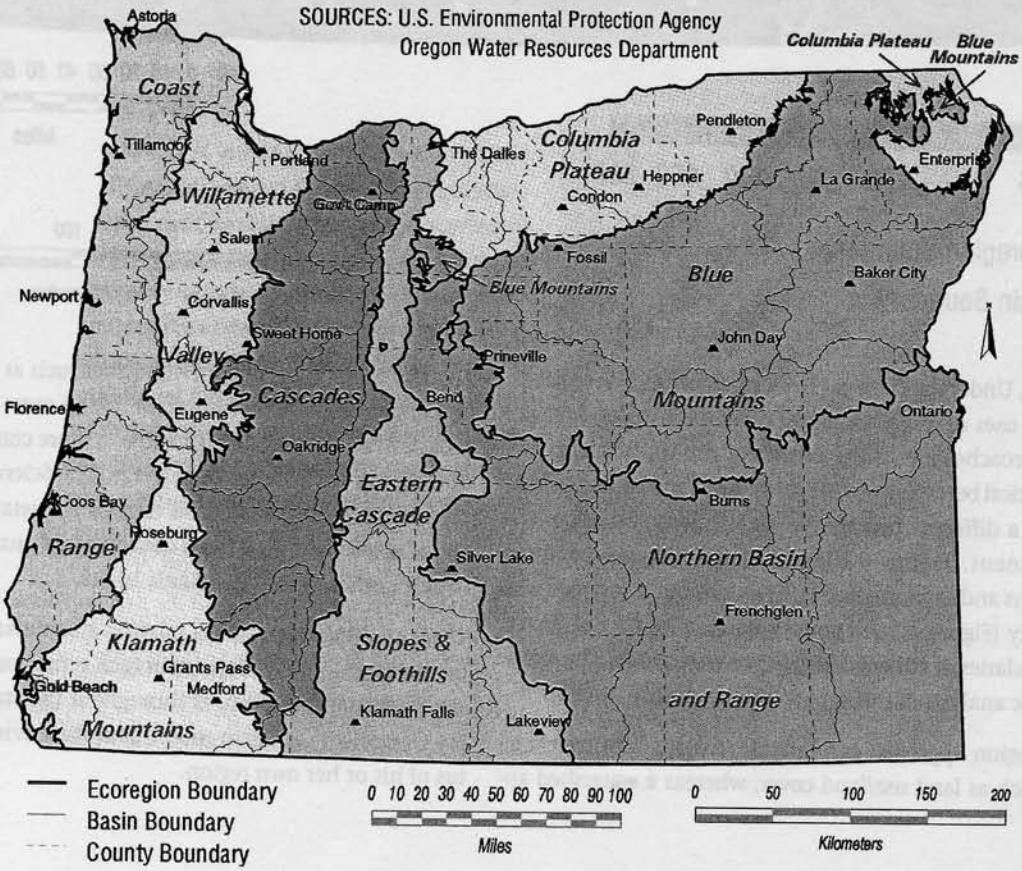


Figure 7. Ecoregions, Drainage Basins, and Counties



This decade has seen a divergence in economic performance across the state. Fishing and timber regions have seen slower growth than other areas of the state.

Tom Gentle, OSU EESC

Oregon's Economic Status

These are good times for Oregon's economy. A stable, growing national economy, statewide population growth, and emergence of the state's high technology industrial base has fueled eight years of economic expansion. However, Oregon's economy cannot be summed up so simply. This decade has seen a divergence in economic performance across the state. Regions with extensive employment in the timber and fishing industries have seen much slower economic growth than other regions of the state. And among these regions, there is further divergence.

Those areas which have seen the most crippling effects of the downturn of Oregon's resource-based manufacturing industries have seen little or no growth in real per capita personal incomes. Much of this was due to the general decline in average wages. Between 1990 and 1998 real average annual wages (adjusted for inflation) fell in every ecoregion except the Columbia Plateau (+$900) and the Willamette Valley (+$2,200). Average annual wages in the Coast ecoregion were the hardest hit, falling by $1,700 since 1990, in real terms. The loss of resource-based jobs in many rural areas accounted for much of this decline in average wages, as relatively high-paying resource-based jobs were replaced by lower-paying service and tourist industry jobs.

But not everywhere has this meant economic stagnation. Deschutes County, for example, saw a loss of timber jobs equivalent to over four percent of total county employment in the last decade, but total employment grew by more than 40 percent during the same period. The reason for such phenomenal growth in Deschutes County has been rapid population growth. More than the loss of timber jobs, population growth has been the primary driver of local economies throughout much of the state over the last decade. Again, while the timber job losses explain a small portion of the variation in job growth among counties, population explains more of that variation, much more.

Obviously, the reasons behind Oregon's rapid population growth are more complex than simply the availability of jobs, and the reasons for the variation in economic expansion include issues that have been more pervasive, and perhaps more meaningful, than the loss of resource-based jobs. Surveys of recent in-migrants echo this. One of the most frequently cited reasons for moving to Oregon has consistently been the quality of life. Clearly, the environment matters to Oregonians new and old, and it has had a measurable impact on Oregon's economy.

The most comprehensive, consistent, and defensible snapshot of Oregon's economy currently available is a 1993 Social Accounting Matrix (SAM) model. This model shows that traditional resource-based industries, those heavily dependent upon direct harvest of renewable environmental inputs such as timber, food, forage, or fish, generated roughly 20% of Oregon's jobs in 1993. The relative share of the economy represented by these industries has been declining as Oregon's economy has grown and diversified. Other sectors (such as manufacturing), though not based directly on extraction or harvest, depend on the environment for resources such as clean water and power, and environmental amenities are important factors in attracting new manufacturing industries. The manufacturing sector generated nearly 20% of Oregon's jobs in 1993 and has been growing rapidly over the past two decades. Other sectors (such as tourism and services) are generally less dependent on direct inputs of water and power, but are increasingly dependent upon factors related to a healthy environment (such as recreation opportunities, aesthetics, open space). The construction and service sectors generated 31% of the state's jobs in 1993. Finally, federal transfers and income pay-

ments from outside the region to households and to state and local governments generated over 25% of Oregon's jobs in 1993. Amenities (environmental and other) are particularly important factors in attracting retirees and high income residents to Oregon.

There is the need to understand the status of the environment now and over time so that it can be managed sustainably. The human population in Oregon will continue to grow, bringing a continuing challenge to the environment. The disparate economic conditions across the state raise questions about whether natural resource-based industries could be increased or managed in different ways while still retaining Oregon's environmental quality and its natural goods and services. These are public policy questions, but the answers to all of them depend on a thorough understanding of the health and capacity of our environment.

Indicators of Ecosystem Health

Oregon's environment is complex and its parts are interwoven. If the health of this complex system is to be regularly evaluated, a set of measurements must be identified that will indicate the status and trends of key parts of the environment. We need indicators because we cannot measure everything. Each of the resource chapters in the *State of the Environment Report* suggests indicators which collectively assess the health of Oregon's ecosystems and natural resources. These indicators do not focus on human actions that affect environmental quality. Instead, they provide a quantitative answer to the original question, "From a scientific perspective, what is the health of Oregon's environment?"

In that way, the indicators suggested in this report are different from benchmarks developed by Oregon's Progress Board. They do not set targets or define performance goals. They do not rely only on monitoring systems already in place in the state. They do not always fit comfortably into current agency programs. These indicators suggest a new way to measure trends in the environment by monitoring ecosystem health. Some can be used immediately to take the pulse of the environment, others will provide important information in the future once frameworks are developed for collecting data.

The Science Panel has proposed a subset of those key indicators to the Progress Board to begin to guide the State's basic environmental monitoring program. As a group, these 18 selected indicators provide a strong measure of environmental health. However, these 18 indicators cannot fully convey the state of the environment in Oregon. Additional indicators listed with the resource summaries should be considered as a broader index for measuring the health of Oregon's complex ecosystems and natural resources.

18 Indicators Submitted to the Progress Board

Water Quantity

1. Degree to which stream flows meet ecological needs based on the proportion of in-stream water rights that can be met

Water Quality

2. Proportion of streams and rivers with good to excellent water quality according to the Oregon Water Quality Index

Marine Ecosystems

3. Number of at-risk stocks of marine fish and shellfish, as defined by state or federal listing as overfished or at risk of being overfished; or by listing as threatened or endangered under state or federal Endangered Species Acts

Estuarine Resources

4. Area of estuarine wetlands (tidal marsh/swamp habitat) compared to historical area (acres and percent)

Freshwater Wetlands

5. Change in area of freshwater wetlands as compared to historical distribution (acres/percent)

Riparian Ecosystems

6. The amount of intact or functional riparian vegetation found along streams and rivers
7. Trends in the health of stream communities using an index comparing invertebrate populations to those expected in healthy aquatic habitats

Freshwater Fish Communities

8. The percentage of wild, native fish populations, including salmon, that are classified as healthy

Forest Resources

9. Amount of commercial forest types in different structural stages compared to amounts in healthy forest systems
10. Timber harvest relative to sustainable levels (reference: estimated sustainable levels in plans and management intentions)

Agricultural Ecosystems

11. Trends in soil quality and erosion rates
12. Area of land in agricultural production

Urban Areas

13. Percentage of assessed groundwater that meets the current drinking water standards
14. Frequency that the Air Quality Index exceeds the existing standards
15. The amount of carbon dioxide emitted

Biological Diversity

16. Change in area of native vegetation types
17. Percentage of at-risk species that are protected in dedicated conservation areas
18. Number of nuisance invasive species

Section II. Status of Key Natural Resources

The following chapter includes summaries of the environmental condition of many of Oregon's major natural systems and resources. These summaries are based on much longer resource chapters contained in the full report, and are the building blocks of the State of the Environment Report. In the resource chapters of the full report, the authors attempt to define the health of each resource in terms of the three perspectives of a healthy environment: naturally functioning landscapes; sustainable productivity; and compliance with environmental law. They describe the current condition and trends, and project where there may be future risks to the health of these natural systems. Based on best available information, the authors suggest a set of indicators whose measures would help take the pulse of the environment.

Health of Aquatic Ecosystems

A watershed is composed of a mixture of land habitats that are connected and drained by a network of streams that eventually drain into larger streams and rivers. Within a watershed, there may be mixtures of land habitats or terrestrial ecosystems such as forests or croplands. Aquatic ecosystems are composed of mixtures of habitats within streams or rivers. The health of aquatic ecosystems is controlled by conditions within the watershed as well as the aquatic ecosystem itself. That is, the characteristics of streams and rivers are shaped by geology, water flow (hydrology), climate, natural disturbances (floods, fire, land slides, etc.), the amount and quality of water, in-stream habitat, and the biological community (plants and animals). For the watershed and aquatic ecosystems to remain healthy, all the processes and connections, such as upstream to downstream, upland to floodplain, or groundwater to stream channel movements, must function properly. The extent to which these characteristics and processes reflect the natural range (prior to intensive human development) is the best long-term indicator of environmental health of watersheds and aquatic ecosystems.

A healthy stream or river is one that retains these natural processes and a variety of well-distributed habitats which can support native fish and other aquatic species. Streams and rivers are also regarded as healthy when they meet human goals but do not adversely affect other resources. Most river systems in Oregon have been heavily modified in order to achieve various direct human benefits, including flood control, irrigation, hydropower, municipal and industrial water supply, navigation, and recreation. Many of these water development activities have altered natural physical, chemical, and biological processes leading to declines in ecosystem goods and services.

Water Quantity

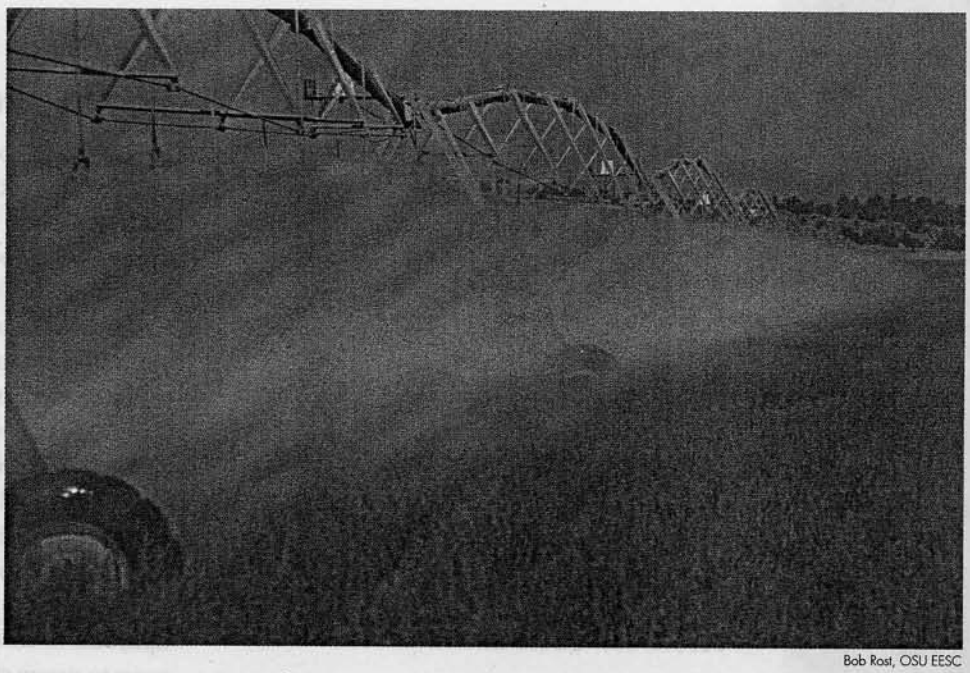
Background:

The story of water in Oregon is divided by geography (east and west) and by season (wet and dry). West of the Cascade Mountains the annual precipitation ranges from 40 to 140 inches, and only about 10 to 25 inches east of the mountains (Figure 5). Historically the challenge to water development in Oregon has been to contend with the extreme variations in seasonal precipitation and runoff. Dam construction has been the primary tool. The concentration of dams is much greater west of the crest of the Cascades, where most of the dams were constructed primarily for flood control or hydroelectric power production on the Columbia, Willamette and Rogue rivers. Dams east of the Cascade crest were constructed primarily for irrigation, which accounts for 90% of the water withdrawn on the eastside. Out-of-stream usage, such as irrigation occurs throughout the State, but is much greater as a percent of total

water usage east of the Cascades. In-stream usage, especially hydroelectric power production, is much greater west of the mountains.

Status:

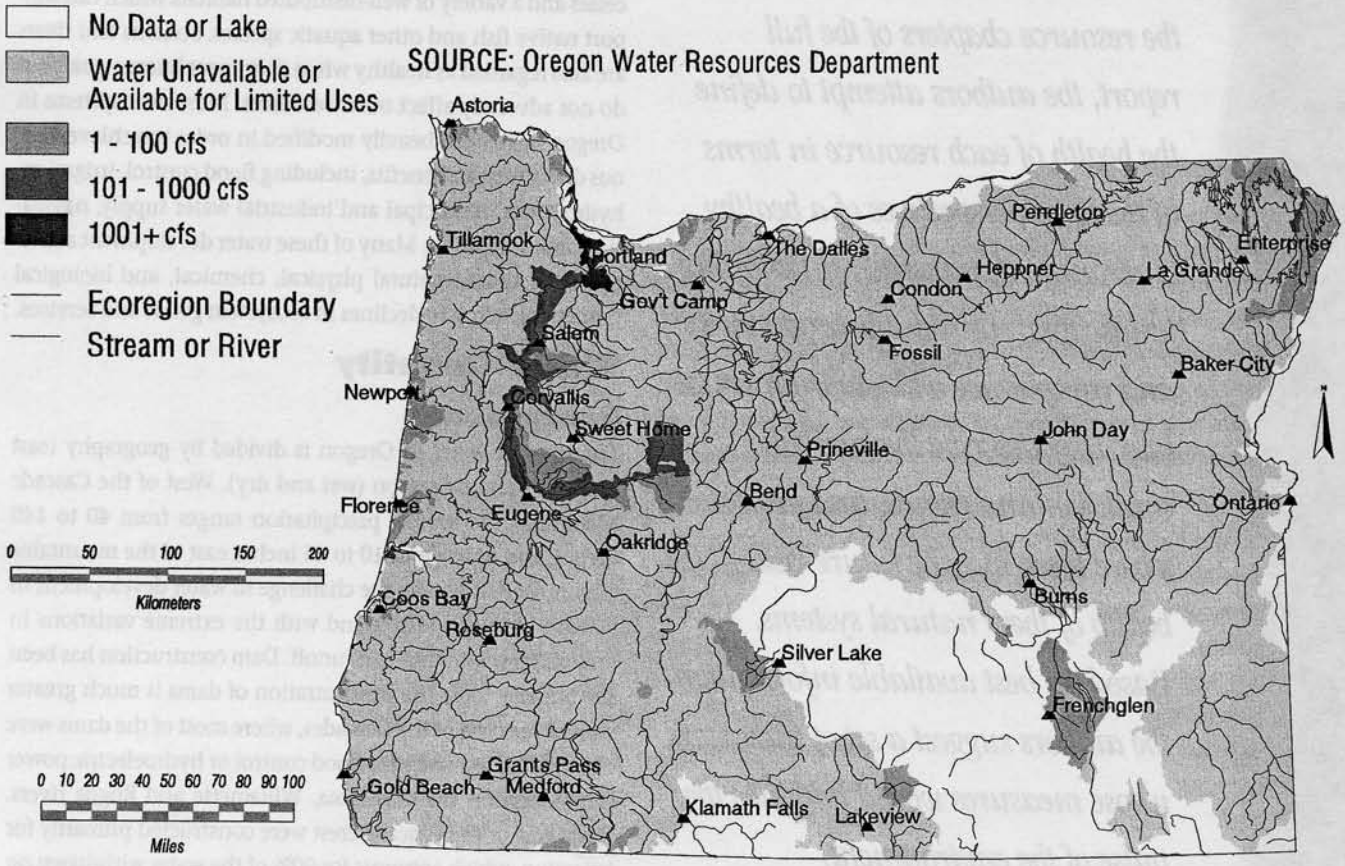
Oregon's currently available water supply is fully- or often over-allocated during the low flow summer and fall months (Figure 8). Water use in Oregon is governed by its "prior appropriation doctrine," and the rights to keep water in a stream for fish and wildlife (in-stream rights) are typically junior in priority to older out-of-stream rights. Across the state, there are more in-stream needs than streamflows to meet them. Approximately 60% of these in-stream rights can expect to receive their full allocation eight years out of ten in late winter and early spring; only 20% can expect to receive their full allocation in late summer and early fall. Again, this varies

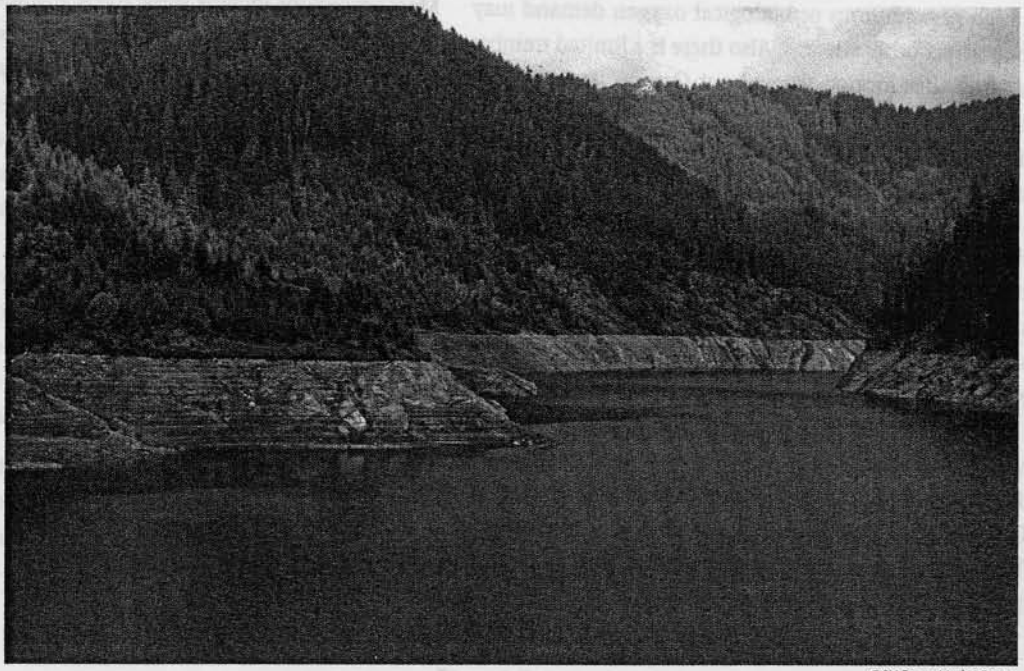


Bob Rost, OSU EESC

Providing enough water to satisfy all rights is an increasing challenge for the future.

Figure 8. Unused Water Available in August in 8 out of 10 years





OSU Forest Media Center

Oregon's currently available water supply is fully or over-allocated during low flows.

by geography and season. In the Columbia Plateau ecoregion, less than 20% of the in-stream rights can expect to receive their full allocation nine months of the year. In the Willamette Valley and Cascades ecoregions, more than 80% of the in-stream water rights can expect to receive their full allocation in the winter, but only about 25% in the early fall.

The challenge of providing enough water to satisfy all rights will increase in the future, especially without water conservation measures, intensive water management, and water planning linked with land use planning. This increasing demand for water will be linked with the projected 34% increase in human population over the next 25 years in the state. And some climate models predict 10 to 25 percent reductions in late spring-summer-early fall runoff amounts in coming decades.

Recent changes in river operations, including those enacted by the National Marine Fisheries Service to protect endangered Snake River salmon, have reduced use of water for power generation. While total water withdrawals from surface and subsurface sources increased 20% between 1965 and 1995, the recent trend shows a 6% decline between 1990 and 1995. Statewide ground water represents about 12% of all water withdrawals, a proportion which has not changed significantly over the past 30 years. Groundwater dependence is much higher in the Willamette Valley (30%) and Columbia Plateau (18%) where this extraction has resulted in significant drawdown of aquifers and the implementation of groundwater management areas.

Key Indicators:

- Degree to which stream flows meet ecological needs based on the proportion of in-stream water rights that can be met
- Extent to which the natural hydrologic processes have been modified from unregulated reference conditions
- Extent to which instream flows have been impacted by water diversions for out-of-stream uses
- Ability of the system to continue to provide flood control, irrigation, hydropower, municipal/industrial water supply, navigation, and recreation benefits
- Changes in groundwater availability

Water Quality

Background:

Water quality can be measured in various ways, but the most common method in Oregon is the Oregon Water Quality Index (OWQI). This index combines measurements of temperature, dissolved oxygen, biochemical oxygen demand, pH, ammonia and nitrate nitrogen, total phosphorous, total solids and fecal coliform. Because water quality is influenced by streamflow (for example, high flows dilute the concentration of pollutants so water quality increases during high flows), water quality indices are measured during high and low flow periods. Different components of the OWQI cause low indicator measurements in various locations. For example, high summer temperature may cause low quality in some streams

while high phosphorous or biological oxygen demand may adversely affect other streams. Also there is a limited number of sampling sites located throughout Oregon, and they are not located on a randomized statistical basis, so care must be exercised in interpreting the OWQI. Nevertheless, the OWQI is a large, consistent and reliable data set that covers the State.

Status:

Generally, water quality in Oregon is categorized as poor during low flow periods by the OWQI, except in mountainous areas. Average OWQI values indicate that the Cascades ecoregion has excellent water quality, the Coast Range and Blue Mountain ecoregions have fair water quality, and the Klamath Mountains, Willamette Valley, Columbia Plateau, Northern Basin and Range and the southern end of the Eastern Cascade Slope ecoregions have poor water quality indices. These assessments are averaged over the years of record, and in some years the water quality is higher.

Most ecoregions include some rivers and streams with excellent water quality and others with very poor water quality. For example, the index for the Klamath Mountains ecoregion as a whole measured poor, but within the ecoregion the Illinois River has excellent water quality and Bear Creek and Deer Creek have poor water quality. In particular stream reaches, there are strongholds of excellent water quality that should be protected. Individual rivers or streams show significant improvement or decline in water quality over time, but overall there has been little change throughout the state in the last 20 years. Slight improvement in the average OWQI has occurred in the Willamette Valley, Cascades, Columbia Plateau, Blue Mountains and Klamath Mountain ecoregions.

Using 1997 as an example (Figure 9), instances of good or excellent water quality occur most often in the forested uplands of Oregon. Both forest practice rules on public and private forests and lack of development help explain this result.

Figure 9. Water Quality & Forested Lands

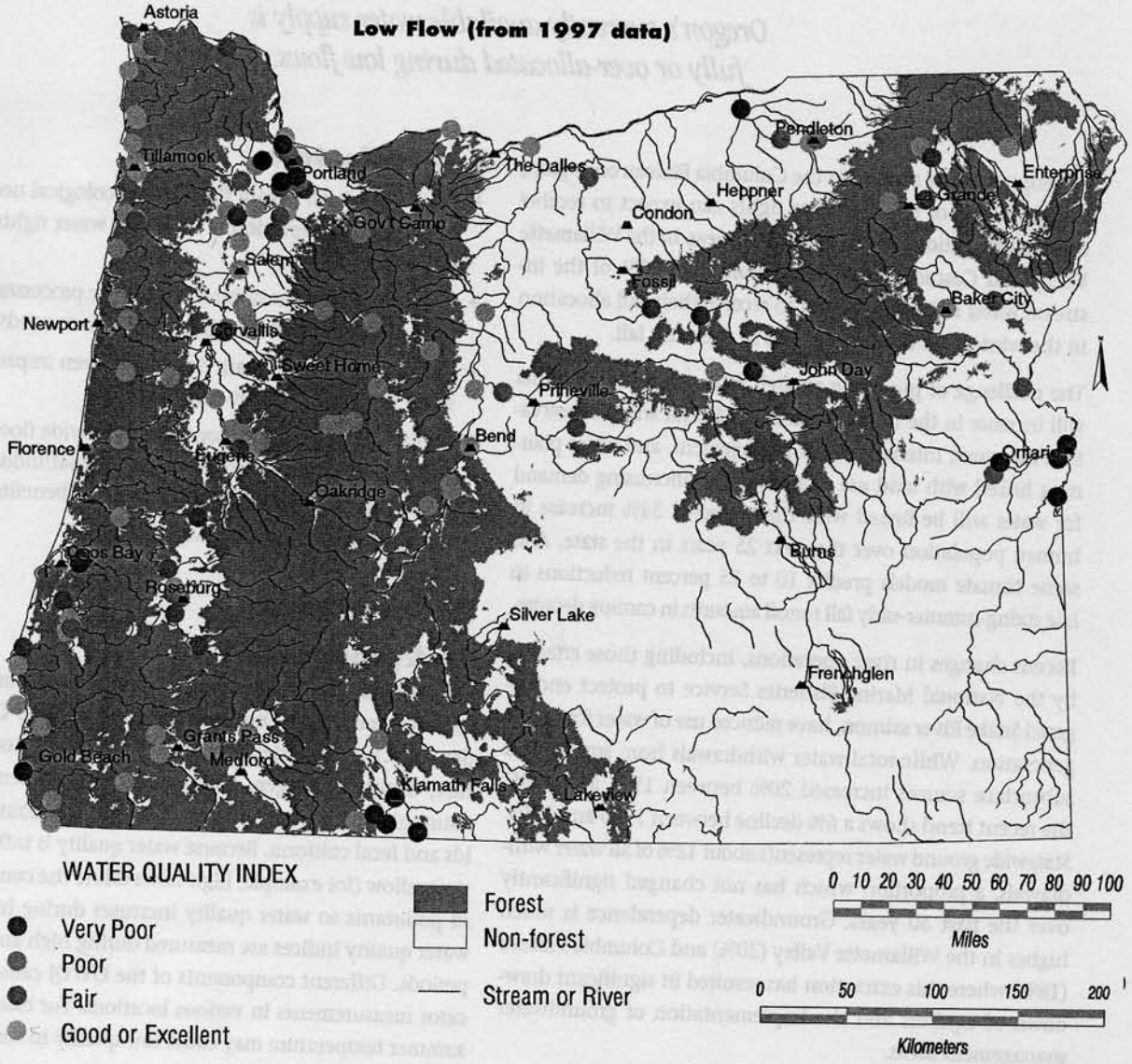


Figure 10. Waterbodies on Oregon's 1998 303(D) List

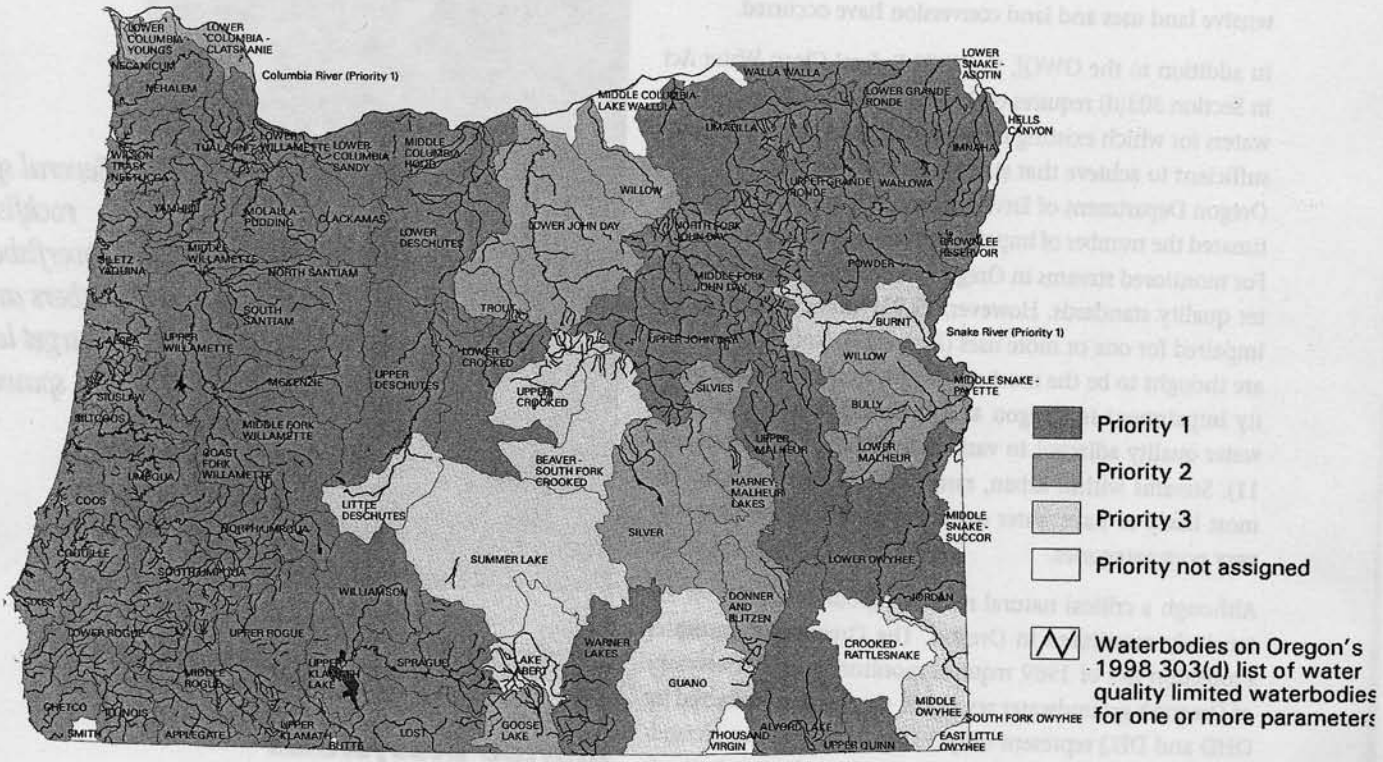
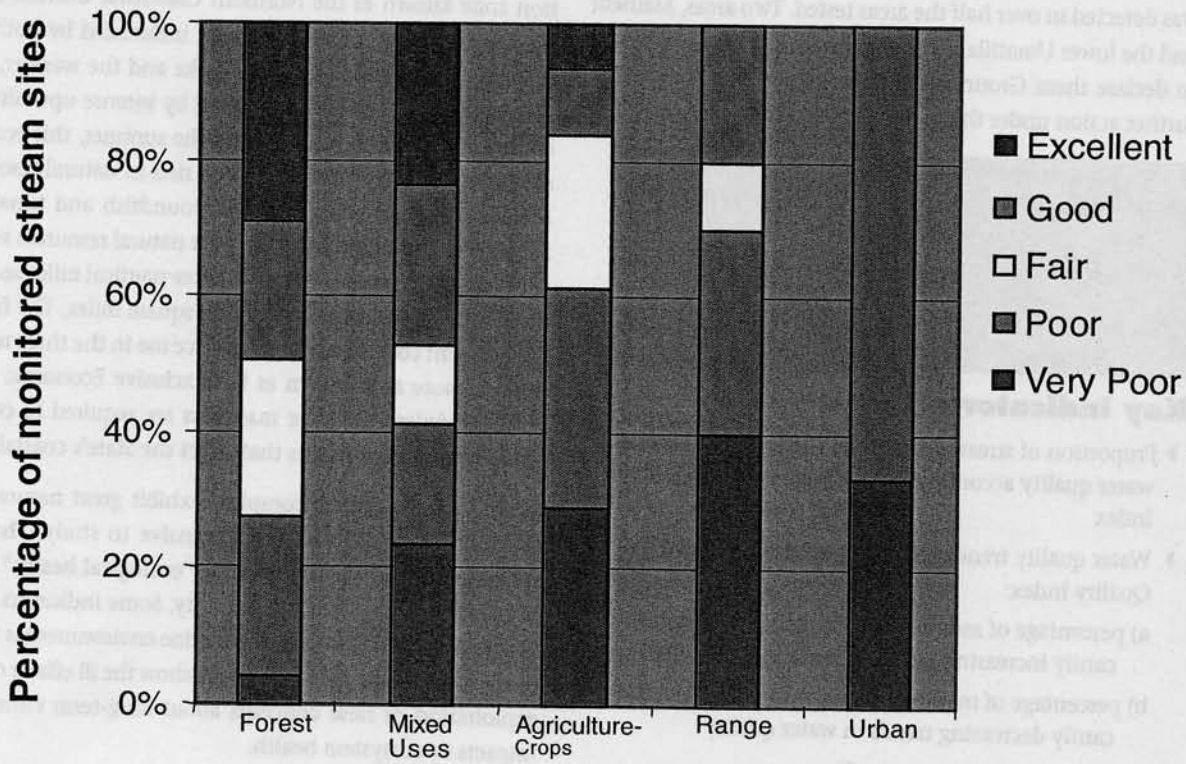


Figure 11. State Water Quality Conditions

Based on Oregon Water Quality Index, by Land Use Type



Categories based on dominant land use within a 5 mile radius of the monitoring site. If no land use type represented at least 50%, the site was designated "Mixed Uses."

On the other hand, instances of poor or very poor water quality occur most often in the nonforested lowlands where intensive land uses and land conversion have occurred.

In addition to the OWQI, the 1972 Federal Clean Water Act in Section 303(d) requires each state to identify those surface waters for which existing required pollution controls are not sufficient to achieve that state's water quality standards. The Oregon Department of Environmental Quality (DEQ) has estimated the number of impaired stream miles within Oregon. For monitored streams in Oregon, over 5,687 miles meet water quality standards. However, 13,937 miles of streams are impaired for one or more uses (Figure 10). Nonpoint sources are thought to be the most significant sources of water quality impairment in Oregon at this time. DEQ has evaluated water quality adjacent to various land use categories (Figure 11). Streams within urban, range and agricultural areas are most likely to have water quality classified in the poor and very poor categories.

Although a critical natural resource, groundwater is not extensively monitored in Oregon. The Oregon Groundwater Protection Act of 1989 requires monitoring and assessment of Oregon's groundwater resources, yet the data collected by OHD and DEQ represent only 30.8% of sites where groundwater uses have been recorded. The quality of groundwater is unknown for the remaining 69.2% of the state where groundwater is used. Some evidence of groundwater contamination was detected in over half the areas tested. Two areas, Malheur and the lower Umatilla basin, presented enough of a concern to declare them Groundwater Management Areas requiring further action under the Groundwater Quality Act.

Streams within urban areas often have poor or very poor water quality.

Key Indicators:

- Proportion of streams and rivers with good to excellent water quality according to the Oregon Water Quality Index
- Water quality trends according to the Oregon Water Quality Index:
  - a) percentage of monitored stream sites with significantly increasing trends in water quality
  - b) percentage of monitored stream sites with significantly decreasing trends in water quality
- Changes in groundwater quality

Jim Good, OSU Marine Resources Management

Several species of rockfish are overfished, and others are below target levels for spawning.

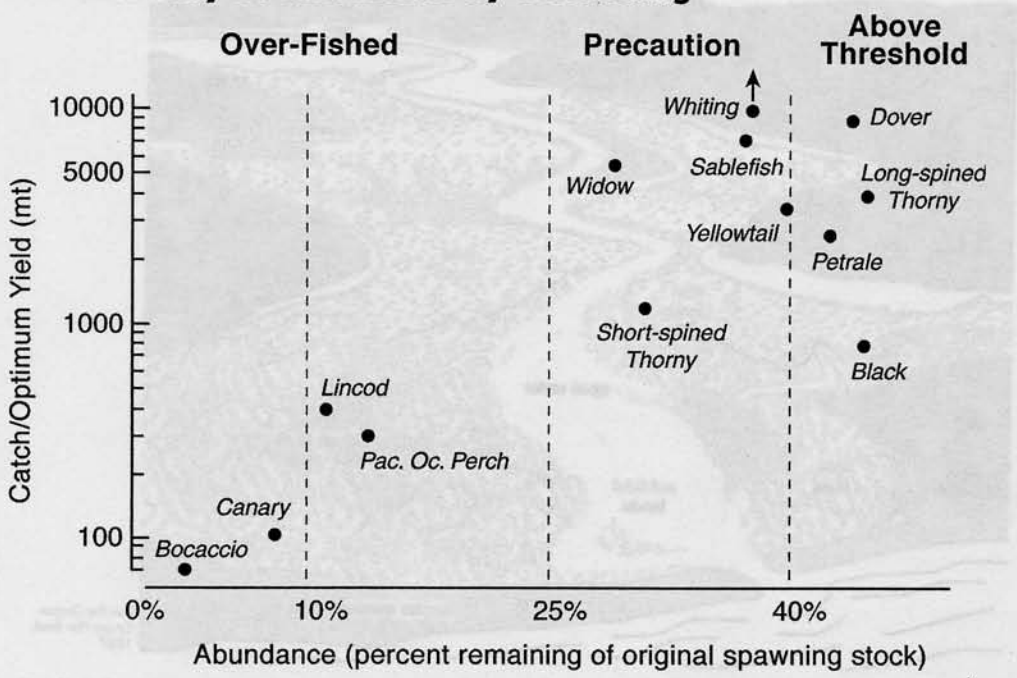
Marine Ecosystems

Background:

Oregon's coastal ocean is part of the larger ecological transition zone known as the Northern California Current Large Marine Ecoregion, an area strongly influenced by both the subarctic waters of the Gulf of Alaska and the warmer, subtropical waters of California. Fueled by intense upwelling of cooler, nutrient-rich water during the summer, this ecological region is highly productive and rich in natural resources including salmon, crab, shrimp, groundfish and tuna. The State of Oregon has jurisdiction over natural resources within the territorial sea, which extends three nautical miles seaward and encompasses more than 1,100 square miles. The federal government controls natural resource use in the three to 200-mile offshore area known as the Exclusive Economic Zone, although federal resource managers are required to consult with Oregon on decisions that affect the State's coastal zone.

Marine ecosystems are complex, exhibit great natural variability, and are difficult and expensive to study. These attributes make it hard to assess the "ecological health" of the ocean with much scientific certainty. Some indicators examined here suggest that Oregon's marine environment is in relatively good condition, while others show the ill effects of overexploitation or raise concerns about long-term cumulative impacts to ecosystem health.

Figure 12. Catch and Abundance Indicate Some Rockfish May Be Threatened by Overfishing



Status:

The condition of marine fisheries is mixed, with many stocks in good shape, but some threatened by overfishing and other pressures (Figure 12). Some species of groundfish have declined to very low levels due to overestimates of production and allowing too many boats to fish too long. Strong management measures have been required to protect remaining fishes and begin to rebuild stocks. The potential impacts of mobile fishing gear on the diversity and productivity of the seabed habitat that supports groundfishes is another concern. Coastal coho salmon and several stocks of steelhead trout are listed as threatened under the Endangered Species Act. The health of these anadromous stocks is affected by many factors, including natural variability in ocean conditions, excessive fishing pressure, mortality at dams, increasing predator populations, and poor habitat conditions in watersheds. The most significant risk to marine fisheries, however, is our insufficient understanding of the complex interactions of natural and human caused changes in stock health.

The collapse and subsequent closure of the coho salmon fishery has resulted in increased commercial and recreational fishing pressure on nearshore subtidal rocky reef areas. This trend is likely to continue, placing nearshore groundfish populations at risk. Rocky shores are protected from many potential disturbances, but most subtidal rocky reef habitats that may be important as fish refugia or rearing areas have no special protection.

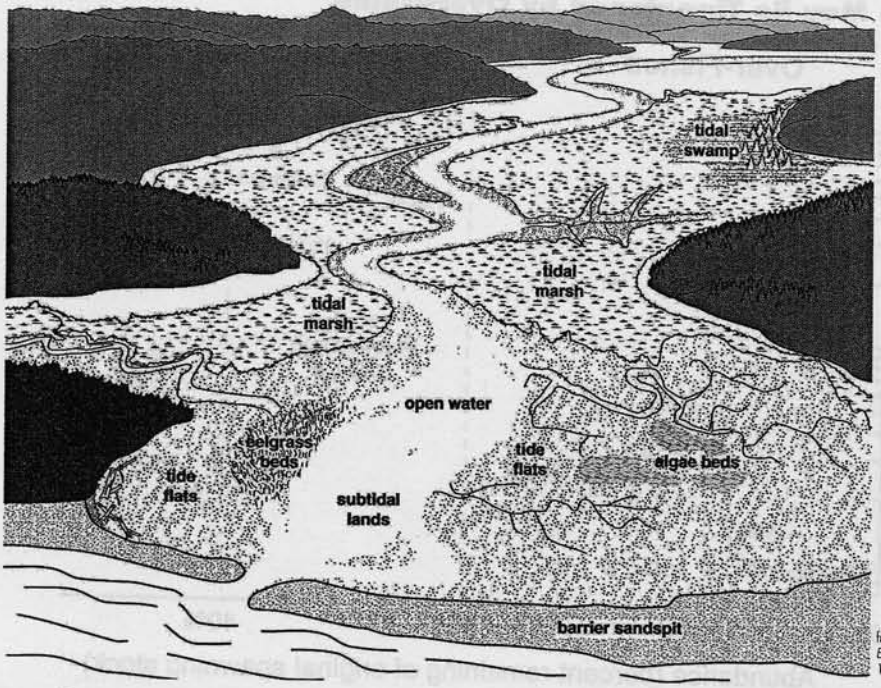
With the exception of the sea otter which was extirpated from the coast of Oregon in the 1800s, marine mammal (pinnipeds) populations have increased and are healthy today. Effective species and nearshore habitat protection measures are the principal reasons for their successful recovery.

The physical integrity of Oregon's beaches are threatened by the combined effects of winter storms that inevitably cause erosion of oceanfront property, armoring such as riprap or seawalls built to control that erosion, and the gradual rise in sea level along parts of the coast. The cumulative effect of shoreline armoring is the gradual elimination of the natural process of sand replenishment provided by the erosion of dunes and bluffs. As sand supply diminishes and sea level rises, the prospect along some stretches of coast is gradually narrowing beaches that cease to function as viable recreation areas.

Key Indicators:

- Number of at-risk stocks of marine fish and shellfish, as defined by state or federal listing as overfished or at risk of being overfished; or by listing as threatened or endangered under state or federal Endangered Species Acts
- Bottom habitat degradation (trawl areas and intensity)
- Marine mammals (pinniped population trends)
- Kelp forests (location, area, and biomass)
- Marine protected areas (number and area)
- Harmful algal blooms and toxic shellfish (recurrence and severity)
- Shoreline armoring and beach loss (armored miles and trends)

Figure 13. Estuary Habitats



from the *Oregon Estuary Plan Book*, 1987

Estuarine Ecosystems

Background:

Estuaries are ecological transition zones that connect the marine ecosystem with the adjacent watershed. These highly productive ecosystems provide temporary or permanent homes to a wide variety of organisms—some of marine origin, others from upstream and some unique to the estuary itself. Estuarine marshes, eelgrass beds, mudflats, subtidal channels, and other habitats serve important roles in the life cycles of marine and anadromous species like crabs, salmon, herring, migratory waterfowl, shorebirds and hundreds of lesser known species (Figure 13).

Natural variability and extremes in temperature, salinity, tides and river flow make estuarine ecosystems and organisms relatively resilient to disturbances. However, alterations such as filling, dredging, the introduction of non-native species, and excessive waste disposal have changed Oregon's estuaries, reducing their natural resiliency and functional capacity.

Estuaries have always attracted humans, from native peoples to present-day retirees and tourists. Today, a variety of local, state and federal laws, regulations, and programs govern a diverse group of public and private estuary and shoreline users. Most submerged and intertidal lands and natural resources are state owned and managed, although there is some federal ownership of wildlife refuges and recreation areas. Land along estuary shorelines is almost exclusively privately owned.

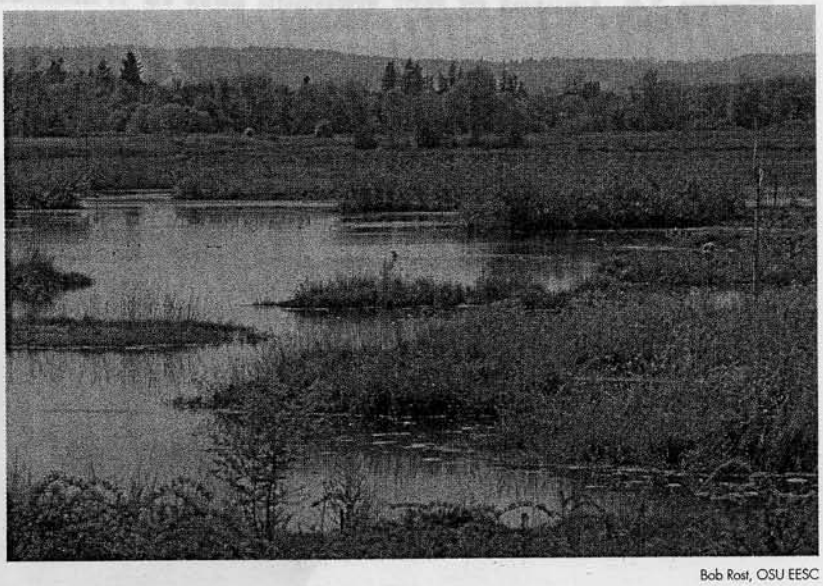
Status:

The most significant historical changes in Oregon's estuaries are the diking, draining and filling of wetlands and the stabilization, dredging, and maintenance of navigation channels. Between about 1870 and 1970, approximately 50,000 acres or 68% of the original tidal wetland area in Oregon estuaries was lost. Despite these significant historical wetland conversions and continuing degradation by pollutants, nuisance species, and navigational improvements, much of the original habitat that existed in the mid-1800s is relatively intact today. Local zoning plans now protect 98% of remaining estuarine wetlands and 89% of subtidal areas, and hundreds of acres of former estuarine marshes are being restored.

Jim Good, OSU Marine Resources Management and Sea Grant

Warrenton's former tidal wetlands illustrate alterations that are typical in many Oregon estuaries: diking, draining, farming, logging, filling for roads and airports, and commercial and residential development.

Wetlands are more than just habitat for waterfowl. Healthy wetlands store water, reduce winter flooding, and sustain summer stream flows. They improve water quality by recycling nitrogen and phosphorus, and by filtering sediments and other pollutants.



Bob Rost, OSU EESC

Introduced species comprise a significant proportion of Oregon's estuarine flora and fauna; for example, 30% of the benthic organisms in Yaquina Bay are estimated to be introduced species. Some introduced species are considered beneficial and have been purposely introduced, such as Japanese oyster, striped bass and eastern softshell clam. Others, such as European green crab, have been introduced accidentally, often in ballast water from large ships, and pose serious threats to native estuarine communities.

Estuarine ecosystems owe their unique character and productivity in part to freshwater inflow from the upper watershed that helps dilute pollution and flush waste out of the system. However, consumptive use of fresh water has reduced these flows by as much as 60 to 80% during summer peak demand periods. The consequences are uncertain at this time, but consumptive demand is likely to increase with human population and tourism growth. There are too few water quality measurements from which to make a comprehensive assessment, although there are some high to moderate fecal coliform concentrations in estuaries surrounded by significant agricultural land uses.

Although there is uncertainty about the severity of potential threats to Oregon's estuaries, the greatest concerns include the reduction in freshwater inflow, the impacts of nuisance species, continued physical alterations, excessive sediment and runoff pollution from local and watershed sources, and pressures associated with population and tourism growth.

Key indicators:

- Area of estuarine wetlands (tidal marsh/swamp habitat) compared to historical area (acres and percent)
- Area of estuarine habitats protected (acres and percent)
- Aquatic nuisance species (occurrence and extent)
- Freshwater inflow (flow rate and timing)
- Estuarine water quality trends

Freshwater Wetlands

Background:

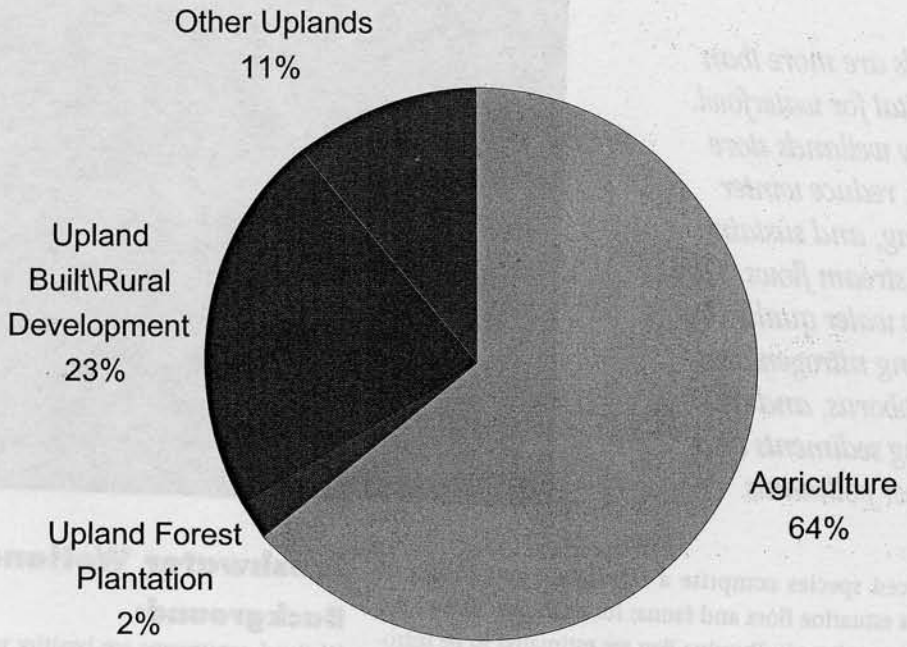
Wetland ecosystems are healthy when their hydrologic and biochemical processes are intact, and native wetland plant and animal communities are sustained. Healthy wetland ecosystems retain their capacity to provide valued goods and services such as nutrient cycling, fish and wildlife habitat, hydrologic control (e.g., floodwater reduction and maintenance of summer stream flows), and water quality improvement.

There are many types of freshwater wetlands, including valley bottom marshes, forested swamps, bogs, and wet meadows. Each wetland type has specific characteristics and provides many types of services. For example, floodplain sloughs temporarily store water and thus reduce downstream flooding, and streamside wetlands provide food and shelter for salmon and trout. There are many direct activities (e.g., filling, draining, and introduction of pollutants) and indirect activities (e.g., groundwater withdrawal, poor upland land management) that eliminate or damage wetlands. For example, many wetlands adjacent to rivers and streams have been disconnected from them by road or levee construction, and as a result have lost much of their hydrologic and habitat characteristics and functions.

Status:

Much of Oregon's agricultural activity and some urban development has taken place in areas that once were wetlands. An estimated 38% of Oregon's original wetlands have been lost. About 57% and 75% of original wetlands have been lost from the Willamette Valley and Klamath Basin, respectively. The Oregon Natural Heritage Program has to date identified 518

Figure 14. Causes of Net Wetland Loss to Willamette Valley Upland, 1982-1994



wetland plant communities in Oregon, and 151 (29%) of them are endangered. In the Willamette Valley, less than 1% of the original wet prairie exists today, and 44% of the historical wetland plant communities are considered imperiled. Throughout Oregon, 24% of the wetland dependent amphibians are considered similarly at risk. Comprehensive data on the amount of wetland area for the entire state are not available. Similarly, there are limited data on current wetland trends. However, in a recent study the Oregon Division of State Lands found that 6,877 acres of wetland had been lost in the Willamette Valley over the period of 1982 to 1994, most to agriculture and rural development (Figure 14). The general conclusion is that current wetland losses continue, though at much slower rates than those estimated for historical wetland loss.

Key Indicators:

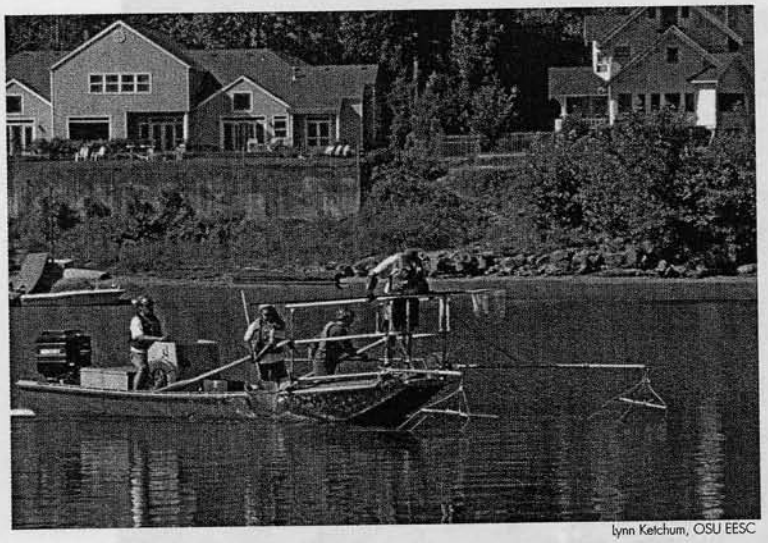
- Change in area of freshwater wetlands as compared to historical distribution (acres/percent)
- Permitted change in wetland area (acres/percent)
- Change in diversity and distribution of wetland types
- Changes in native wetland plant and animal assemblages
- Degree of connectivity with other aquatic resources and upland habitats
- Changes in hydrologic characteristics

Riparian Ecosystems

Background:

Riparian areas, transition zones between aquatic and terrestrial ecosystems, are exceptionally important parts of the Oregon landscape. These corridors along streams, rivers, wetlands, lake margins, and estuaries are easily changed by land-use practices, and recovery can take decades to centuries. Healthy riparian areas retain the structure and function of natural landscapes as they were before the intensive land use and land conversion that has occurred over the last 150 to 200 years.

Riparian vegetation shades streams, contributes leaves and large wood to streams, takes up nutrients, and stabilizes streambank and floodplain soils. These corridors strongly influence water quality, including stream temperature, nutrient loading, sedimentation, and contaminants from terrestrial sources. Food webs in stream ecosystems depend on terrestrial vegetation as a source of food inputs and habitat structure (e.g., large wood, pool formation, stream bank stabilization). Birds, mammals, amphibians and other terrestrial organisms depend on riparian areas for diverse habitat, cover, and food sources in close proximity to water. Riparian areas also serve as corridors for the movement of terrestrial animals and plants across the landscape. Much of Oregon's lowland riparian areas are in private ownership (Figure 15). From stabilizing banks to cleansing runoff, these riparian areas contain potentially important commodities for human use beyond their high real estate value.



Lynn Ketchum, OSU EESC

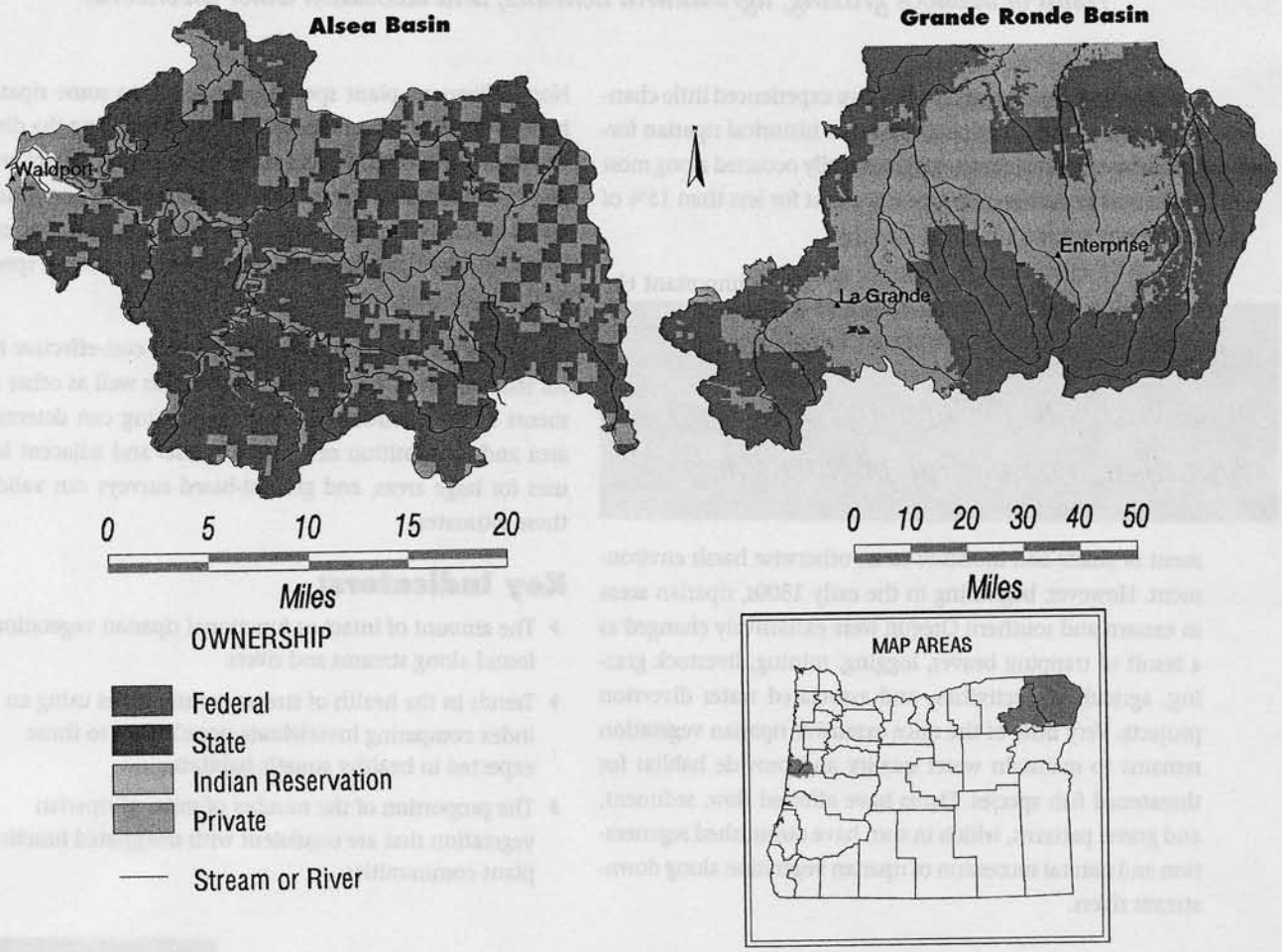
Much of the riparian area along the mainstem Willamette has been reduced by various land uses.

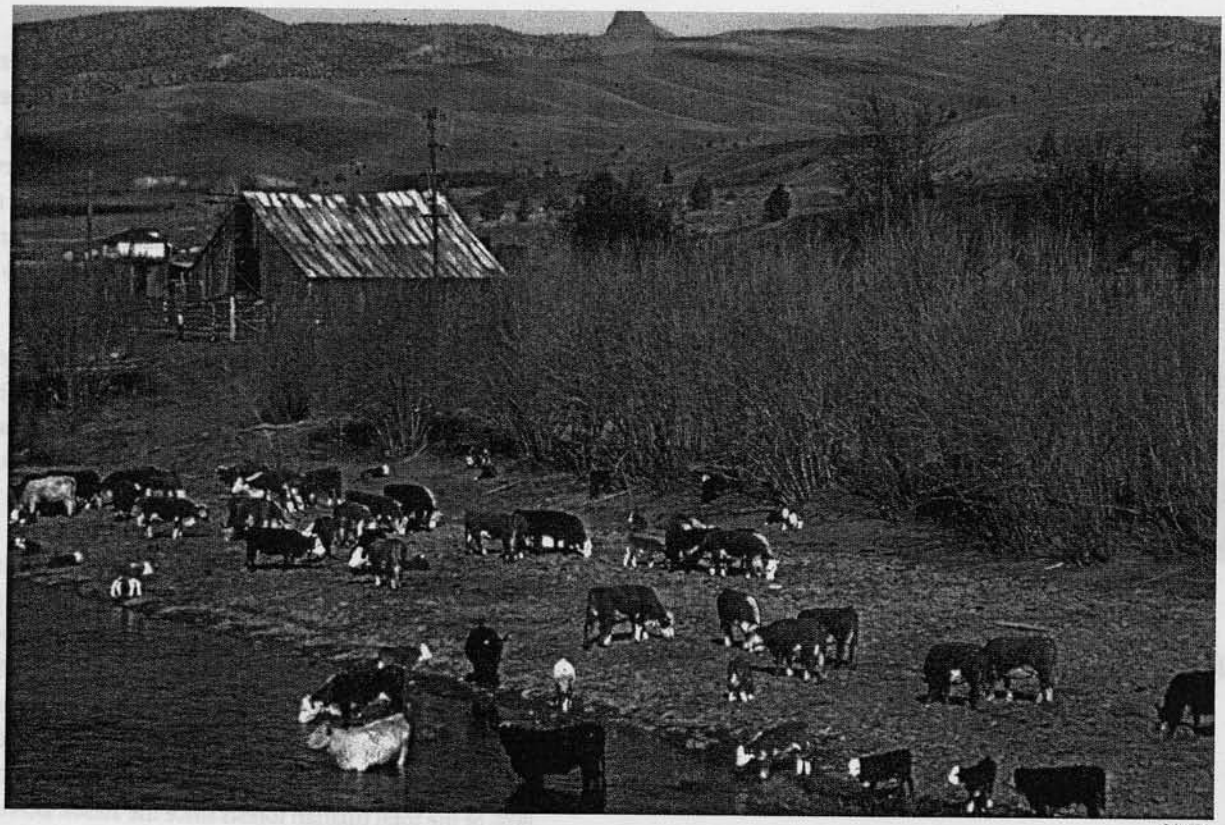
Status:

Oregon contains approximately 114,500 miles of rivers and streams. There are no statewide measurements of the area of riparian vegetation, although there are estimates from some more localized regions. Using a very simple and conservative estimate of 100-yard riparian corridors on each side of the stream, the estimated total area of riparian habitat for flowing waters in Oregon is 22,900 square miles, about 15% of the total area of the state.

Land use activities have reduced the numbers of large trees, the amount of closed-canopy forests, and the proportion of older forests in riparian areas. In western Oregon, riparian plant communities have been altered along almost all streams and rivers. In the western Cascades, Willamette Valley, Coast Range, and Klamath Mountains, riparian areas on privately owned land are dominated by younger forests because of timber harvest, whereas riparian areas on public lands have greater amounts of mature conifers. Old coniferous forests now comprise approximately 20% of the riparian forests in the Cascades, but only 3% in the Coast Range. Along the mainstem of the upper Willamette River, there has been an 80% reduction in river channel complexity and a reduction of more than 80% of the total riparian forests since the 1850s. Downstream

Figure 15. Examples of Land Ownership and Streams, Westside and Eastside





OSUEEC

Riparian areas in eastern and southern Oregon have been altered extensively as a result of livestock grazing, agricultural activities, and associated water diversions.

portions of the Willamette River have experienced little channel change, but more than 80% of the historical riparian forest has been lost. Older forests historically occurred along most of the McKenzie River, but now account for less than 15% of its riparian forests.

In eastern Oregon, riparian areas provide an important element of shade and moisture to an otherwise harsh environment. However, beginning in the early 1800s, riparian areas in eastern and southern Oregon were extensively changed as a result of trapping beaver, logging, mining, livestock grazing, agricultural activities, and associated water diversion projects. Very little of the once extensive riparian vegetation remains to maintain water quality and provide habitat for threatened fish species. Dams have affected flow, sediment, and gravel patterns, which in turn have diminished regeneration and natural succession of riparian vegetation along downstream rivers.

Riparian practices are controlled to a much greater degree on forest lands than on urban, agricultural, or rangelands.

Non-indigenous plant species pose a risk to some riparian habitat by dominating local habitats and reducing the diversity of native species. For example, from the upper McKenzie River to the mid-section of the Willamette River, non-indigenous species increased from 10% of the observed species in the headwater riparian zones to more than 50% of the species in the mainstream riparian forests.

Satellite remote sensing is a powerful and cost-effective tool for tracking Oregon's riparian resources, as well as other elements of the environment. Remote sensing can determine area and composition of riparian forests and adjacent land uses for large areas, and ground-based surveys can validate these estimates.

Key Indicators:

- The amount of intact or functional riparian vegetation found along streams and rivers
- Trends in the health of stream communities using an index comparing invertebrate populations to those expected in healthy aquatic habitats
- The proportion of the number of miles of riparian vegetation that are consistent with designated functional plant communities

Freshwater Fish Communities

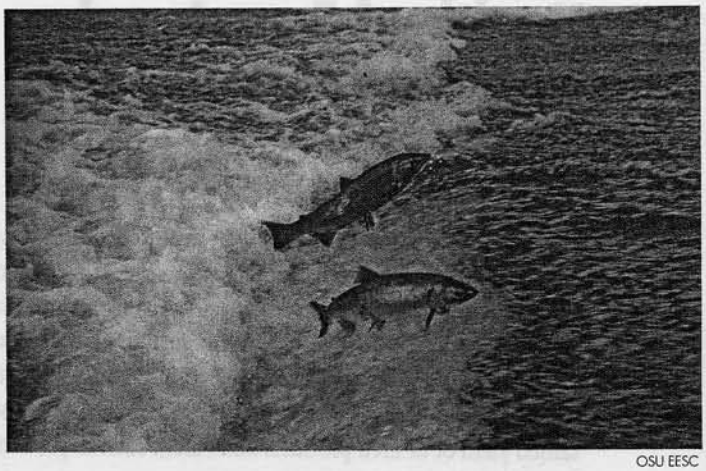
Background:

Fish have played a central role in the history and economy of Oregon. Indeed, our regional identity is closely tied to salmon that effectively link the land, rivers, and Pacific Ocean. Fish support commercial fishing, coastal charter sport fishing, fishing on inland streams and lakes, sporting goods and resorts.

The health of Oregon's freshwater fish can be considered from all three perspectives of health developed in this report. A healthy fish resource is a naturally fluctuating population that maintains its abundance, composition, and distribution across the landscape without continued human intervention. Healthy fish stocks may also be considered as those that provide some level of harvest, and still maintain self-sustaining populations. Additionally, environmental laws seek to maintain native species. Healthy fish communities are composed of primarily native species, and species from other regions are not dominant.

Status:

Sixty-three species or recognized subspecies of native freshwater fish occur in Oregon. Currently, 14 of those species or subspecies are listed under the Endangered Species Act as threatened or endangered, and an additional 15 species are considered potentially at-risk and are listed as candidate species. Five of the listed species are salmon and trout, and 226 genetically distinct populations face significant risk of extinction. Thus, 45% of Oregon's freshwater fish species have declined and are at some risk of extinction. Among the 50 states, Oregon ranks fifth in terms of the greatest number of listed fish species. In response to concerns about the health of salmon populations, commercial and sport harvests have been sharply curtailed, and fishing for coastal coho salmon was eliminated entirely from 1994 to 1998.



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Forty-five percent of Oregon's freshwater fish species have declined or are at risk of extinction.

Occurrence of tumors, lesions, and deformities in fish is a direct measure of fish health. Systematic data are not available statewide, but in the Willamette River, skeletal deformities comprised less than 5% of the sampled fish population upstream from Corvallis, 20% between Corvallis and Newberg, and there was a 56% incidence rate in the Newberg pool.

More than 32 species of freshwater fish have been introduced into Oregon, and are now self-sustaining, making up approximately one-third of Oregon's freshwater fish fauna. Introduced species frequently are predators on native species, compete for food resources, and alter freshwater habitats. In 1998, introduced species were found to comprise 5% of the number of species found in the upper Willamette River, but accounted for 60% of the observed species in the lower river near Portland.

Lynn Ketchum, OSUEEC

Scientists monitor occurrence of tumors and other abnormalities in Willamette River fish. With increasing urbanization and industrial development, relationships between toxic contaminants and the health of both fish and human communities are extremely important yet poorly understood.

Key Indicators:

- The percentage of wild, native fish populations, including salmon, that are classified as healthy

  (This measurement would provide several additional indicators that are informative, including proportions of exotic fish species, proportions of fish that are diseased or deformed, presence of species at risk, and relative abundances of salmonids.)

- Level of harvest that is allowed for both commercial and sport fishing

  (Harvest limits reflect economic, political, and social objectives; they are insensitive to short-term changes in abundance.)

- Trends in extinctions and threatened or endangered listings

  (This provides an extreme measure of Oregon's environment, but rarely serves as an early warning system.)

Health of Forest and Rangeland Ecosystems

Forests

Background:

Applying the three perspectives of ecosystem health developed in this report, the health of Oregon's forests can be considered in multiple ways. Healthy forests maintain their characteristic species composition, age structure and key processes such as producing tree growth and stabilizing soil. Healthy forests also maintain their productive capacity to ensure a sustained yield of desired products and values such as providing recreational opportunities.

Wildfire and periodic insect outbreaks have historically been important influences in shaping the composition and structure of forests in Oregon. Wildfires historically have occurred in the western Oregon forests on the average of about every 300 years, but every 15 to 50 years in the eastern drier Ponderosa pine forests. Thus, the evaluation of many forest practices is based on their ability to emulate the historical effects of wildfire, insects, and drought.

Status:

Almost half of the state's total land area is covered with forests, ranging from the moist forests of the Coast, Cascade and coastal portion of the Klamath Mountain ranges to the drier forests of eastern Oregon. Overall there has been a reduction in Oregon forestland, with estimates of this reduction since 1970 ranging from 1.8% to 8.0%. Data from the U.S. Forest Service indicate that for the period of 1973 to 1982, about 2.4% of the non-federal forest and agricultural land base in western Oregon was converted to residential use. During 1982 to 1994, conversion of these lands slowed with about 0.8% being lost to urban and residential use.

Old-growth forests in western Oregon are currently at relatively low levels compared to historical times because of past harvest, but they should increase significantly under implementation of federal and state plans. In the Coast Range, the amounts of old growth will still fall short of the estimated average levels that occurred historically. In the Cascades old-growth forests may reach historic levels, although the older forests will be concentrated at somewhat higher elevations. There is a moderate to high probability that these forests will provide habitat to support viable populations of species naturally associated with older forests.

Younger forests (approximately 0 to 40 years of age) under both federal and non-federal ownerships in western Oregon are extensively, often densely stocked, and generally lacking in structural diversity. While their amount may be within the historical range, it is probably higher than the historical average. These young forests lack key habitat attributes that would have existed after major fires, such as patches of large trees, snags and down wood, shrubs, and a diversity of tree densities. Many of these forests on federal lands are slated to become old growth forest. Unless management practices are allowed to proceed to help these forests develop some of these post-disturbance characteristics, the development of old growth habitat conditions may be substantially delayed.

The private forestlands will likely create most of the young stands of the future in western Oregon. Under current forest practice rules, landowners have little incentive to leave the forest structure that would emulate post-disturbance condi-

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Young forests are extensive throughout the westside, generally the result of timber harvest. State forest practices rules help ensure prompt replanting on private forest lands, but diversity of forest structure and of species composition remain a challenge.

Significant portions of eastside forests are under stress because stands are too dense. Active management, including prescribed fire and timber thinning, may help to recreate the historical variety of stand ages and conditions that offers firebreaks and fewer food sources for insects.

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tions except perhaps in riparian areas. As a consequence, forest dwelling species that depend on structures found in natural young forests may face difficulties in the future.

Successful reforestation and management practices on western Oregon forestlands enable relatively high rates of growth of conifer species, although with the outcome of simplifying some structure and composition of the forests. Diseases are not a major problem in the state's western forests except for Swiss needle cast along the coast.

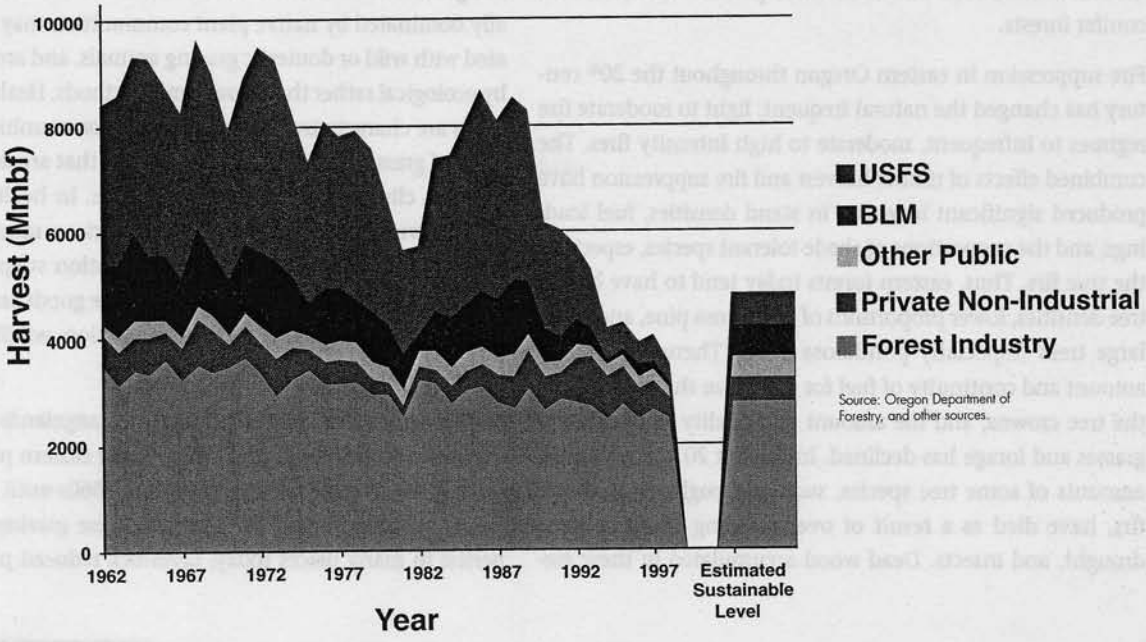
Current forest growth exceeds current harvest on lands that have historically been used for commercial timber production. Growth and harvest are generally in balance on private lands, while growth is significantly above harvest on state and federal lands. Much of the growth on state and federal land will be used to rebuild old growth forests.

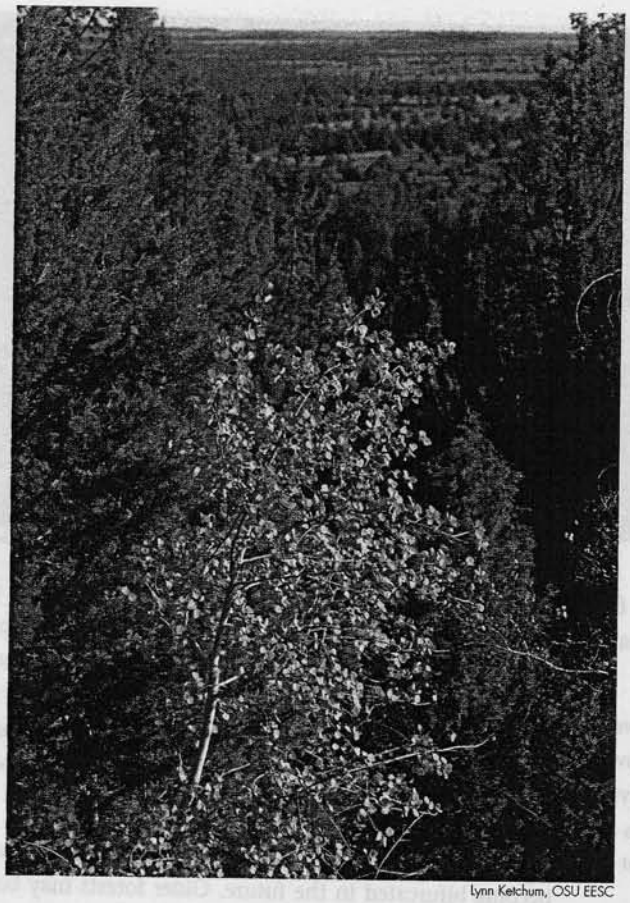
Timber harvest in western Oregon during the last few years has been about half of the levels of the late 1980s (when it was over 6 billion board-feet per year) due to major harvest limitations on federal lands, particularly in the west Cascades. Recent harvest levels on private lands, the projected source of most of western Oregon's future harvest, can generally be sustained into the future (Figure 16).

Current trends suggest that Oregon's westside forests may become bifurcated in the future. Older forests may be concentrated on federally owned uplands, while most younger forests may be on privately owned lowlands. Few middle-aged forests may be expected to develop over time, except on State lands.

In eastern Oregon, frequent, low to moderate intensity natural fires at low to moderate elevations historically resulted in

Figure 16. Total Historical Harvest by Owner and Estimated Sustainable Level





Lynn Ketchum, OSU EESC

Fire suppression has allowed juniper to invade beyond its historical range.

multi-aged stands of ponderosa pine, along with mixed conifer stands dominated by Douglas-fir on moister sites. At high elevations, infrequent, high intensity fires created largely even-aged stands of true fir and spruce. Most of the commercial timber production is from ponderosa pine stands at low to moderate elevations and from drier portions of the mixed conifer forests.

Fire suppression in eastern Oregon throughout the 20th century has changed the natural frequent, light to moderate fire regimes to infrequent, moderate to high intensity fires. The combined effects of timber harvest and fire suppression have produced significant increases in stand densities, fuel loadings, and the proportions of shade tolerant species, especially the true firs. Thus, eastern forests today tend to have higher tree densities, lower proportions of ponderosa pine, and fewer large trees (especially ponderosa pine). There is a greater amount and continuity of fuel for fires from the ground into the tree crowns, and the amount and quality of understory grasses and forage has declined. In the last 20 years, sizeable amounts of some tree species, such as Douglas-fir and true firs, have died as a result of overcrowding on drier sites, drought, and insects. Dead wood accumulated in these forests has fueled large, intense fires which have, in turn, caused changes in species composition in some of these forests.

Most forest lands in eastern Oregon are federally owned. Federal managers in recent years have made a dramatic shift in management to conserving biodiversity through maintaining and restoring the natural composition, structure, and processes of these forests. Timber harvest levels have plummeted and the timber that is harvested tends to be small and higher cost wood from understory thinnings. Permanent long-run plans are still in development, but it is clear that forest restoration on the east side will require active management including prescribed fire and timber harvest. Controversies over active management of federal forests, especially concerns over impacts on threatened fish stocks, make full implementation of these policies difficult and uncertain.

Key Indicators:

- Amount of commercial forest types in different structural stages compared to historical amounts
- Timber harvest relative to sustainable levels
- Extent of major forest types
- Landscape pattern of patches
- Conversion of forest land to more developed uses
- Diversity of species within stands
- Presence of large conifers in disturbed areas
- Stand density
- Annual growth of trees
- Extent of management activity

Rangelands

Background:

Rangelands are lands that are unsuitable for cultivation, usually dominated by native plant communities, may be associated with wild or domestic grazing animals, and are managed by ecological rather than agronomic methods. Healthy rangelands are characterized by native plant communities in mixtures of grasses, forbs, shrubs and forests that are determined by soils, climate and disturbance regime. In healthy rangelands, invasive non-native species comprise a minimal component of the plant community. Vegetation suppresses soil erosion. Healthy rangelands also produce goods and services such as livestock grazing, timber production, wildlife habitat and recreation.

Since Europeans settled in Oregon, many rangelands have been converted to croplands and cities. In the eastern parts of the state, heavy grazing occurred from the 1860s until the Taylor Grazing Act of 1934. The effects of these grazing practices persist in many places today. Livestock reduced plant cover

in some rangelands so that the natural fires (occurring historically every 15 to 50 years) were less frequent. Juniper was prevented from occupying most steppe communities by these naturally recurring fires, but it spread rapidly once fires were curtailed. Juniper is an extremely competitive species and as its canopy increases, understory species such as sagebrush and grasses are reduced or eliminated. Because these understory plants served as fuel, as they die off the area becomes essentially fireproof.

Status:

There is no systematic monitoring program in Oregon to assess the current condition of rangelands, or the outcomes of rangeland management practices. For example, some data for Oregon rangelands indicate that the acreage in good to excellent rangeland increased between 1982 to 1992, but the data are too variable to draw quantitative conclusions.

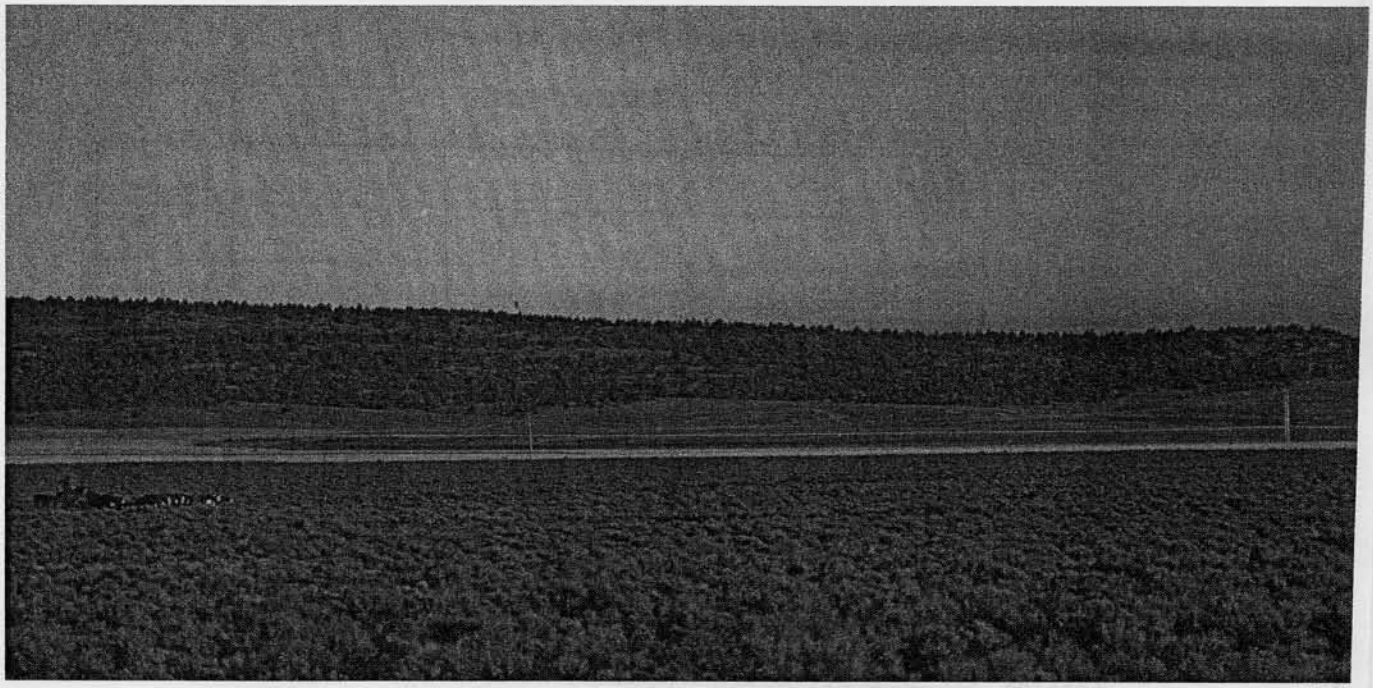
Sagebrush grasslands, commonly referred to as shrub/steppe dominate almost one-fifth of the land area of Oregon. About 2.8 million acres of formerly shrub/steppe communities are now dominated by invasive non-native species (e.g., cheatgrass, medusahead). Lack of fire has resulted in an increase in sagebrush dominance and the expansion of juniper woodlands that has decreased the mosaic character of the landscape. The grassland component is especially under-represented on the current landscape.

Many invasive weeds pose a severe threat to rangeland integrity. Cheatgrass, the most common and widespread invasive species at this time, provides plentiful fuel and may increase fire intervals well above natural frequencies. Under this condition of cheatgrass dominance, native perennial plants are reduced because they do not have the opportunity to recover between the increased fire events.

In the Malheur County area of the Northern Basin and Range Ecoregion, upland data show agricultural conversion has affected 12% of the area and native shrubland has declined by 13% from historic times. Other changes were attributed to exotic plant invasion and juniper woodland encroachment. Elsewhere in this ecoregion, agricultural development is less, but exotic plant invasions and encroachment of woodlands remain important agents of change.

Key Indicators:

- Extent and growth of key plant species that influence important ecological processes (such as water, nutrient and energy cycles)
- Proportion of non-native invading species
- The trend in ecological condition of degraded areas
- Soil erosion rates
- Mosaic pattern of plant cover as compared to conditions when fire was a natural event, with fire interval approximating the natural range of variation (e.g., 8-35 years in ponderosa pine, 15-200 years in various sagebrush communities)
- Sustainable timber and/or livestock production



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Oregon's upland rangelands have significantly recovered from previous overgrazing, but riparian areas remain a challenge.

Health of Agricultural Ecosystems

Background:

Agriculture represents an important component of the Oregon economy. Intensive production of food and fiber causes significant changes in natural ecosystem processes, resulting in the requirement for investing large amounts of energy and materials to sustain these agricultural ecosystems.

Nearly 17.5 million acres of Oregon land is under agricultural usage (28% of the total area of the state), 68% of which is pasture or grazing land and 19% is harvested cropland. Oregon's gross farm gate receipts (1997) were almost $3 billion, from about 125 agricultural commodities. Nursery and greenhouse crops generated about 17% of total receipts, the largest share of any commodity while accounting for less than 1% of total farmland acreage. Approximately 55% of all Oregon farms are in livestock production and pasture, accounting for two-thirds of total agricultural acreage, only about 25% of total farm gate receipts. The nominal value of all livestock production has increased only slightly over the past 20 years, while crop production has increased at a rate of approximately 5% per year over this same period. Together the value of all crop and livestock production has increased by 4% per year over 20 years. For the past few years, employment in the food processing and food manufacturing sector remained at about 25,000 employees, accounting for 10% to 12% of total manufacturing employment in the state.

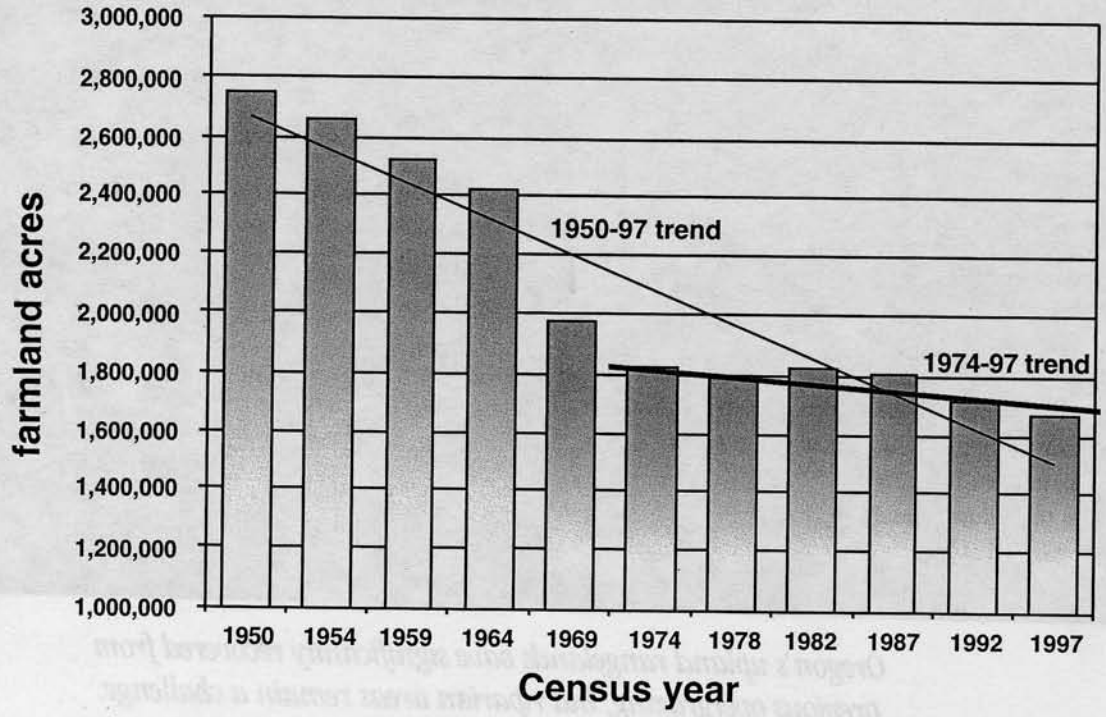
Total harvested acreage was stable at around 3.4 million acres in the late 1970s and early 1980s, but then declined by 12% in the late 1980s as highly erodable land was removed through the Conservation Reserve Program (CRP). The majority of this land in Oregon is in the Columbia Plateau ecoregion. The benefits of the CRP have included reduction in erosion and sedimentation, increased habitat for wildlife and increased opportunity for recreational activities. Over the past 10 years, total harvested acreage has been stable, with an average of about 3.05 million acres.

Status:

Conversion of agricultural lands to other uses declined significantly after enactment of Oregon's land use regulations in 1973. However, conversion continues to pose a threat to the viability of agriculture, particularly in the Willamette Valley (Figure 17). Not only are agricultural lands directly lost through conversion, but the remaining agriculture may become less efficient when farms become fragmented and interspersed with suburban development.

Agricultural yields are being sustained at present, but detailed analysis of trends among commodities is needed to determine whether or not soil health and productivity are being impaired by erosion and loss of organic carbon. Soil erosion rates have been inventoried on state and private land, cultivated and uncultivated (at the time of the measurement) and pastureland. Erosion rates calculated for the years 1982 and 1992 show a 42% reduction in erosion over the decade. Rates per acre have also decreased with rates as high 25 ton/acre in

Figure 17. Land in Farms, Willamette Valley, 1950-97



Oregon growers continue to make advances toward improved productivity while attempting to moderate impacts to the environment, including the adoption of alternative pest control techniques. Yet in some areas, persistent pesticide residues, as well as nitrate and phosphate levels, exceed standards for drinking water and healthy aquatic life.

Bob Rost, OSU EESC

1982, but in 1992 the highest rate was 10.6 tons/acre. Nevertheless, erosion rates in 1992 (the most recent year for which data are available) indicate a loss of 11,744,600 tons; 68% of the annual total in the Columbia Plateau and 16% in the Willamette Valley. Erosion rates in these areas are considered excessive.

In the semiarid conditions of eastern Oregon, after 100 years of cultivation, there have been losses of organic matter exceeding 40%. No-till, direct seeding technologies have been developed in the Pacific Northwest, and if implemented they can drastically reduce loss of organic carbon, and limit erosion rates.

Agriculture competes with many other uses for a finite supply of water. Increased focus on water management, conservation, and allocation efficiency mechanisms will be essential in the future.

Approximately 250 to 300 pesticide active ingredients are used in Oregon, excluding anti-microbial ingredients. The annual application rates are about 13.4 million pounds and the amount used has remained about the same over the past 20 years. Pesticide usage for some crops has decreased (e.g., on small grains), increased in others (e.g., in nurseries with the expansion of the industry), and remained relatively stable in others (e.g., tree fruits).

Some pesticide residues in ground and surface waters exceed drinking water standards and concentrations necessary to protect aquatic life. Since 1984, 29 pesticides and pesticide residues have been detected in Oregon's groundwater. Agriculture is not the only source of these contaminants. In the majority of cases, detection has been limited to one river basin, although Dacthal and atrazine have been found in several basins. Detected concentrations of Dacthal are far below the hazardous levels for drinking water; all measurements for atrazine were below these standards except for a few along the North Coast. Of the remaining pesticides found in Oregon groundwater, dieldrin, dinoseb, heptachlor and pentachlorophenol (PCP) were detected at levels that exceed drinking water standards or guidelines. Several of these (dieldrin, dinoseb and heptachlor) are no longer used in Oregon; PCP use has declined significantly over the last ten years and is restricted to a few wood treatment facilities. However, these chemicals persist for a long time in the environment, which is one reason they have been banned.

Pesticides are found more frequently in surface waters than in groundwater in Oregon. From a summary in the Willamette Valley, chlorinated hydrocarbons were recently found in fish tissues despite a ban on their use since the 1970s. Eight pesticides exceeded safety levels for drinking, aquatic life, or both. Fish and clam tissues and sediments all contained organochlorine pesticides at detectable levels. A 1999 study in the Hood River Basin of organophosphate insecticides, commonly used in orchards, found samples above the water quality standard.

Data on pesticides suggest there are instances of concern in both groundwater and surface, and from sources beyond agriculture. However, more data will be required to adequately

assess the distribution of these chemicals and the potential hazard that they pose. The new pesticide tracking legislation should enable better monitoring of pesticide use, and lead to advances in pesticide management. In addition, Integrated Pest Management (IPM) approaches to pest, disease and weed control limit pesticide use, and there is evidence that IPM is being increasingly adopted in a number of commodities.

Alternatives to pesticides, including biological control are also practiced, although not on a wide enough scale. The state has an excellent record in the use of biological agents to control invasive weeds and has more weed species suppressed by these approaches than any other western state.

Over 60,000 tons of nitrogen are applied in the Willamette Basin each year. Ninety-eight percent of stream samples contain detectable nitrate concentrations: values range from 0.054 to 22 mg/L. Forested basins had the lowest nitrate levels, particularly those where the forested area exceeded 90%. The U. S. Environmental Protection Agency sets the maximum contaminant level (MCL) for drinking water at 10 mg/L. Nitrate concentrations exceeded the MCL in Bear and Zollner creeks in the Pudding Creek basin, northeast of Salem. Both drain an area of more than 50% agricultural land.

Ninety-five percent of stream samples in the Willamette basin contained detectable concentrations of total phosphorus, ranging from 0.01 to 1.3 mg/L. Dissolved orthophosphate was detected in 89% of steams, at concentrations ranging from 0.01 to 0.93 mg/L. Forty-five percent of streams yielded total phosphorus concentrations that exceeded the 0.1mg/L maximum value cited by the Environmental Protection Agency as a goal for prevention of nuisance plant growth in streams. Sixty-eight percent of steams exceeding this limit drained largely agricultural land.

A number of practices may serve to reduce nutrient contamination from livestock and crop production. Confined Animal Feeding Operations (CAFOs) are required to develop animal waste regulation plans, and nutrient management plans for crops are reducing wasteful use of chemical fertilizers.

Oregon farmers have been quick to adopt improved agricultural practices in the past. Today new technologies and farming practices are available to reduce soil erosion rates, increase soil organic carbon, limit the use of pesticides, and contain inputs of nitrogen and phosphorous fertilizers. Supported by legislation that regulates adverse environmental impacts, many changes that have taken place have been in response to specific environmental problems, without system-level consideration of the farm as part of a surrounding landscape. There is considerable evidence of the benefits of a system-level perspective, in terms of enhanced farm production and reduced ecological and economic costs. The long-term sustainability, both ecological and economic, of agriculture in Oregon, depends upon advances that will be made at this more integrated level. The establishment of more sustainable practices will anticipate new regulatory controls, rather than respond to them, and return agriculture in Oregon to greater production stability and reduced impact to the environment.

Key Indicators:

- Trends in soil quality and erosion rates
- Area of land in agricultural production
- Adoption of sustainable practices (including approaches to soil, nutrient, waste, pesticide and water management)

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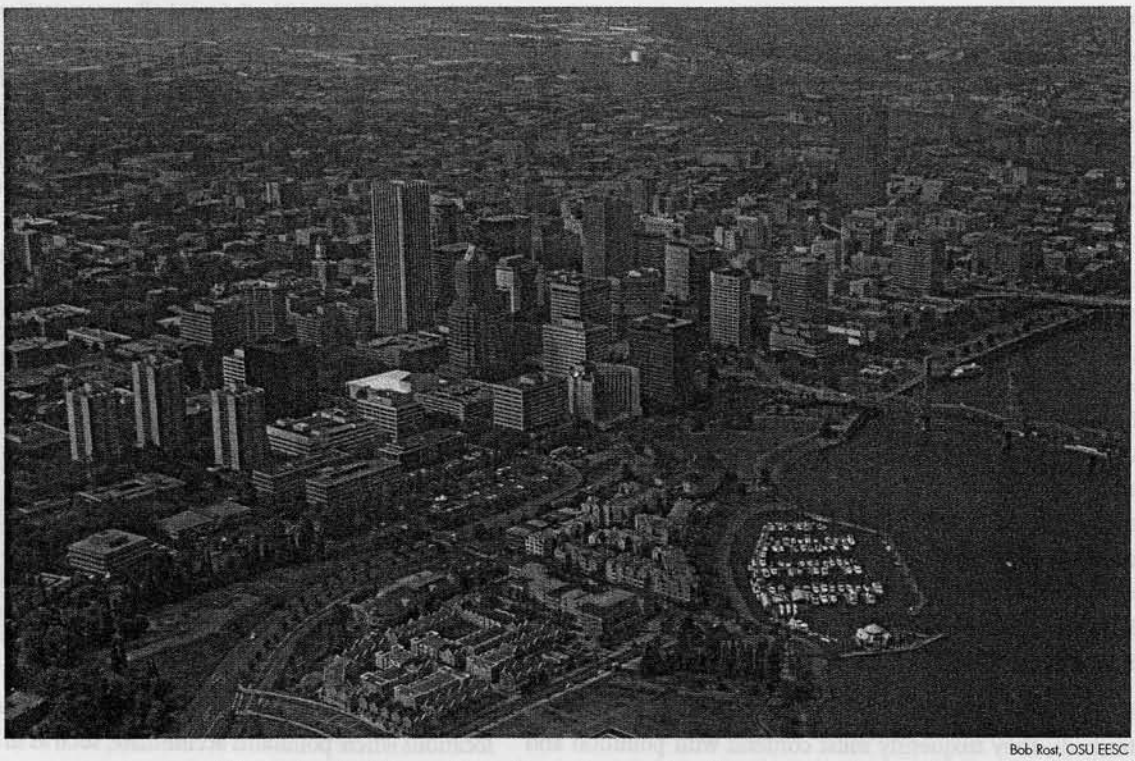
Soil erosion poses risks to future agricultural productivity, particularly in the Columbia Plateau ecoregion.



Bob Rost, OSU EESC

The extent of paved surfaces in most urban areas impacts water quality, flood control, and habitat diversity.

Health of Urban Areas

Background:

Urban areas (defined by urban growth boundaries) occupying about 6% of the State's land area, are home to the majority of Oregon's population, and are key drivers of many aspects of the economy. The health of these urban areas can be measured by many scales of social welfare and economic strength. However, this report focuses on environmental health, and thus urban systems are evaluated on the three general ways in which human activities can disrupt natural processes:

(a) natural habitats are destroyed and new habitats are created;

(b) the flows of water, organisms and materials across the landscape are altered; and

(c) artificial materials are produced and many of them are not assimilated by natural processes.

Status:

▸ *Natural Habitats Are Destroyed and New Habitats Are Created*

The annual rate of conversion of forest and farmlands to residential and urban uses has declined dramatically since comprehensive land use planning was implemented during the 1980s. Most of the current conversion is within specific Urban Growth Boundaries, designed to contain urban sprawl. However, these laws were not written to address ecological issues, such as clean water or ecosystem function within urban boundaries. In order to meet the economic and social needs of humans, native vegetation and habitats in urban areas may be destroyed and converted to buildings and paved surfaces. The runoff from these impervious surfaces can drain oil and other pollutants into urban streams. With riparian edges reduced, there is very little buffering capacity left along most urban streams.

Urban areas are facing demands to better protect streamside habitat and enhance riparian corridors to allow fish passage along streams and rivers. A combination of healthy upland and aquatic habitats is needed to ensure healthy conditions for fish. Elevated water temperatures in many Oregon streams and rivers, including those in urban areas, will remain an important challenge — approximately 30% of assessed streams are warmer than the standard set to protect salmon.

▸ *Flows of Water, Organisms and Materials Across the Landscape Are Altered*

Water quality is threatened by a variety of sources, especially nonpoint sources (primarily stormwater runoff). A recent review of data in four Oregon river basins shows approximately 85% of pollution coming from nonpoint sources. While the nonpoint contribution in particular urban areas may be somewhat different, these largely uncontrolled discharges have a significant effect on surface water quality. Pollutants from urban areas include pesticides, fertilizers, other chemicals,

runoff from roadways and parking lots, and sediments from soil erosion. Sewage overflows remain a problem, but will be significantly reduced over the next decade by infrastructure improvements in several cities. While wastewater flowing into municipal wastewater treatment plants has tripled since 1940 (primarily because of population growth), pollution loads from treatment plants have dropped 60% in this period.

Urban systems alter the natural flows of water, organisms and materials by changing natural patterns and by creating other pathways. Obstructions in the natural drainage systems alter water quality and affect fish and other aquatic organisms. Impervious surfaces increase the amount and change the timing of runoff, construction activities frequently increase erosion, and toxic and other harmful materials are carried into streams from industrial and home sites. Overloading nature's capacity to assimilate pollution such as excessive sewage, storm water overflow, chemicals, and sedimentation all affect the health of aquatic ecosystems and may constitute human health hazards.

Because urban areas tend to be located in lower parts of watersheds, they frequently must contend with pollution and other materials which are transported from locations upstream. Similarly, air pollution in the Columbia Gorge may originate partly from local vehicular traffic, but also from pollutants emitted from more distant sources.

▸ *Artificial Materials Are Produced That Are Not Assimilated by Natural Processes*

There have been significant improvements in Oregon's air quality during the past 15 years, with decreases in measured levels in ambient air of fine particles, ozone, sulfur and nitrogen dioxides, carbon monoxide and lead. Air quality monitoring shows all areas of the state in compliance with health-based National Ambient Air Quality Standards (NAAQS). While Medford and Portland both have had concentrations of ozone above the standard for several days in recent years, both areas remain within allowable tolerances of NAAQS. The overall downward trends are in large part the result of reductions in wood stove use and open burning, and a higher proportion of newer and cleaner automobiles and trucks. However, population increases and higher vehicle miles traveled per person have the potential to reverse these favorable trends unless additional emission reductions are achieved, especially in some locations where pollutants accumulate, such as in the Columbia Gorge. Additional attention is also beginning to be paid to emissions and impacts of toxic air pollutants.

Many Oregon cities are investing in new infrastructures to manage stormwater runoff, protect open space, and minimize the impacts of urbanization on naturally functioning landscapes.

Oregon's CO_2 emissions rose 13% from 1990 to 1997 (as compared to an 11% increase nationally). However, Oregon's CO_2 per capita emission dropped 1%. Electricity production generates 44% of the CO_2 emissions, but CO_2 emissions are growing at a higher rate (21%) than increases in electricity use (14%). Several factors beyond economic and population growth contributed to increasing CO_2 emissions: more use of older coal and natural gas-fired power plants which are not as efficient as newer plants, and replacing energy from the nuclear Trojan power plant with fossil fuel power.

Uncontrolled, non-point sources of pollution have a significant effect on water quality.

Although the number of hazardous waste generators in Oregon is declining, the quantity of waste being generated is increasing. This trend is illustrated in part by the reported rate of hazardous waste water generation, which has risen several fold since 1993 to 8.3 million tons (metric) in 1998. While much of this waste is treated and managed properly, the overall impacts on the state's waters is not clear. Additional challenges include safely recovering banned and canceled pesticides from existing stockpiles and working with households and smaller, less regulated businesses to minimize the cumulative impact of their wastes on the air, water and land. Of particular concern are materials that are toxic, persistent and bioaccumulative in nature.

Most of Oregon's solid waste is generated in urban areas, though the large majority of disposal takes place in rural areas.

In 1998, Oregonians generated 4.3 million tons of municipal solid waste, of which 37% was recovered (recycled, composted or burned as fuel). The generation rate (disposal plus recovery) of municipal solid waste has risen 5.7% per year on average since 1992. Recovery rates have increased 11% per year on average, while disposal rates have increased 3.2% — twice the growth rate of Oregon's population. Most of Oregon's solid waste is generated in urban areas, though the large majority of disposal takes place in rural areas.

Urban regions include much of the state's contaminated land. The Portland metropolitan area contains approximately one-third of the known sites where land and affiliated groundwater are contaminated by spills and past practices (other than underground petroleum tanks). However, many of these urban sites are being restored and managed for beneficial reuse of the land. Key areas such as the lower Willamette River are receiving focused cleanup efforts.

Information on ambient concentrations of pollution is variable. Data for key air quality parameters are generally more comprehensive than for water quality, though in both cases data on toxic compounds is quite limited. Data on hazardous material use, generation and releases are typically self-reported by only certain larger companies, making more difficult the task of conducting comprehensive assessments of urban exposures and risks.

Because these are materials that are produced by humans, the environmental indicators focus on amounts produced rather than characteristics of the environment. The effects on the environment of these materials are included in other indicators in the report, for example, water quality and the health of fish populations.

These materials are largely the by-product of everyday life. Existing indicators focus on the amounts that are produced rather than the effects they have on the environment. Other indicators developed in the *State of the Environment Report* focus on the effects these by-products have on various aspects of the environment, such as water quality and the health of fish populations.

Key Indicators:

- Percentage of assessed groundwater that meets the current drinking water standards
- Frequency that the Air Quality Index exceeds the existing standards
- Trends in aggregate toxic and hazardous emissions
- Trends in waste production compared to recovery

There are no comprehensive data in Oregon from which to calculate the status of urban environments, although some cities collect these data. Therefore, indicators of urban health are not well developed, but might include the following:

- Amount of urban expansion into agricultural lands and other land cover types
- Amount of urban riparian area remaining intact and/or still providing hydrological and biological services
- Amount and configuration of habitat and green space remaining in the urban region

Current indicators of environmental health focus on measures of water quality in the receiving streams, lakes and rivers. Other than in a few localities, data to evaluate these indicators are not available. In the future, urban health indicators could be expanded to address topics such as:

- Obstacles to free-flowing streams and rivers
- Habitat quality of urban stream, lakes and rivers
- Corridors among and configuration of urban habitats to allow movement of native plants and animals

OSU EESC

More than half of Oregon's grasslands, prairies, and bottomland forests have been lost through conversion to agriculture, urbanization, and invasions by exotic plants.

Biological Diversity

Background:

In its simplest definition, biological diversity (biodiversity) refers to the variety of species and habitats that exist across the landscape. The concept is frequently expanded in other ways, for example, to the genetic variation within a single population or to the ecological processes that support a community of populations. Biological diversity is important for the long-term functioning of ecological systems. Genetic variation within a species enables it to survive by adapting to current conditions and to evolve in response to changing conditions. Ecosystems with a diversity of native organisms and habitats are better able to regenerate following disturbance, or to resist invasions by exotic species, and to provide such ecosystem services as erosion reduction, water purification, and climate amelioration. Of course, biological diversity supports natural resource industries that produce commodities such as fiber, food, fuel, building materials, and medicines and pharmaceuticals.

There are several significant challenges to measuring biodiversity. First, biodiversity can be considered at several different hierarchical levels, such as population, species, ecosystem and landscape. Second, there is relatively little information on the vast majority of many groups of plants and animals such as insects, microfungi and molluscs. Third, populations of organisms are very dynamic so measurements may require continuous re-sampling. Thus, biodiversity is frequently evaluated by habitats since they may serve as convenient surrogates for many other components of biodiversity. Biodiversity is also evaluated with respect to individual species known to be at risk. Assessing biodiversity requires knowing how particular species are distributed and whether their populations are viable. Relatively few species in Oregon are monitored sufficiently closely to enable us to know precisely their geographic range and their populations.

Status:

The distribution of lands in conservation status across the state is uneven. Recent changes in federal land management have improved the outlook for biodiversity on federal forests in Oregon. In the three westside ecoregions with extensive federal forests (Coast Range, Klamath Mountains, West Cascades), about 25% of all lands have biodiversity among their man-

agement objectives. In contrast, the Willamette Valley and Columbia Plateau ecoregions, almost entirely in private ownership, have less than 2% of their lands managed for biodiversity. Eastside ecoregions with large federal ownership have 2 to 7%.

Some habitat types, such as alpine and subalpine meadows are well protected (more than 90%), but others are more poorly protected, including big sagebrush-bunchgrass (with less than 2% in areas managed for long-term biodiversity conservation), Oregon white oak woodlands (3.3%), and bitterbrush steppe (0.1%).

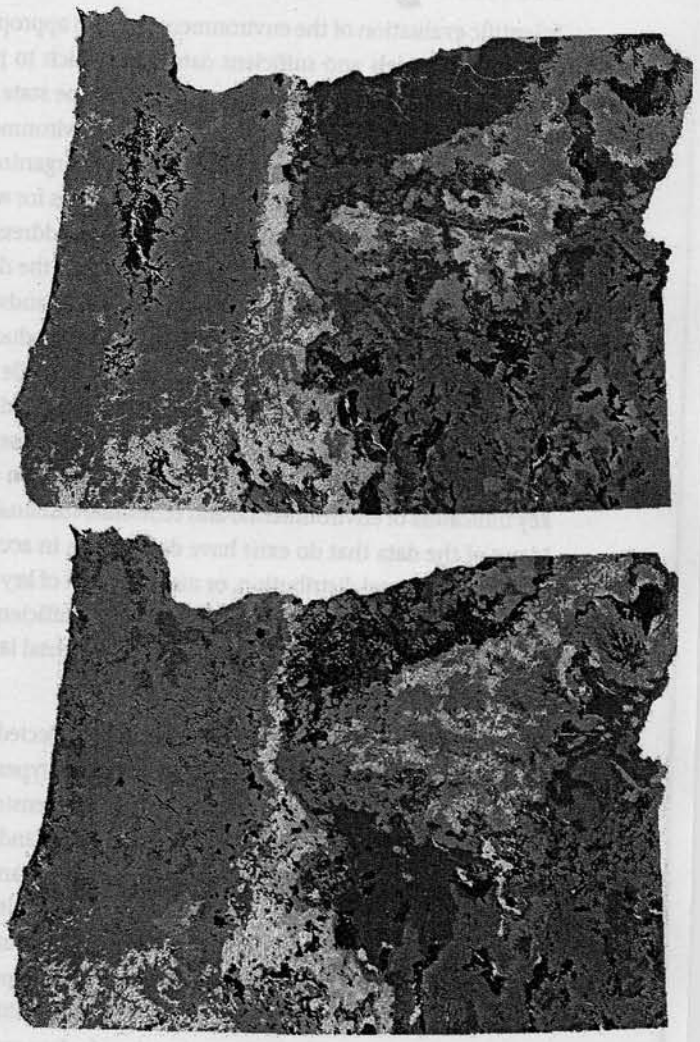
Diverse community types, such as Oregon white oak woodlands, that lie in the path of suburban development, are vulnerable to continued loss.

A significant number of species or taxonomic groups are considered nationally endangered or threatened: 91 groups are listed as critically endangered, 67 listed as endangered, 77 as threatened and 403 considered as endangered or threatened in Oregon.The Oregon Gap Analysis Project, a joint federal-state project, undertook to identify "gaps" in current protection of Oregon's species diversity. The project estimated species distributions from habitat requirements, known species ranges, and the distribution of vegetation type, and produced maps for all the state's native birds, mammals, amphibians and reptiles (Figure 18). Coarse-scale distributions exist for fish, trees and butterflies, and much is known about vascular plants. These species distributions were compared to the ownership and protection status of lands in Oregon to determine areas where there were concentrations or "hot spots" of unprotected or poorly protected species.

Key Indicators:

- Change in area of native vegetation types
- Percentage of at-risk species that are protected in dedicated conservation areas
- Number of nuisance invasive species
- Maintenance of habitats (statewide distribution of native habitats)
- Protection of at-risk species (status of Oregon's most vulnerable species)

Figure 18. Species Richness—Historical and Current



Data Collection and Management

Scientific evaluation of the environment requires appropriate assessment models and sufficient data from which to judge the status of key natural resources throughout the state. The Science Panel found that, for the most part, environmental data gathering and management in Oregon is organized to measure point sources of pollution and other issues for which the regulatory system was initially established to address. It is not well suited to measure today's concerns about the degree to which we are sustaining naturally functioning landscapes or the ability of the environment to sustainably produce the goods and services humans desire. Consequently, while some excellent data management programs are underway and there are ample data available on some issues (e.g., the chemical aspects of water quality), there are far too few data on many key indicators of environmental and economic sustainability. Many of the data that do exist have deficiencies in accuracy, spatial or temporal distribution, or measurement of key structural or functional parameters. There is also insufficient data to measure the degree to which some environmental laws are being met, such as air quality.

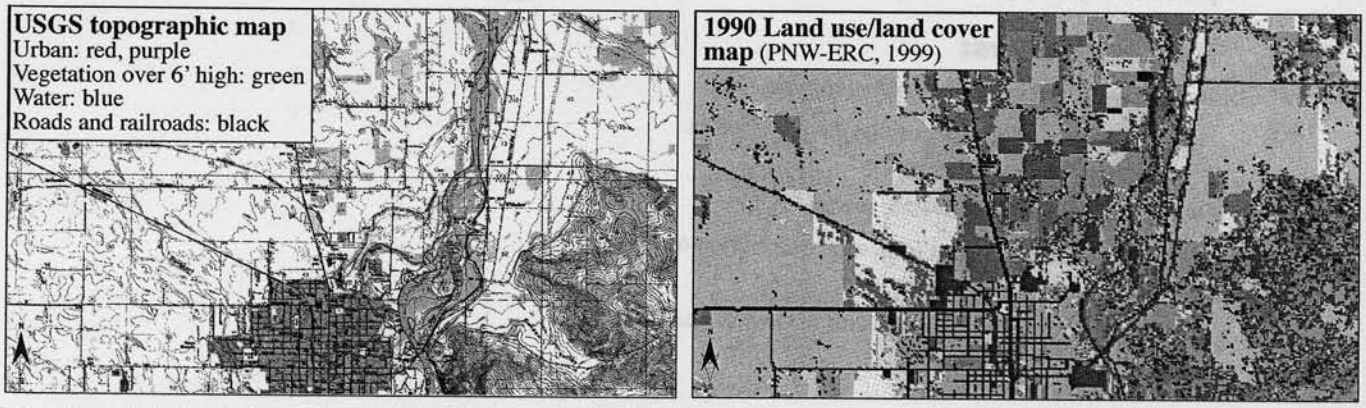
Among the most important information to be collected is the systematic measurement of land use and land cover types across the state. These data can be collected by remote sensing and then refined with on-the-ground samples to verify and refine the satellite images (Figure 19). Changes in land use and land cover are fundamental to several of the ecosystem health indicators, and they provide a framework for organizing much of the state's ecological information. Additionally, this report and other statewide assessments have demonstrated the difficulty in aggregating statewide data sets. A statewide data center, to track the locations of data and to establish standards, is important to statewide and regional analyses.

OSU Department of Fish and Wildlife

This report provides a new framework for collecting, organizing and evaluating environmental information. Data collection should be guided by the indicators described in this Report and those described in the resource analyses contained in the full report. Many of the required data are now being collected by various federal and state agencies. In these instances, premium should be placed on comparable and consistent measurements over time and space so as to permit reasonable statistical confidence in the data interpretations. For many data sets, it will be necessary to increase the intensity of measurements, for example, to include more age classes or life cycle stages of organisms.

Oregon can now design an effective and efficient program for collecting and managing environmental data. First, by comparing the data required for each major indicator of ecosystem health with the data sets currently being collected, it will be possible to decide if the current data are sufficient, or if different data should be collected. Second, the data collection system should be explicitly tied to land use patterns that are measured by regularly-scheduled remote sensing images and validated by on-the-ground sampling. Third, many of the indicators are based on trends or changes in measured parameters over time. Sampling methods should be designed to ensure that adequate data are collected over time and that these data are maintained in a dedicated archive for long-term use. With these steps, and a coordinated process among the state and federal agencies, it is feasible to implement an effective environmental data collection and analysis framework for Oregon.

Figure 19. Topographic and Land Use/Land Cover Maps of Lebanon, Oregon



View of area north of Lebanon, OR., comparing USGS map with land use/land cover map of over 50 categories of LU/LC (each represented here by a different color) depicting urban (four residential densities, commercial, industrial, mixed use), forest (hardwood, hardwood/conifer, conifer by age bracket, closed/open canopies), agriculture (including grass seed-grain-meadowfoam, irrigated field crops, row crops, orchards, grass, nursery), transportation (railroads; primary, secondary, other roads), water. [Scale: approx. 1:100000]

Impacts of Climate Change

Most scientists concur that increasing greenhouse gas emissions from human activities are altering the world's atmosphere. Although there are numerous greenhouse gases that result from human activity, the release of carbon dioxide (CO_2) from burning fossil fuels is the major source (Figure 20).

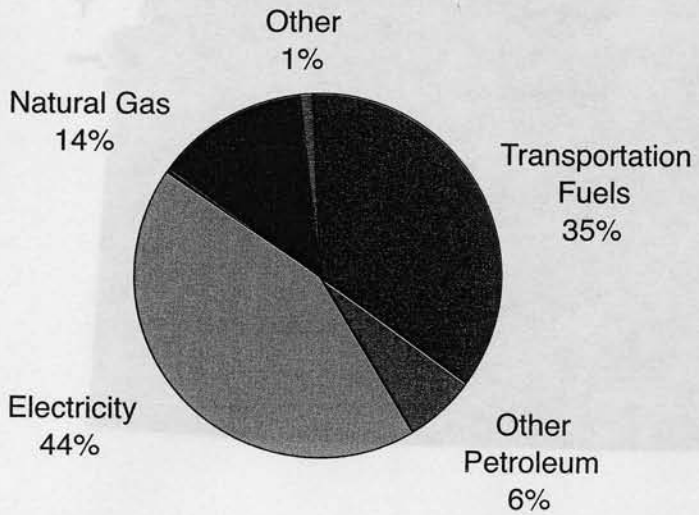
The potential climate change from increasing CO_2 emissions and other greenhouse gases generated from human activity could have a significant impact on Oregon's ecosystems and the natural resources base of our economy.

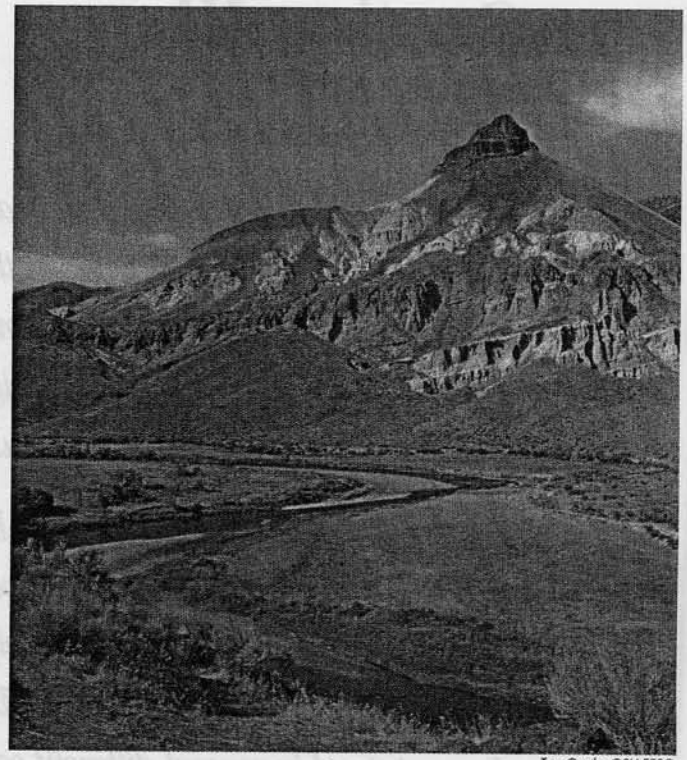
A study that the Climate Impacts Group at the University of Washington published in November 1999, examines possible consequences of climate change in the Pacific Northwest by the year 2050. Computer models predict that the Northwest will become gradually warmer and wetter, with most of the precipitation increase in the winter. The average of seven models estimates that within the next 50 years temperature will increase by more than 5°F, precipitation will increase 5%, average snow depth will decrease by 33%, and annual stream flow will decrease by 11%.

Wetter winters may mean increased flooding of rivers and more landslides on steep coastal bluffs and developed hillsides. The region's warm, dry summers may see some increase in rainfall, but the gains will more than be offset by soil moisture losses from increased evaporation by 2050.

Loss of moderate-level snow pack from warmer winter temperatures may have enormous and mostly negative impacts on the region's water resources, forests, and salmon. There will be less snow pack in the mountains, and the peak runoff on the Columbia River is likely to occur in May, rather than

Figure 20. Oregon CO_2 Emissions





Tom Gentle, OSU EESC

Warmer winters could mean less snowpack and lower streamflows in summer.

June, with lower flows and shortages later in the summer. Changes in water flow and temperature will affect salmon and other fish, leading to spawning and rearing difficulties. Warmer summers with higher evaporation may cause more drought-stressed trees, leading to increased forest diseases and pests and increased forest fires. Oregon's water supply, already over-allocated in some places, may be further diminished. Demand for irrigation and municipal water will increase at a time when reservoirs have insufficient water.

Avoiding CO_2 emissions in the first place may be the most reliable way to address climate change.

Climate change is a global phenomenon with local impacts. In response to those impacts, Oregonians may be called upon to reduce net emissions of carbon to the environment. Despite initiatives to reduce power plant emissions, to provide mass transit options, and to develop renewable energy source, Oregon's CO_2 emissions are growing more rapidly than the rest of the country.

Key Indicator:

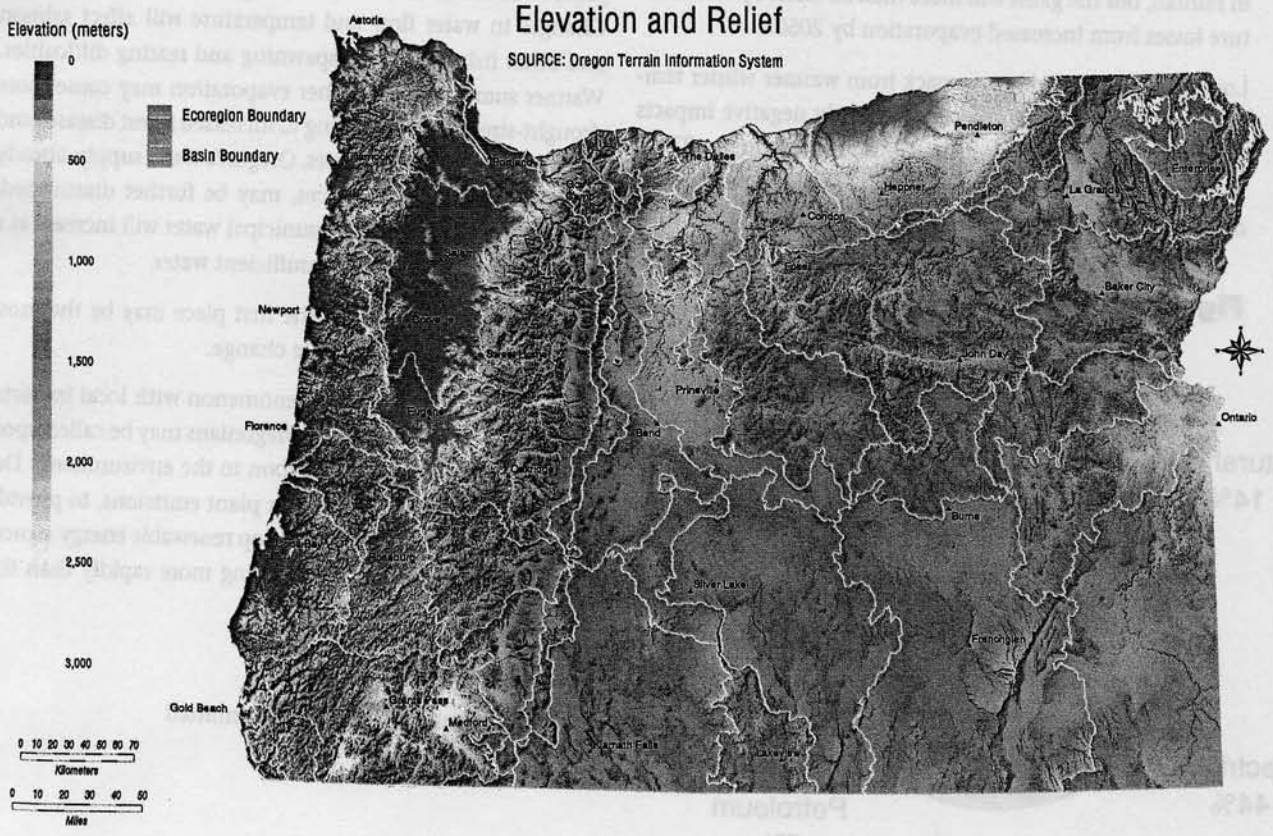
- The amount of carbon dioxide emitted

Section III. Ecoregions

The previous section provides an examination of the status of individual natural systems and resources. In this section, the Science Panel considers the interaction of many natural systems in particular regions of the state. Again, in the full report each of Oregon's eight ecoregions is described more fully. Here, each is briefly summarized using different aspects of ecosystem health.

The maps contained in this section help orient the reader to the physiographic boundaries of each ecoregion, as well as the major river basins than drain them. Ecoregions are defined largely by physical parameters such as elevation and relief (Figure 21). The watersheds that drain across them may be contained in several different ecoregions.

Figure 21. Elevation and Relief



Coast Range Ecoregion

Oregon's environment is dynamic, and nowhere is that more obvious than in the Coast Range ecoregion. From earthquakes and fire to storms and landslides, physical processes shape the landscape. As the coast has become more populated, natural *processes* have come to be thought of as natural *hazards*—something to be minimized.

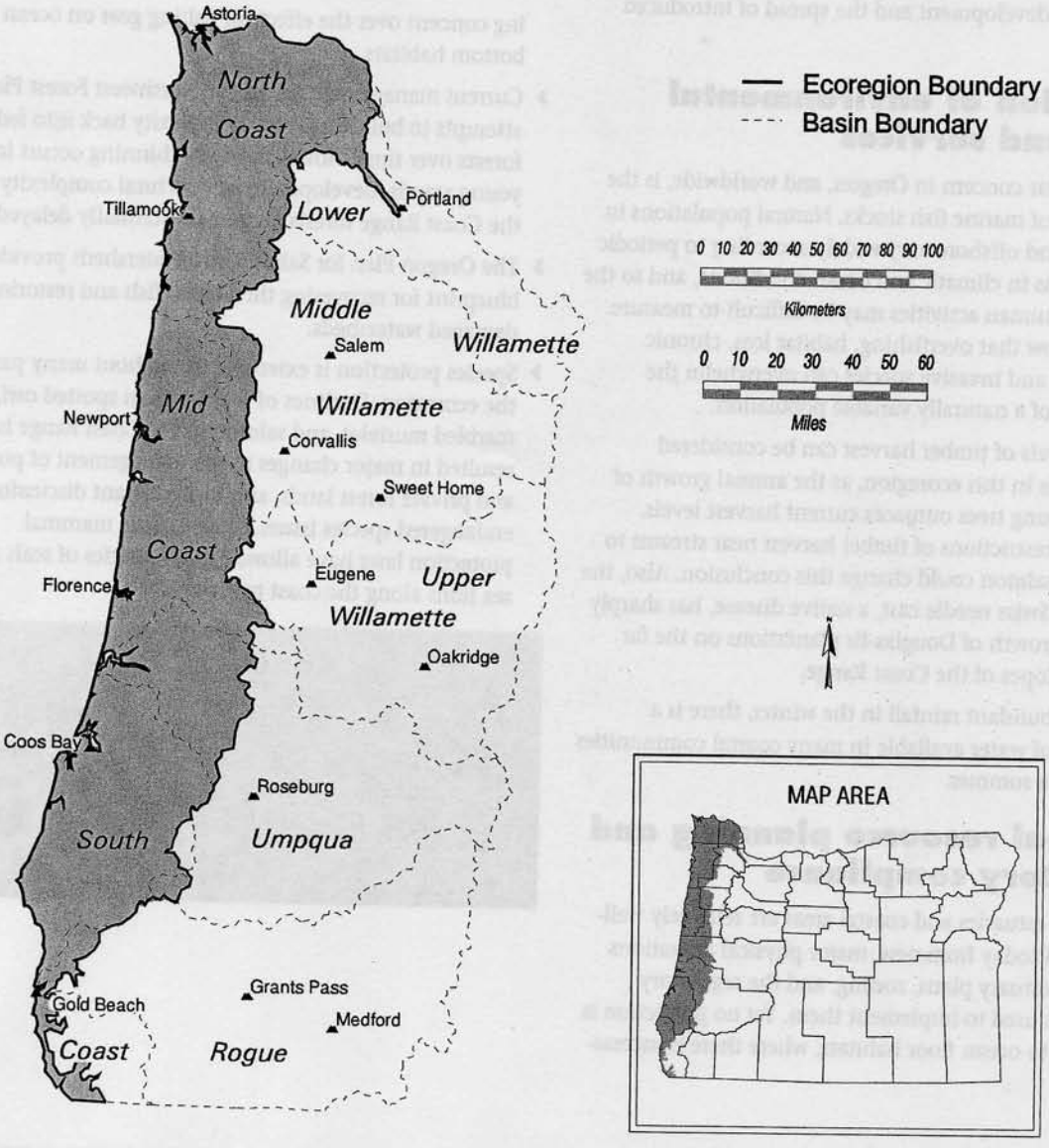
Landscape structure and function

- Jetties built to stabilize river mouths for navigation have disrupted the natural movement of sand along the coast, burying some areas and eroding others.
- Many miles of large riprap revetments have increased erosion of the public beach in some areas.
- Coastal rivers and estuaries were altered long ago when side channels were diked, marshes drained, and channels deepened. Such changes limited habitats available for the many kinds of fish and wildlife dependent on estuarine resources.
- Reducing complexity in Coast Range forests was systematic and purposeful for many years when old native forests were cut and converted to fast-growing young stands and plantations of single species. Over one-third of the federal forests are now young stands, created by clearcutting over the last 40 years, with relatively high densities and relatively little structural diversity.

Biological communities

- Changes in populations of characteristic wildlife species are well known and documented in Coast Range forests, and are primarily a result of changes in the structure rather than the composition of the low- to mid-elevation coniferous forests.

Figure 22. Coast Range Ecoregion and Associated River Drainage Basins



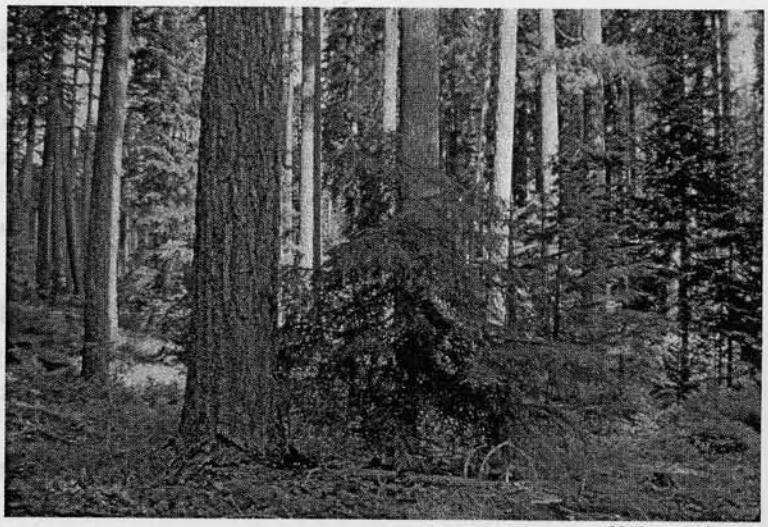
- Coastal salmon have experienced declines similar to those among terrestrial wildlife species dependent on old growth forests, for many of the same reasons. Effects of timber harvest and road-building have resulted in habitat loss and degradation of spawning and rearing habitat. Salmon have also suffered from habitat loss and degradation in estuaries and lowland floodplains from settlement and agriculture. Coho and chum salmon, which are particularly dependent on habitat found in these lowland systems, have experienced disproportionately large declines compared to the more forest-dependent chinook salmon and steelhead.
- Exotic species have invaded all parts of the ecoregion, including Oregon's estuaries, where accidental introductions threaten vulnerable populations of native estuarine invertebrates. Although declines in old-growth dependent species are currently in the spotlight, declining populations of native plants and animals are just as threatened in limited habitats along the coast. In particular, natural communities on grassy headlands and coastal dunes have been greatly diminished due to residential development and the spread of introduced weeds.

Production of environmental goods and services

- Of particular concern in Oregon, and worldwide, is the condition of marine fish stocks. Natural populations in estuaries and offshore vary widely according to periodic fluctuations in climatic and ocean conditions, and so the effects of human activities may be difficult to measure. Yet we know that overfishing, habitat loss, chronic pollution, and invasive species can overwhelm the resilience of a naturally variable population.
- Recent levels of timber harvest can be considered sustainable in this ecoregion, as the annual growth of mostly young trees outpaces current harvest levels. Potential restrictions of timber harvest near streams to conserve salmon could change this conclusion. Also, the spread of Swiss needle cast, a native disease, has sharply reduced growth of Douglas-fir plantations on the far western slopes of the Coast Range.
- Despite abundant rainfall in the winter, there is a shortage of water available in many coastal communities during the summer.

Regional resource planning and regulatory compliance

- Oregon's estuaries and coastal areas are relatively well-protected today from new, major physical alterations through estuary plans, zoning, and the regulatory programs used to implement them. Yet no protection is afforded to ocean floor habitats, where there is increasing concern over the effects of fishing gear on ocean bottom habitats.
- Current management under the Northwest Forest Plan attempts to build structural complexity back into federal forests over time. However, unless thinning occurs in young stands, development of structural complexity in the Coast Range forests may be substantially delayed.
- The Oregon Plan for Salmon and Watersheds provides a blueprint for recovering threatened fish and restoring damaged watersheds.
- Species protection is extensive throughout many parts of the ecoregion. Declines of the northern spotted owl, the marbled murrelet, and salmon in the Coast Range have resulted in major changes in the management of public and private forest lands, and in significant discussion of endangered species issues. Strict marine mammal protection laws have allowed many species of seals and sea lions along the coast to recover.



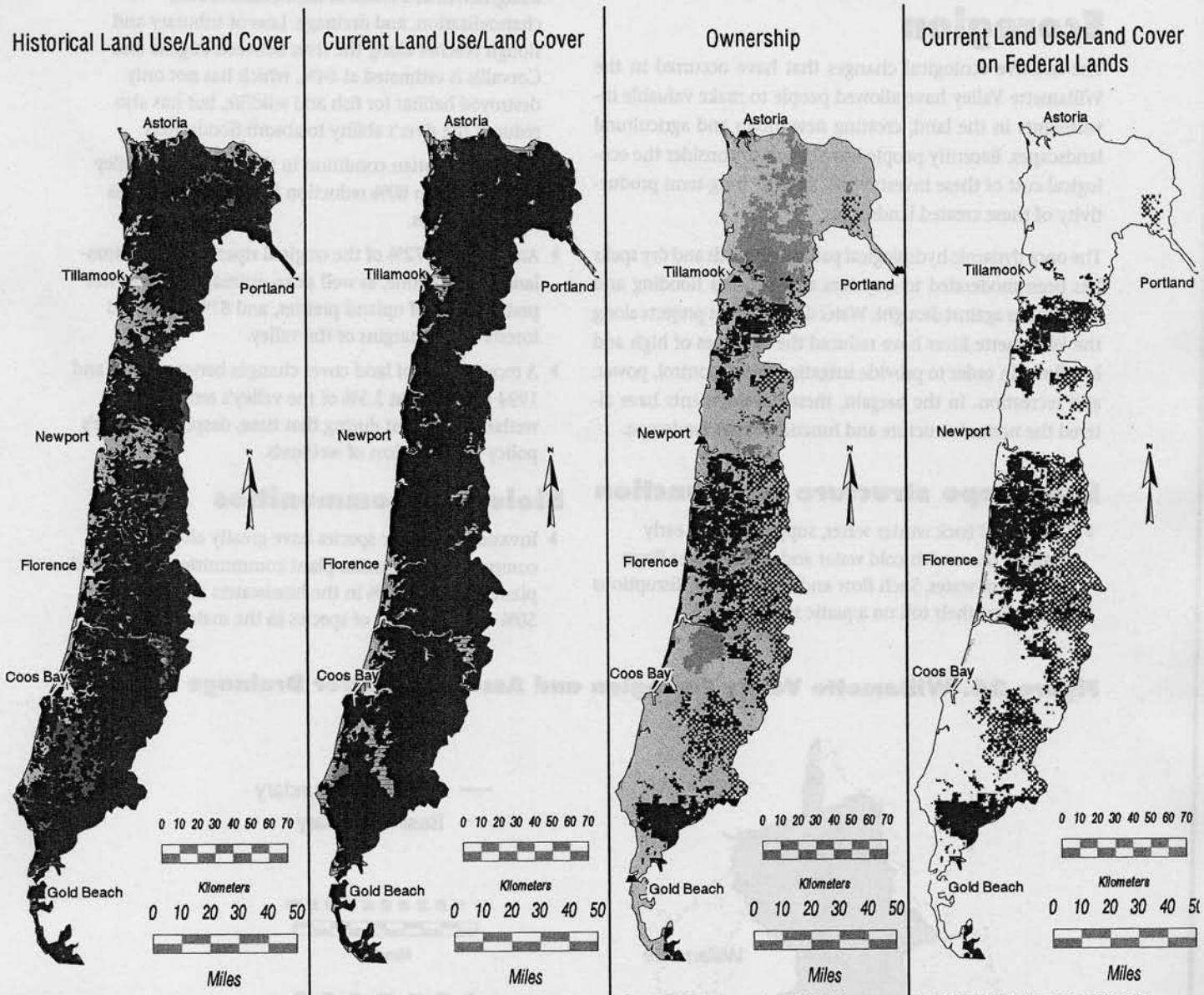
OSU Forestry Media Center

Almost half of Oregon's projected timber harvest is expected to come from the Coast Range ecoregion.

Conclusion

This region has just gone through sweeping changes in the management of its federal forests. Now, the region faces the question of how to restore wild salmon populations and, with them, the health of watersheds and aquatic systems from the mountains to the sea.

Figure 23. Land Use/Land Cover and Ownership of Coast Range Ecoregion



Willamette Valley Ecoregion

The massive ecological changes that have occurred in the Willamette Valley have allowed people to make valuable investments in the land, creating new urban and agricultural landscapes. Recently people have begun to consider the ecological cost of these investments, and the long-term productivity of these created landscapes.

The once dynamic hydrological pattern of floods and dry spells has been moderated to a system that restricts flooding and stores water against drought. Water development projects along the Willamette River have reduced the extremes of high and low flows in order to provide irrigation, flood control, power, and recreation. In the bargain, these developments have altered the natural structure and function of the landscape.

Landscape structure and function

- Dams hold back winter water, supplementing early summer flows with cold water and late summer flows with warm water. Such flow and temperature disruptions have taken their toll on aquatic species.
- Mainstem reaches have been greatly simplified and straightened as a result of dam construction, channelization, and drainage. Loss of tributary and slough reaches along the river between Eugene and Corvallis is estimated at 84%, which has not only destroyed habitat for fish and wildlife, but has also reduced the river's ability to absorb floodwaters.
- Trends in riparian condition in the Willamette Valley have shown an 80% reduction in total riparian area since the 1850s.
- An estimated 72% of the original riparian and bottomland forest is gone, as well as an estimated 99% of wet prairies, 88% of upland prairies, and 87% of upland forests at the margins of the valley.
- A recent study of land cover changes between 1982 and 1994 showed that 2.5% of the valley's remaining wetlands were lost during that time, despite the State's policy of no net loss of wetlands.

Biological communities

- Invasions of exotic species have greatly altered the composition of riparian plant communities. Introduced plants make up 10% in the headwaters and more than 50% of the number of species in the mainstem

Figure 24. Willamette Valley Ecoregion and Associated River Drainage Basins

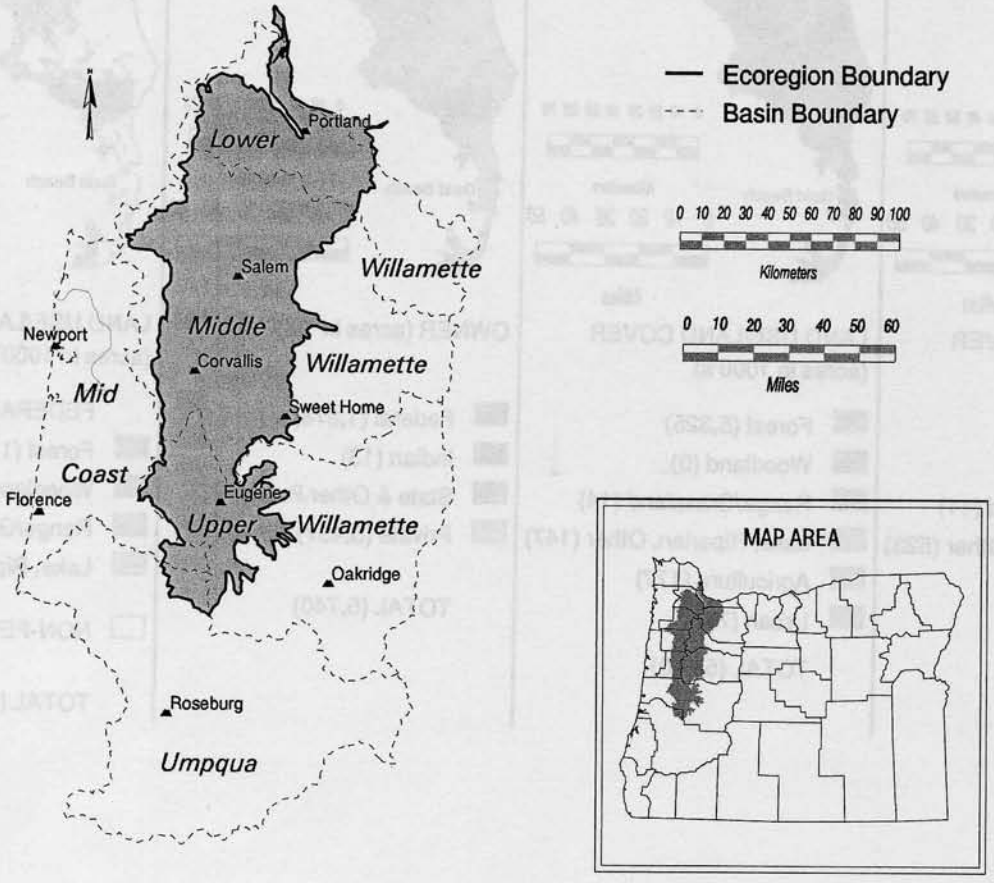
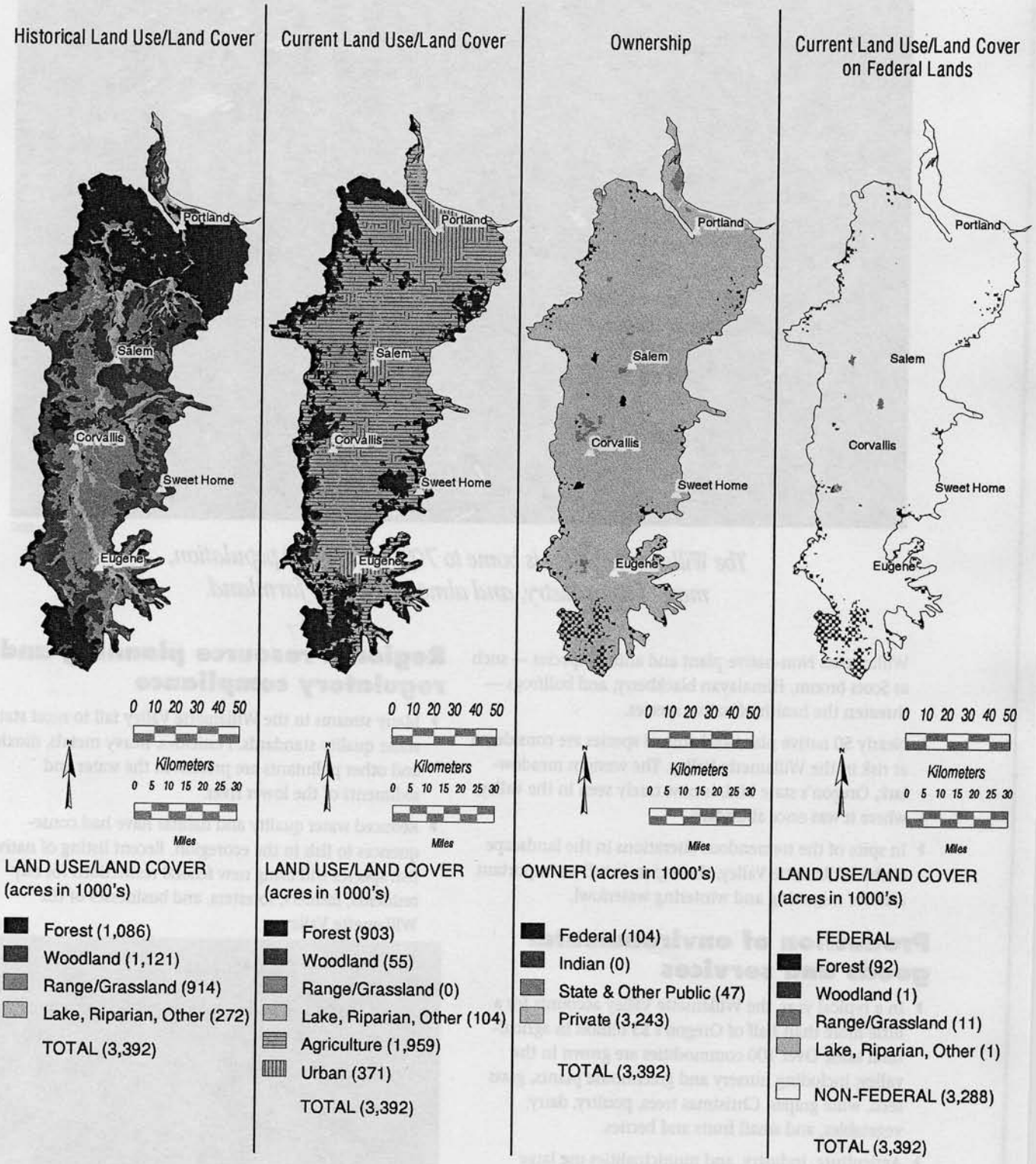


Figure 25. Land Use/Land Cover & Ownership of the Willamette Valley Ecoregion



Bob Rost, OSU EESC

The Willamette Valley is home to 70% of Oregon's population, most of its industry, and almost half of its farmland.

Willamette. Non-native plant and animal species — such as Scots broom, Himalayan blackberry, and bullfrogs — threaten the health of native species.

- Nearly 50 native plant and animal species are considered at risk in the Willamette Valley. The western meadowlark, Oregon's state bird, is now rarely seen in the valley, where it was once abundant.
- In spite of the tremendous alterations in the landscape of the Willamette Valley, the region is still an important area for migrating and wintering waterfowl.

Production of environmental goods and services

- In a typical year, the Willamette Valley accounts for a little more than half of Oregon's $3 billion in agricultural sales. Over 100 commodities are grown in the valley, including nursery and greenhouse plants, grass seed, wine grapes, Christmas trees, poultry, dairy, vegetables, and small fruits and berries.
- Agriculture, industry, and municipalities use large quantities of water. As the valley's population grows, conflicts will increase over the desire for additional water and the negative impacts of water storage on the environment.

Regional resource planning and regulatory compliance

- Many streams in the Willamette Valley fail to meet state water quality standards. Pesticides, heavy metals, dioxin, and other pollutants are present in the water and sediments of the lower river.
- Reduced water quality and habitat have had consequences to fish in the ecoregion. Recent listing of native fish species will bring new federal restrictions for city residents, farmers, foresters, and businesses of the Willamette Valley.

Conclusion

One of Oregon's greatest environmental challenges for this century lies in the Willamette Valley. Transformation of prairies, woodlands, riparian areas, and rivers of the valley has fueled our economic growth and settlement for over 150 years. Yet this transformation has left a mark on our environment and a debt to pay. Whether we can improve the ecological health of the valley, measured currently by recovery of salmon and watersheds, while continuing economic growth and development for homes and communities will be a stern environmental test.

Klamath Mountains Ecoregion

In many ways, the Klamath Mountains ecoregion mirrors the state, with steeply cut mountains and broad river valleys, rainforests and chaparral, a wet west side and a dry east side. Forests, mostly federally owned, cover much of the region's uplands, with privately owned agricultural land in the valleys.

In other ways, the Klamath Mountains ecoregion is a place apart. Plate tectonics has juggled together an assembly of landforms and rock types in a fruitcake geology strikingly different from the rest of the state. The plant communities of the Klamath Mountains are more than just unusual. They are among the most diverse in the world. There are more kinds of cone-bearing trees here, for example, than anywhere else in North America.

Today, the rate of population growth in this region is second only to the Willamette Valley. Resource-based industries survive, but no longer dominate the economy. Most of the population of the ecoregion is concentrated in the valleys along the Interstate 5 corridor. Development is focused on riparian areas along the north Umpqua, Applegate, and upper Rogue rivers in the dry eastern areas of the ecoregion. The demands for agriculture and choice building sites along streams clash with attempts to restore salmonid habitat.

Changes in upland landscapes occurred progressively throughout the 20th century, with timber harvest and changes in natural patterns of fire. Currently in the Klamath Mountains, major threats to ecological health come not so much from agriculture and logging, but from industrial and rural residential development. As the population grows, so grows the need for regional planning. One of the region's strengths is the will of local communities, many of whom are working together to plan a sustainable future.

Landscape structure and function

- Years of fire suppression has led to an accumulation of fuels and an increasing risk of uncontrolled, conflagration fires in the interior portions of the ecoregion. Scattered rural development makes prescribed fire difficult. In particular, the checkerboard BLM forests of the north and east, where cutover public lands intermingle with private ownerships, pose challenges for forest management.
- Settlement and agriculture in the dry Rogue valley encouraged overallocation of most of the tributary streams as early as 1900. Lower flows, reduced streamside cover, and streambeds shallowed by sediment have raised stream temperatures as much as 10°F in some parts of the Rogue Basin.
- Recovery from past development (particularly water development and riparian damage) is a continuing challenge. Studies suggest that extensive past damage may be reversing in some areas through changes in land use practices and habitat restoration.

Figure 26. Klamath Mountains Ecoregion and Associated River Drainage Basins

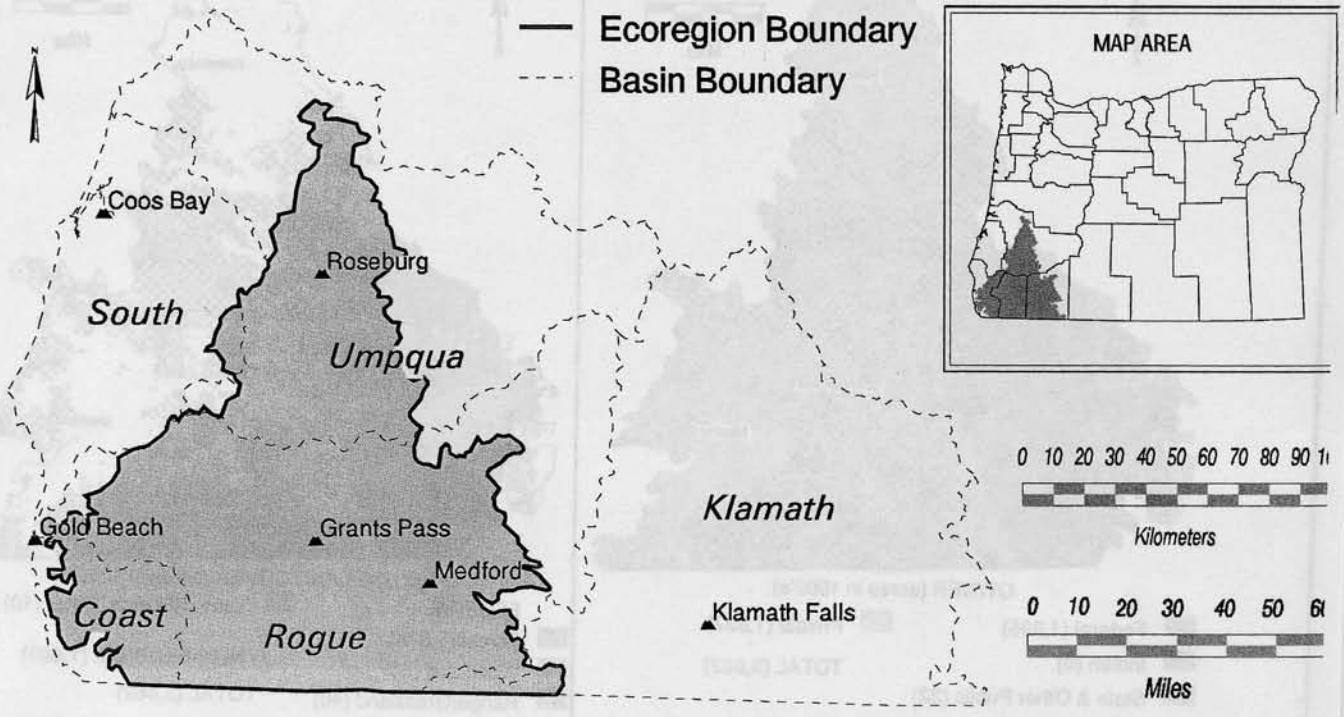
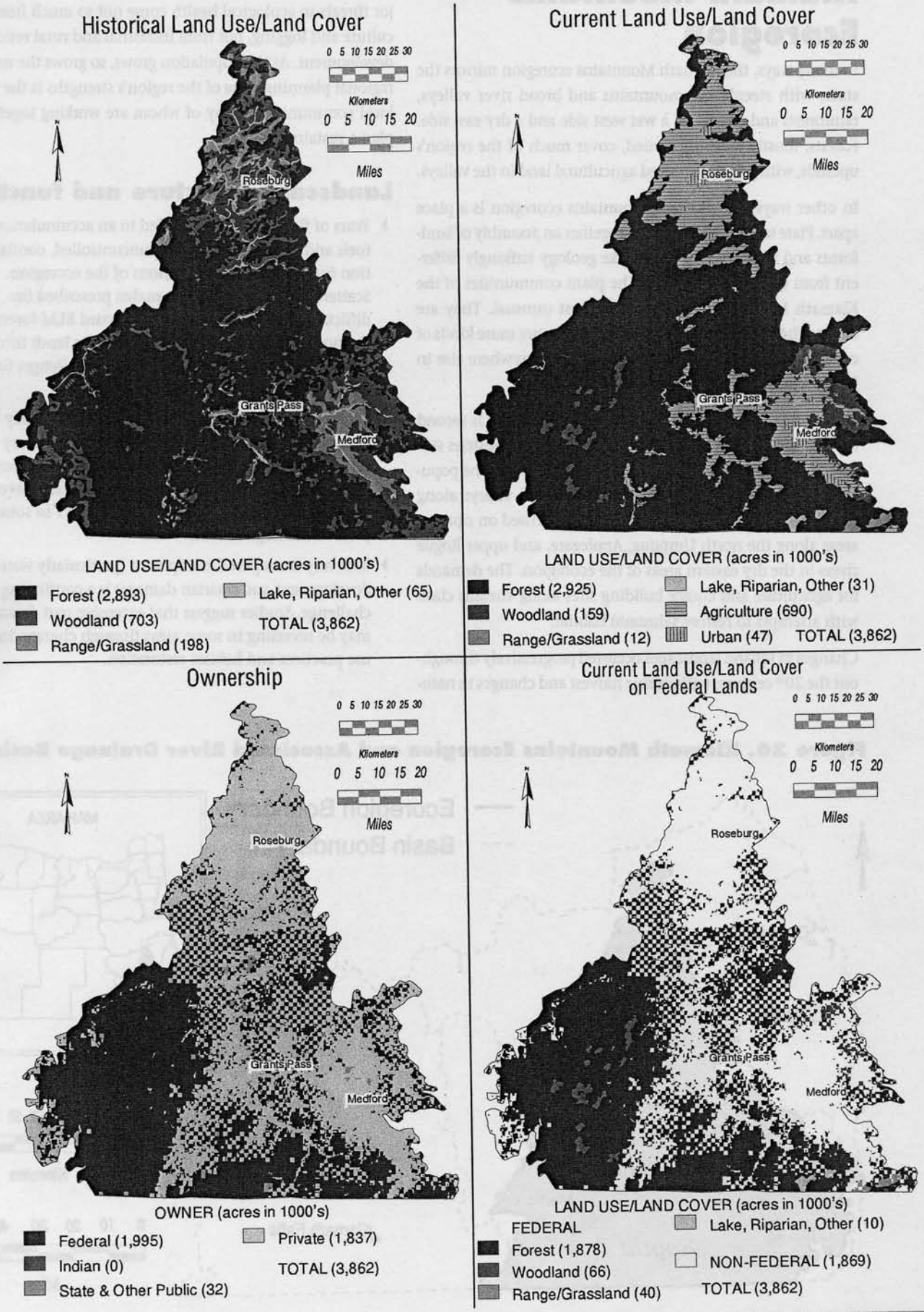


Figure 27. Land Use/Land Cover & Ownership of the Klamath Mountains Ecoregion



Much of the oak woodland and grassland of eastern portions of the ecoregion have been converted to agriculture and, more recently, to increasing rural residential development.

OSU EESC

Biological communities

- Native stocks of almost all the region's anadromous fish are declining, including the Rogue basin coho salmon, listed as threatened under the Federal Endangered Species Act.
- Inventories of streams in the northern half of the ecoregion found aquatic insect communities degraded throughout the area, an indication of reduced aquatic health. However, the headwater systems in the Siskiyou Mountains have been less impacted, and provide significant habitat for wild salmon and steelhead.

Production of goods and services

- The Rogue Valley has long been famous for its orchards, yet agriculture is declining in some parts of the valley due to increased suburban development. Harvested acreage in Douglas, Jackson, and Josephine counties declined by 18% during the 1990s.
- In recent years, the number of timber jobs has declined 23%, and yet still represents well over half the manufacturing employment in the region. Likely future timber harvest from federal lands will be from smaller, less valuable trees than in the past.

Regional planning and compliance with regulations

- High summer temperatures limit the water quality for many streams in all but the western portion of the ecoregion. The state Forest Practices Act regulates riparian buffers in forested areas, but there are no similar restrictions on agricultural land or in rural developments. Where riparian vegetation has been removed, there is little shade to protect streams from too much warming.
- Senate Bill 1010 plans are being developed currently in many watersheds to reverse declining water quality in streams.
- The federal Northwest Forest Plan provides much of the region's western forests with policies that should help improve ecological health. Success of these policies may hinge on reducing excessive fuel loadings from the dry interior forests. Up to 90% of the Siskiyou National Forest, for example, is designated to be managed for ecological values. Recent and likely future changes to the forest practice rules should help protect forested riparian areas on private lands.

Conclusion

The potential conflict of salmon conservation with human use of riparian areas and water withdrawals, especially for agriculture, urban growth, and rural residential use, will remain the key to ecological health of the region for years to come.

Cascades Ecoregion

The Cascades ecoregion is an abundant producer of goods and services, from timber to high quality water. Controversies over the northern spotted owl, logging of old growth forests, and management of federal lands put the region in the spotlight during the 1990s as forest managers and local communities struggled to find solutions. Since then, the Cascades ecoregion has become a center for innovative federal management of forests.

Landscape structure and function

- Old growth structural stages in the Douglas fir zone may be at relatively low levels, due to past harvest, but they have the potential to increase significantly under implementation of federal plans. In the long run, old growth amounts could approach average levels that occurred historically, although they will be concentrated at somewhat higher elevations than previously occurred.
- Although many of the high elevation wetlands along the crest of the Cascades are largely intact, some lower elevation wetlands have been altered by road construction, timber harvest, and construction of reservoirs.

Biological communities

- With changes underway on federal lands to increase old-growth structural stages, minimize road building, and rebuild complexity in timber plantations, the risk to wildlife species should diminish over time.
- Resident fish populations throughout the Cascades ecoregion are relatively healthy in many areas, but trends in the health of migratory anadromous salmon and trout populations are declining.

Figure 28. Cascades Ecoregion and Associated River Drainage Basins

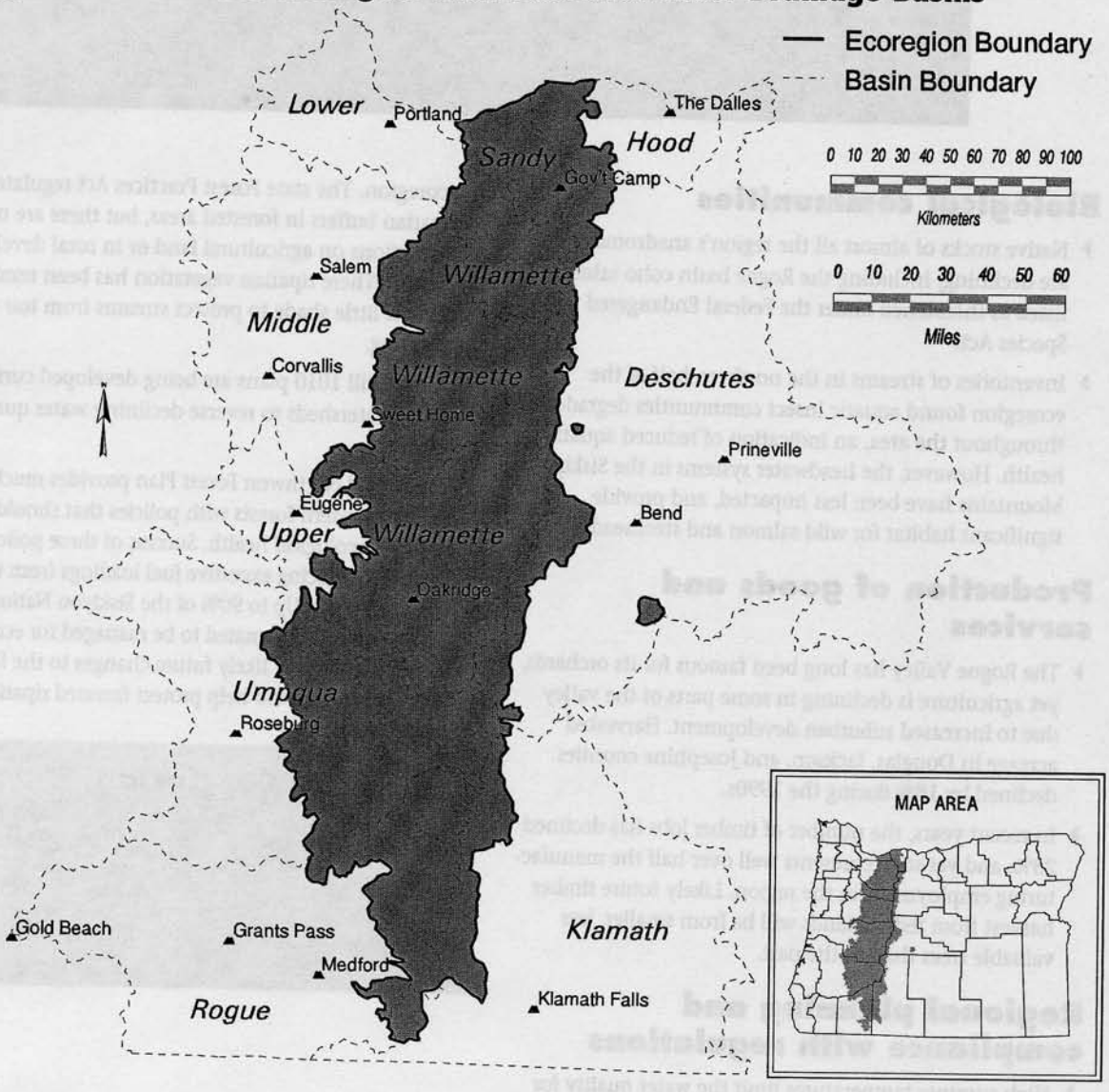
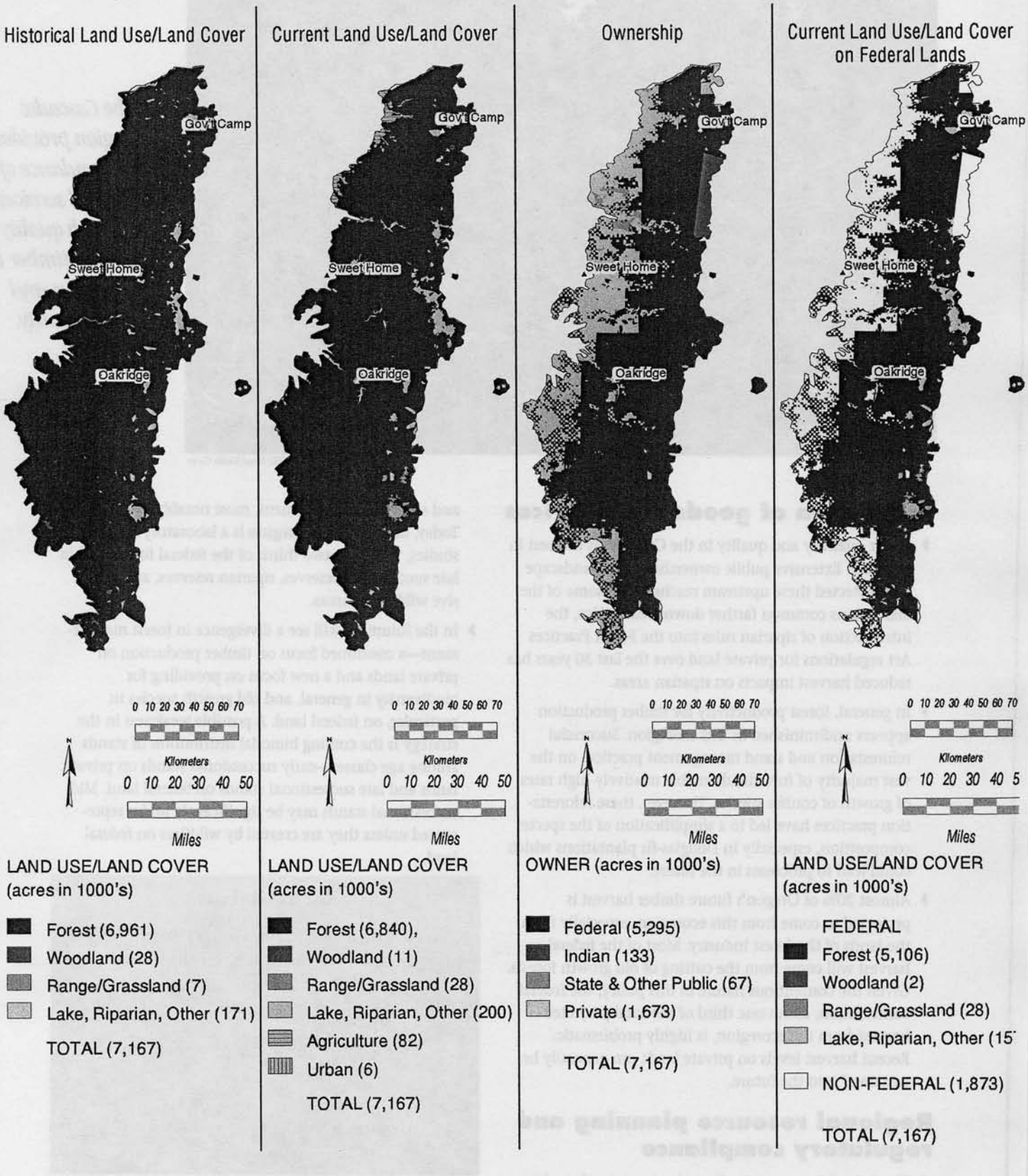
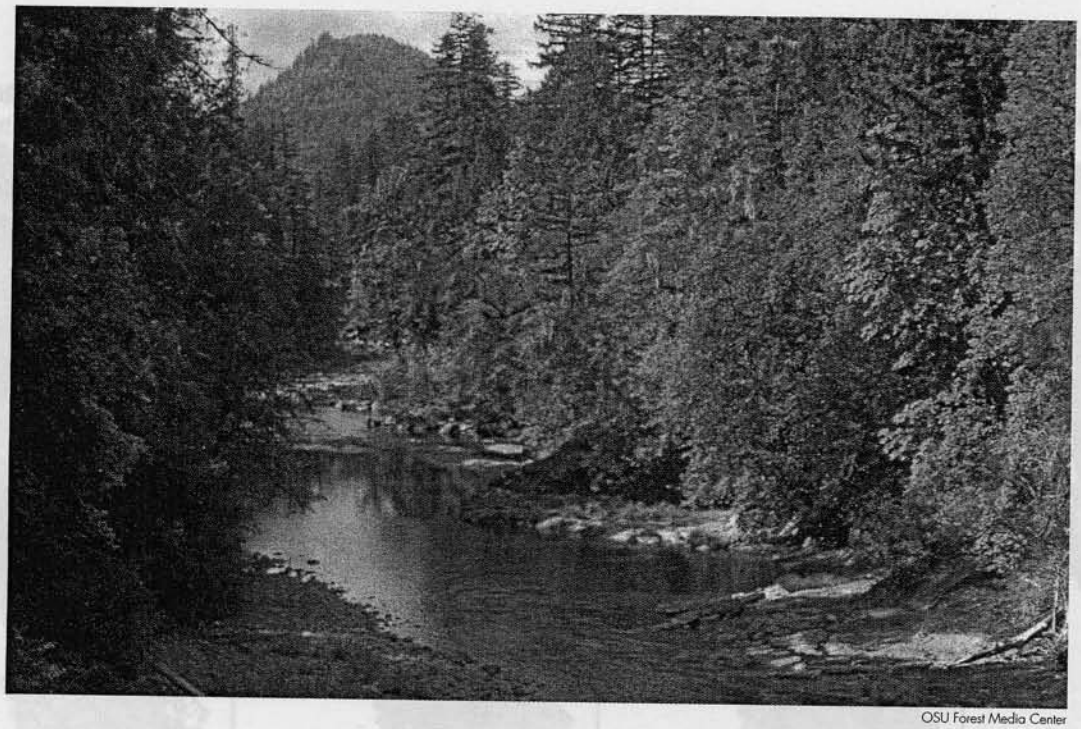


Figure 29. Land Use/Land Cover & Ownership of the Cascades Ecoregion





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The Cascades ecoregion provides an abundance of goods and services, from high quality water and timber to recreation and scenic beauty.

Production of goods and services

- Water quantity and quality in the Cascades is the best in the state. Extensive public ownership of the landscape has protected these upstream reaches from some of the disruptions common farther downstream. Also, the introduction of riparian rules into the Forest Practices Act regulations for private land over the last 30 years has reduced harvest impacts on riparian areas.
- In general, forest productivity for timber production appears undiminished in this ecoregion. Successful reforestation and stand management practices on the vast majority of forestlands enable relatively high rates of growth of conifer species. However, these reforestation practices have led to a simplification of the species composition, especially in Douglas-fir plantations which could lead to problems in the future.
- Almost 20% of Oregon's future timber harvest is projected to come from this ecoregion, especially from the lands of the forest industry. Most of the federal harvest will come from the cutting of old growth forests. Given the contentious nature of this policy, the federal contribution, about one third of the total projected harvest from the ecoregion, is highly problematic. Recent harvest levels on private lands can generally be sustained into the future.

Regional resource planning and regulatory compliance

- The federal forests of the Cascades ecoregion have been the focus of groundbreaking studies in species recovery and ecosystem management, most notably by FEMAT. Today, much of the ecoregion is a laboratory for these studies, with over two thirds of the federal forest land in late successional reserves, riparian reserves, and extensive wilderness areas.
- In the future we will see a divergence in forest management—a continued focus on timber production on private lands and a new focus on providing for biodiversity in general, and old growth species in particular, on federal land. A possible weakness in the strategy is the coming bimodal distribution of stands among age classes—early successional stands on private lands and late successional stands on federal land. Mid successional stands may be significantly under represented unless they are created by wildfires on federal land.

Conclusion

This ecoregion has more forests, fewer people, and fewer emerging environmental problems than most other ecoregions. Home to the highest water quality in Oregon, classic old growth forests, and a major portion of Oregon's forest recreation, this ecoregion is at the heart of a major shift in federal forest management to emphasize biodiversity. Some environmental problems remain, but it is likely that Oregon's most significant environmental controversies of the future most probably lie in other ecoregions.

Eastern Cascades Slopes and Foothills Ecoregion

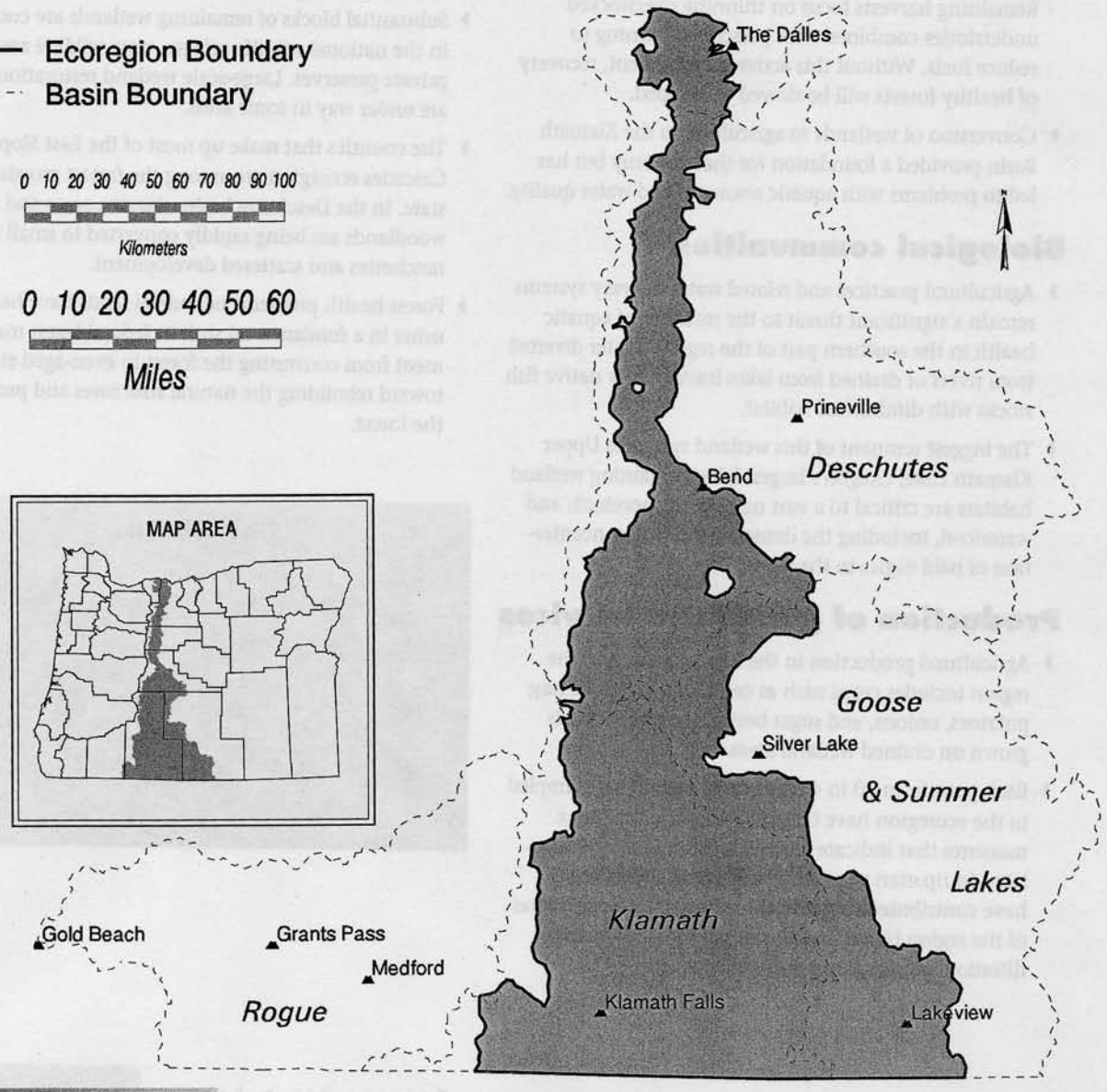
The East Cascades Slopes and Foothills ecoregion is a land of contrasts. From the Columbia River gorge to the Klamath basin wetlands, it is a region of abundant water to the west and abundant thirst to the east. Forests, mostly federally owned, cover most of the region's uplands, with privately-owned agricultural land in the valleys. The contrasts of this ecoregion are reflected in its water quality. Clean cold water flows from perennial springs along the east slope into streams with some of the highest quality water in the state. The low-lying Klamath Basin, in contrast, has sites with some of the worst water quality in the state.

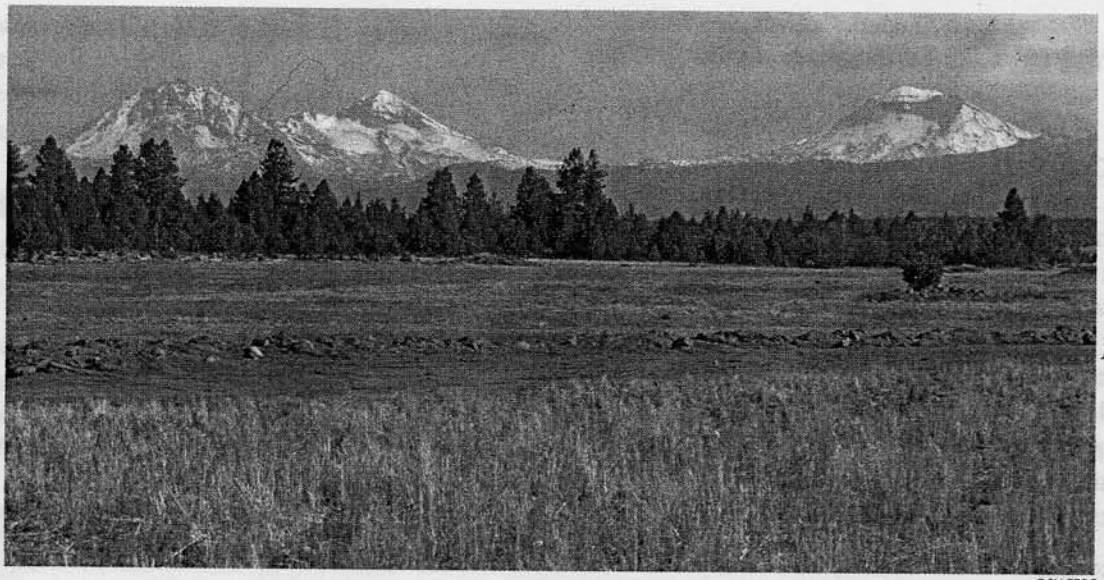
Spring-fed tributaries from the Cascade Mountains provide most of the river's water, which is in turn moved through diversions to irrigate dry Northern Basin and Range lands east of Bend. The Klamath Basin is a broad, flat valley that was once a vast expanse of lakes and marshes. Most of the basin's wetlands have been drained and converted to agriculture.

Landscape structure and function

- Although suppression of fire is a principal cause of forest health problems in the region, reintroduction of fire will be difficult. The region's extensive pine forests and woodlands need fire to thrive. Lack of fire has allowed the forest to become crowded with stressed and dying trees, and dangerous levels of fuel for fire. Today, the threat of a conflagration fire is a serious problem, made even more dangerous by the presence of growing numbers of homes and resort developments interspersed in the forest.

Figure 30. Eastern Cascades Ecoregion and Associated River Drainage Basins





OSU EESC

Much of the high desert lands east of Bend are irrigated with water from the East Cascades Slopes and Foothills.

- Harvest levels on federal forests have dropped precipitously and will likely remain low in the coming years. Remaining harvests focus on thinning overstocked understories combined with prescribed burning to reduce fuels. Without this active management, recovery of healthy forests will be slowed or stopped.
- Conversion of wetlands to agriculture in the Klamath Basin provided a foundation for the economy but has led to problems with aquatic resources and water quality.

Biological communities

- Agricultural practices and related water delivery systems remain a significant threat to the recovery of aquatic health in the southern part of the region. Water diverted from rivers or drained from lakes leaves many native fish stocks with diminished habitat.
- The biggest remnant of this wetland system is Upper Klamath Lake, Oregon's largest lake. Remaining wetland habitats are critical to a vast number of shorebirds and waterfowl, including the densest wintering concentration of bald eagles in the world.

Production of goods and services

- Agricultural production in the Klamath Basin in the region includes crops such as cereal grains, alfalfa hay, potatoes, onions, and sugar beets, much of which is grown on drained wetland areas.
- Each year, from 20 to 40 percent of the streams sampled in the ecoregion have Oregon Water Quality Index measures that indicate very poor water quality. Reductions in riparian vegetation and associated wetlands have contributed to nutrient loading in rivers and lakes of the region by decreasing the potential for nutrient filtration and uptake in streamside areas.

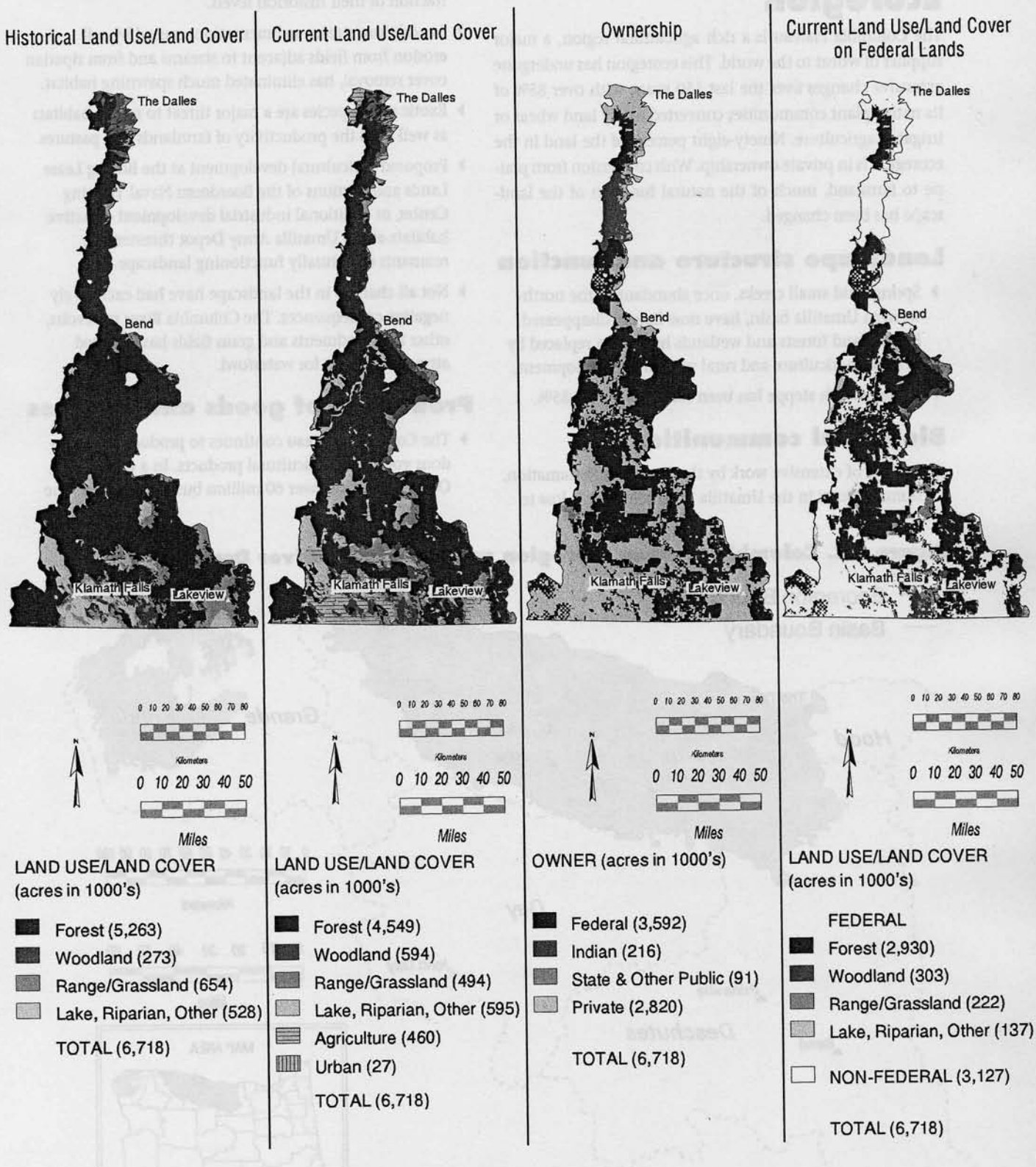
Regional resource planning and regulatory compliance

- Substantial blocks of remaining wetlands are contained in the national wildlife refuges, state wildlife areas, and private preserves. Large-scale wetland restoration efforts are under way in some areas.
- The counties that make up most of the East Slope Cascades ecoregion are among the fastest growing in the state. In the Deschutes basin, riparian areas and open woodlands are being rapidly converted to small acreage ranchettes and scattered development.
- Forest health problems on federal lands have helped to usher in a fundamental shift in federal forest management from converting the forest to even-aged stands and toward rebuilding the natural structures and processes of the forest.

Conclusion

This ecoregion is a tale of two river basins. In the Klamath basin, where water issues are being fought out in court, the effects of agriculture are particularly acute. Farther north, concerns focus on increasing developments in streamside and forested areas and water diversion projects for those developments. The rapidly growing population along the east slope of the Cascades makes environmental restoration difficult and planning essential.

Figure 31. Land Use/Land Cover & Ownership of the Eastern Cascades Slopes and Foothills Ecoregion



The Columbia Plateau Ecoregion

The Columbia Plateau is a rich agricultural region, a major supplier of wheat to the world. This ecoregion has undergone extensive changes over the last 150 years, with over 85% of its native plant communities converted to dry land wheat or irrigated agriculture. Ninety-eight percent of the land in the ecoregion is in private ownership. With conversion from prairie to farmland, much of the natural function of the landscape has been changed.

Landscape structure and function

- Springs and small creeks, once abundant in the northwestern Umatilla basin, have now largely disappeared. Bottomland forests and wetlands have been replaced by irrigated agriculture and rural residential development.
- Big sagebrush steppe has been reduced by over 85%.

Biological communities

- In spite of extensive work by the Bureau of Reclamation, summer flows in the Umatilla River remain too low to maintain summer runs of anadromous fish populations. Native anadromous fish populations have dropped to a fraction of their historical levels.
- In addition, stream sedimentation, caused by soil erosion from fields adjacent to streams and from riparian cover removal, has eliminated much spawning habitat.
- Exotic plant species are a major threat to native habitats as well as to the productivity of farmlands and pastures.
- Proposed agricultural development at the Boeing Lease Lands and portions of the Boardman Naval Training Center, or additional industrial development of native habitats at the Umatilla Army Depot threaten the remnants of naturally functioning landscape.
- Not all changes in the landscape have had exclusively negative consequences. The Columbia River reservoirs, other impoundments and grain fields have created attractive habitat for waterfowl.

Production of goods and services

- The Columbia Plateau continues to produce a tremendous volume of agricultural products. In a typical year, Oregon produces over 60 million bushels of wheat, the

Figure 32. Columbia Plateau Ecoregion and Associated River Drainage Basins

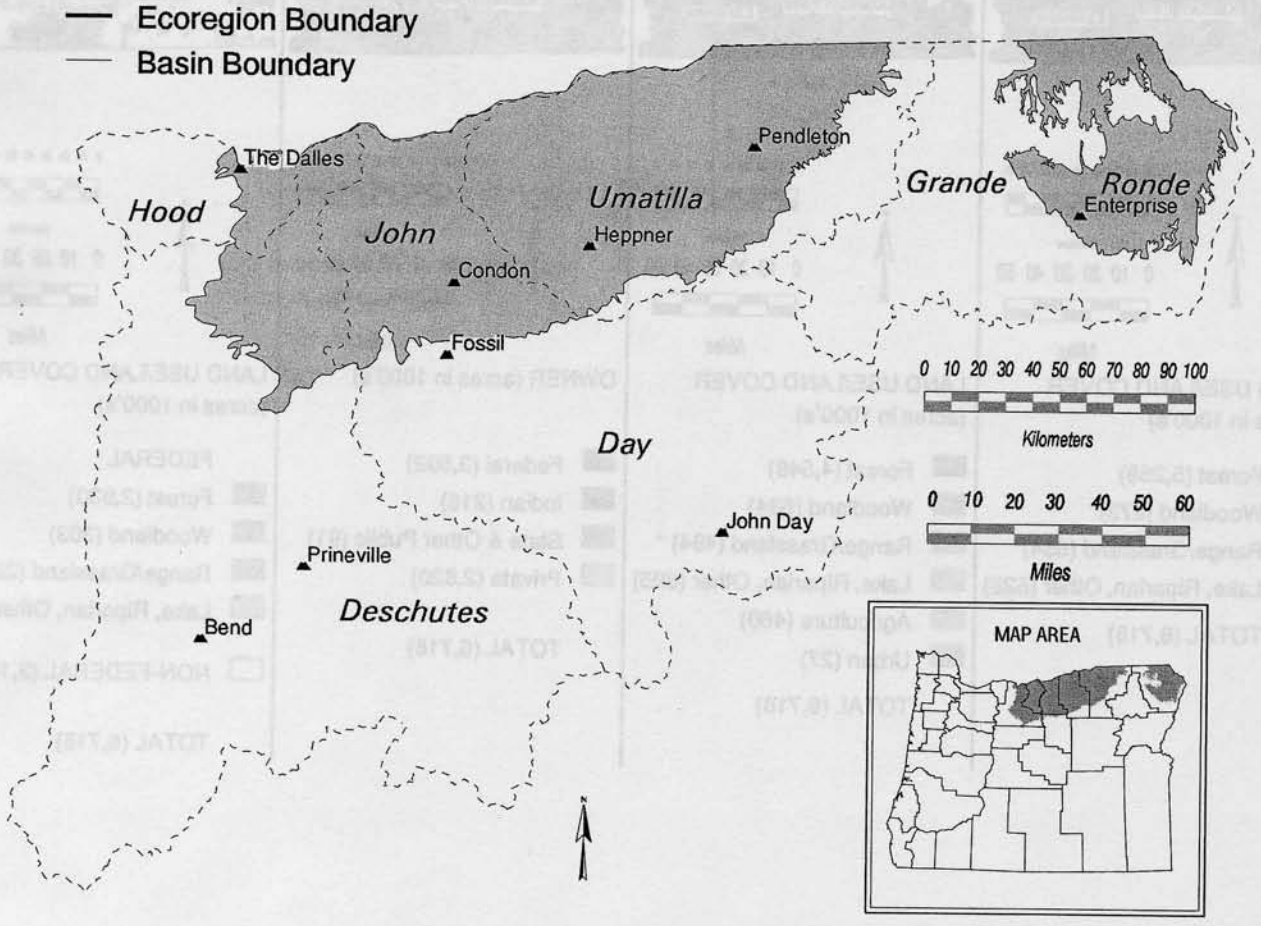
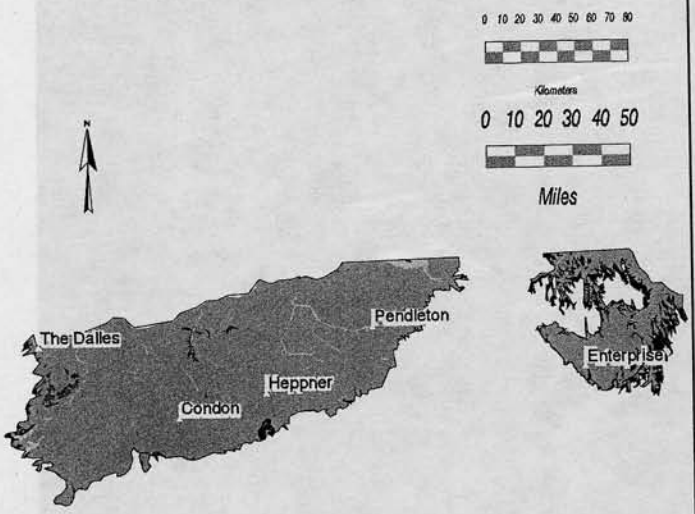


Figure 33. Land Use/Land Cover & Ownership of the Columbia Plateau Ecoregion

Historical Land Use/Land Cover



LAND USE/LAND COVER (acres in 1000's)

- Forest (284)
- Woodland (64)
- Range/Grassland (4,746)
- Lake, Riparian, Other (91)

TOTAL (5,185)

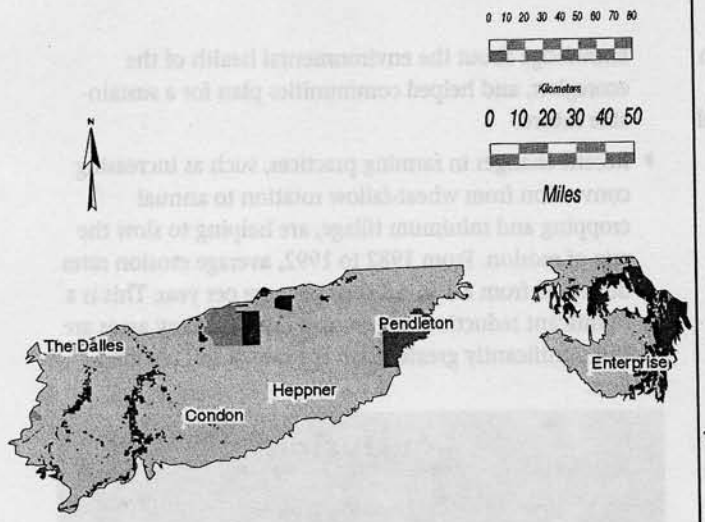
Current Land Use/Land Cover

LAND USE/LAND COVER (acres in 1000's)

- Forest (252)
- Woodland (94)
- Range/Grassland (2,915)
- Lake, Riparian, Other (19)
- Agriculture (1,871)
- Urban (33)

TOTAL (5,185)

Ownership

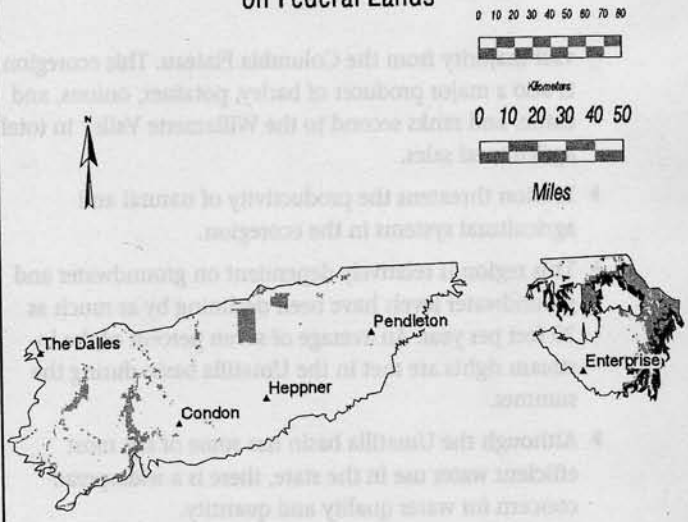


OWNER (acres in 1000's)

- Federal (585)
- Indian (117)
- State & Other Public (121)
- Private (4,367)

TOTAL (5,185)

Current Land Use/Land Cover on Federal Lands



LAND USE/LAND COVER (acres in 1000's)

FEDERAL

- Forest (156)
- Woodland (3)
- Range/Grassland (420)
- Lake, Riparian, Other (5)
- NON-FEDERAL (4,599)

TOTAL (5,185)

OSU EESC

Oregon produces over 60 million bushels of wheat a year on average, most from the Columbia Plateau.

vast majority from the Columbia Plateau. This ecoregion is also a major producer of barley, potatoes, onions, and cattle, and ranks second to the Willamette Valley in total agricultural sales.

- Erosion threatens the productivity of natural and agricultural systems in the ecoregion.
- This region is relatively dependent on groundwater and groundwater levels have been declining by as much as 20 feet per year. An average of seven percent of the in-stream rights are met in the Umatilla basin during the summer.
- Although the Umatilla basin has some of the most efficient water use in the state, there is a widespread concern for water quality and quantity.

Regional resource planning and regulatory compliance

- The ecoregion is part of the much larger Interior Columbia Basin Ecosystem Management Project (ICBEMP), as well as the focus of the EPA's Regional Geographic Initiative. Both projects have increased knowledge about the environmental health of the ecoregion, and helped communities plan for a sustainable future.
- Recent changes in farming practices, such as increasing conversion from wheat-fallow rotation to annual cropping and minimum tillage, are helping to slow the rate of erosion. From 1982 to 1992, average erosion rates decreased from 8.5 to 6.1 tons per acre per year. This is a significant reduction, yet erosion rates in many areas are still significantly greater than the rate of soil regeneration.

Conclusion

The Columbia Plateau ecoregion produces an enormous amount of food for Oregonians and the world. As a result, the people of the region are grappling with the challenges of erosion, water quality, and decreasing groundwater supply.

Blue Mountains Ecoregion

In general, the higher the mountains, the better the water, and the Blue Mountains ecoregion is no exception. Upland water quality is relatively good, and condition of upstream fish habitats is improving. The John Day River system is particularly valuable as a stronghold for aquatic diversity because it is one of few major Columbian tributaries where the genetic integrity of native fish is not compromised by introductions of hatchery salmonids.

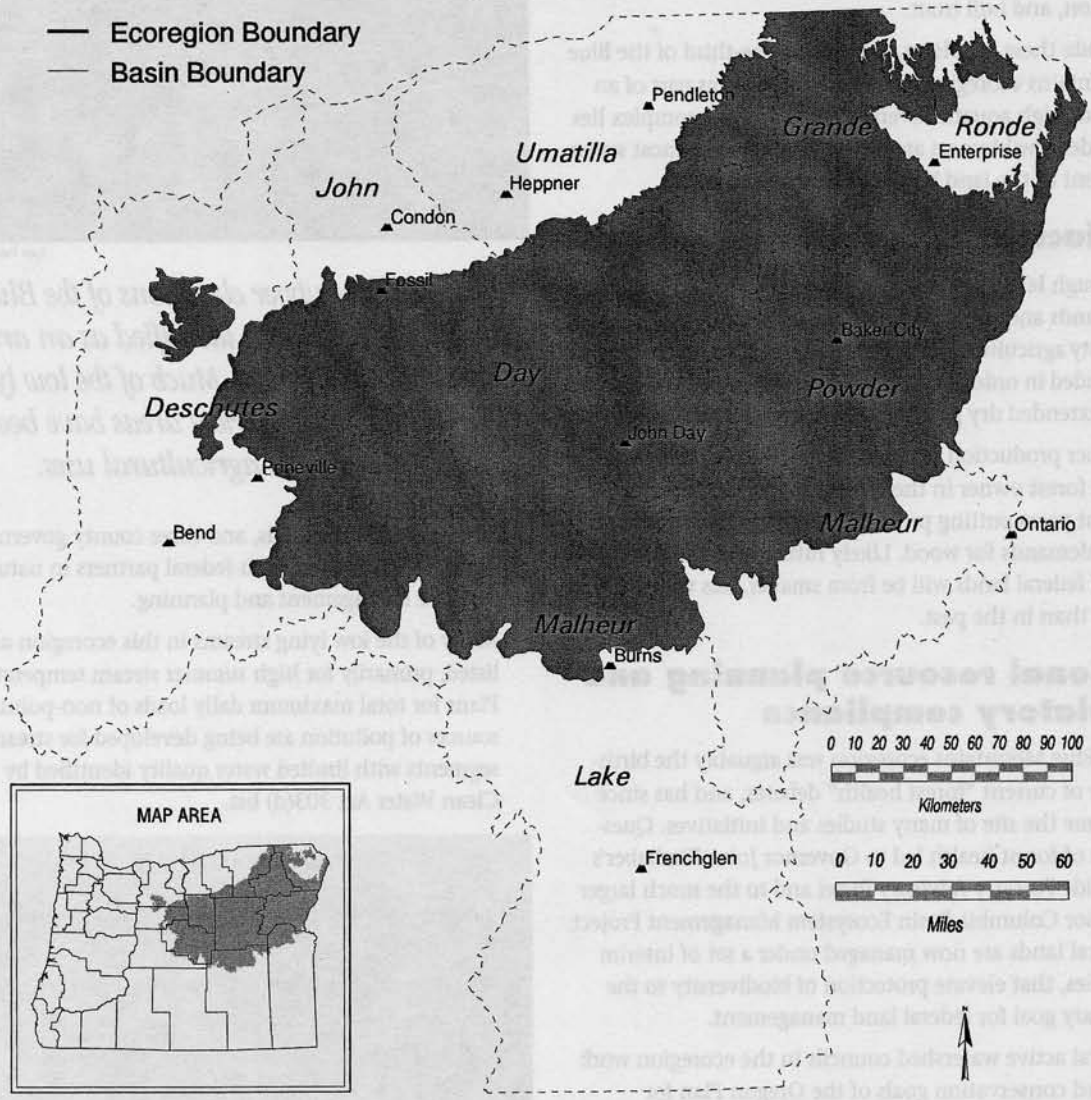
Concerns over threatened fish stocks will likely dominate land use policy in the ecoregion for the foreseeable future. Proposals for dealing comprehensively with this issue abound, many revolve around the highly innovative state plan for conserving salmon and watersheds. This plan relies heavily on a voluntary conservation effort on private lands to complement plans for federal and state lands.

A significant portion of the forest on federal land in this ecoregion is still under stress because stands are too dense, especially the true fir/Douglas-fir understories beneath pines and larch, which increases the likelihood of future mortality in both the understory and overstory. Forests at highest risk are primarily in the ponderosa pine and the drier mixed conifer types. While this risk can be lowered by reducing the density and fuel loadings of smaller trees, such practices are limited by controversies over possible impact on fish habitat and low revenues from the timber that will be harvested under these practices.

Trends suggest we are far from our reference conditions in many key resource systems. Federal management initiatives to restore natural structure and function may make a difference to the future landscape condition. Several new plans for restoration and ecosystem management at various scales have been initiated in this region.

Improving the health of streams and watersheds inevitably involves the lands where people farm, ranch, and live along

Figure 34. Blue Mountains Ecoregion and Associated River Drainage Basins



the river bottoms and the lower stretches of all river basins. As with many ecoregions in Oregon, these lands hold the key to solving many of the ecological problems identified in this section including recovery of threatened fish stocks.

Landscape structure and function

- As a result of past practices, forests in the Blue Mountains today are younger and more densely growing than in the past. Recent changes in federal forest management encourages forest practices that more closely follow natural patterns of fire frequency and stand structure.
- In much of the ecoregion, livestock numbers are greatly reduced since the early 20th century, and many upland areas have shown significant ecological recovery.
- Many riparian areas remain degraded, and ongoing practices have not allowed recovery.

Biological communities

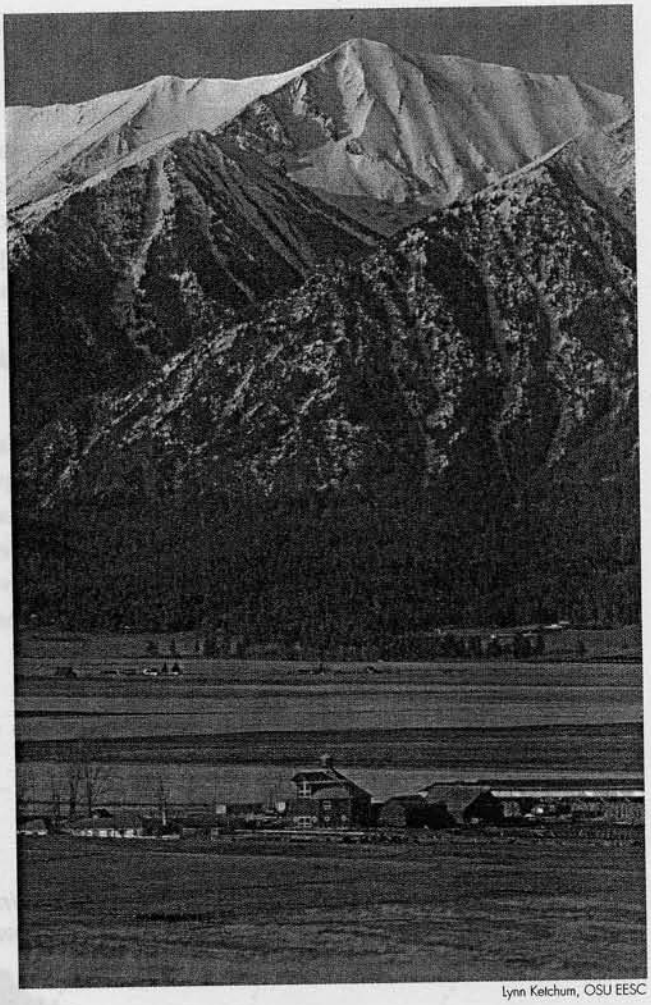
- Loss of landscape structure and function often means loss of critical habitat for native species, such as the Columbian sharp-tailed grouse, Snake River chinook salmon, and bull trout.
- Despite these problems, more than one-third of the Blue Mountains ecoregion has been identified as part of an area of high aquatic diversity. Much of this complex lies in federal wilderness areas, which make up almost seven percent of the land base in the ecoregion.

Production of goods and services

- Through land conversion and water diversion, low lying wetlands and riparian areas have been converted to high quality agricultural land. Streams have been diverted or impounded in order to store water for continued use through the extended dry growing season in this arid region.
- Timber production from the federal forests, the dominant forest owner in the ecoregion, has declined in recent years putting pressure on private lands to meet mill demands for wood. Likely future timber harvest from federal lands will be from smaller, less valuable trees than in the past.

Regional resource planning and regulatory compliance

- The Blue Mountains ecoregion was arguably the birthplace of current "forest health" debates, and has since become the site of many studies and initiatives. Questions of forest health led to Governor John Kitzhaber's Eastside Forestry Advisory Panel and to the much larger Interior Columbia Basin Ecosystem Management Project. Federal lands are now managed under a set of interim policies, that elevate protection of biodiversity to the primary goal for federal land management.
- Several active watershed councils in the ecoregion work toward conservation goals of the Oregon Plan for Salmon and Watersheds, and three county governments are actively involved with federal partners in natural resource management and planning.
- Many of the low lying streams in this ecoregion are listed, primarily for high summer stream temperatures. Plans for total maximum daily loads of non-point sources of pollution are being developed for stream segments with limited water quality identified by the Clean Water Act 303(d) list.



Lynn Kelchum, OSU EESC

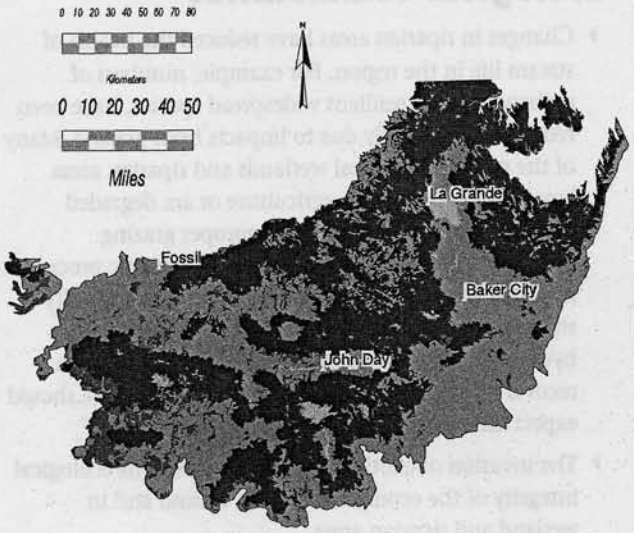
Much of the upper elevations of the Blue Mountains have been identified as an area of high aquatic diversity. Much of the low lying wetlands and riparian areas have been converted to agricultural uses.

Conclusion

Concerns over the health of forests, streams, and watersheds in the Blue Mountains have led to a new management approach still being developed on federal lands. Improvements in the health of these environments will require the participation of the entire Blue Mountains community in partnerships that are now being forged.

Figure 35. Land Use/Land Cover & Ownership of the Blue Mountains Ecoregion

Historical Land Use/Land Cover

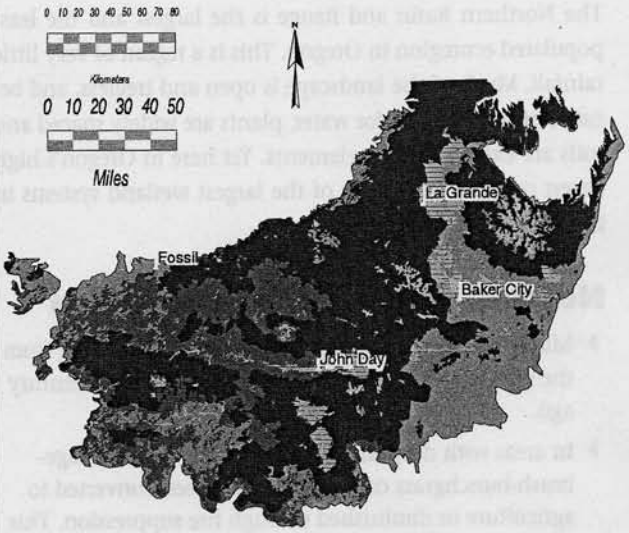


LAND USE/LAND COVER (acres in 1000's)

- Forest (6,795)
- Woodland (638)
- Range/Grassland (5,734)
- Lake, Riparian, Other (170)

TOTAL (13,334)

Current Land Use/Land Cover

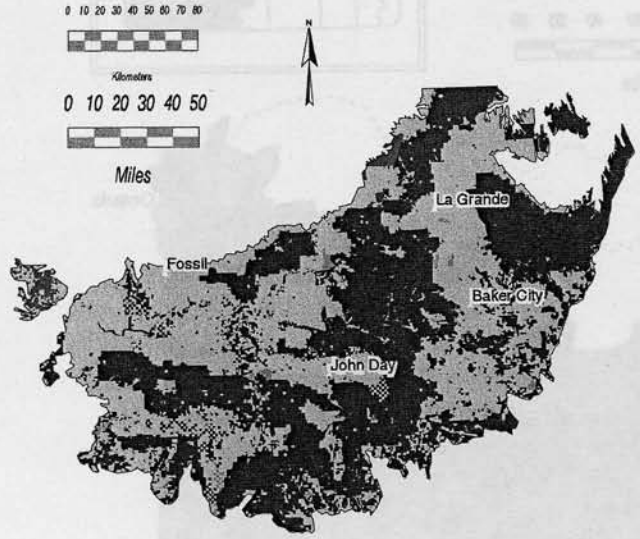


LAND USE/LAND COVER (acres in 1000's)

- Forest (7,012)
- Woodland (2,319)
- Range/Grassland (3,129)
- Lake, Riparian, Other (303)
- Agriculture (553)
- Urban (21)

TOTAL (13,334)

Ownership

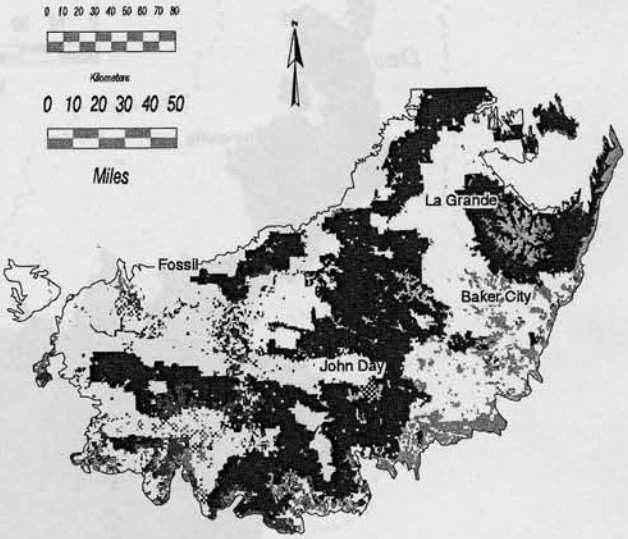


OWNER (acres in 1000's)

- Federal (6,926)
- Indian (155)
- State & Other Public (111)
- Private (6,140)

TOTAL (13,334)

Current Land Use/Land Cover on Federal Lands



LAND USE/LAND COVER (acres in 1000's)

FEDERAL

- Forest (5,001)
- Woodland (663)
- Range/Grassland (1,121)
- Lake, Riparian, Other (141)

NON-FEDERAL (6,406)

TOTAL (13,334)

Northern Basin and Range Ecoregion

The Northern Basin and Range is the largest and the least populated ecoregion in Oregon. This is a region of very little rainfall. Much of the landscape is open and treeless, and because of competition for water, plants are widely spaced and soils are exposed to the elements. Yet here in Oregon's high desert one can find some of the largest wetland systems in the West.

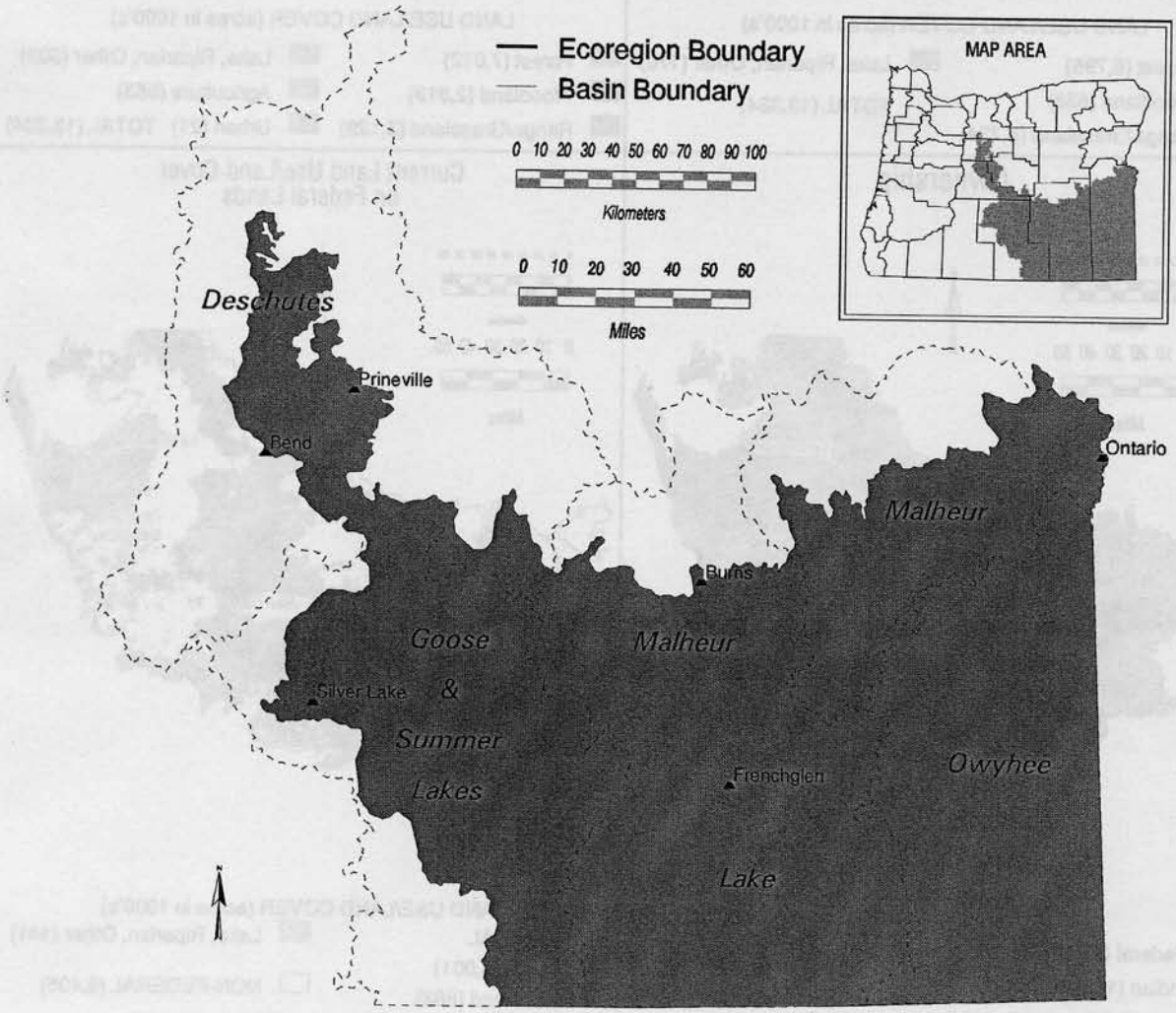
Natural structure and function

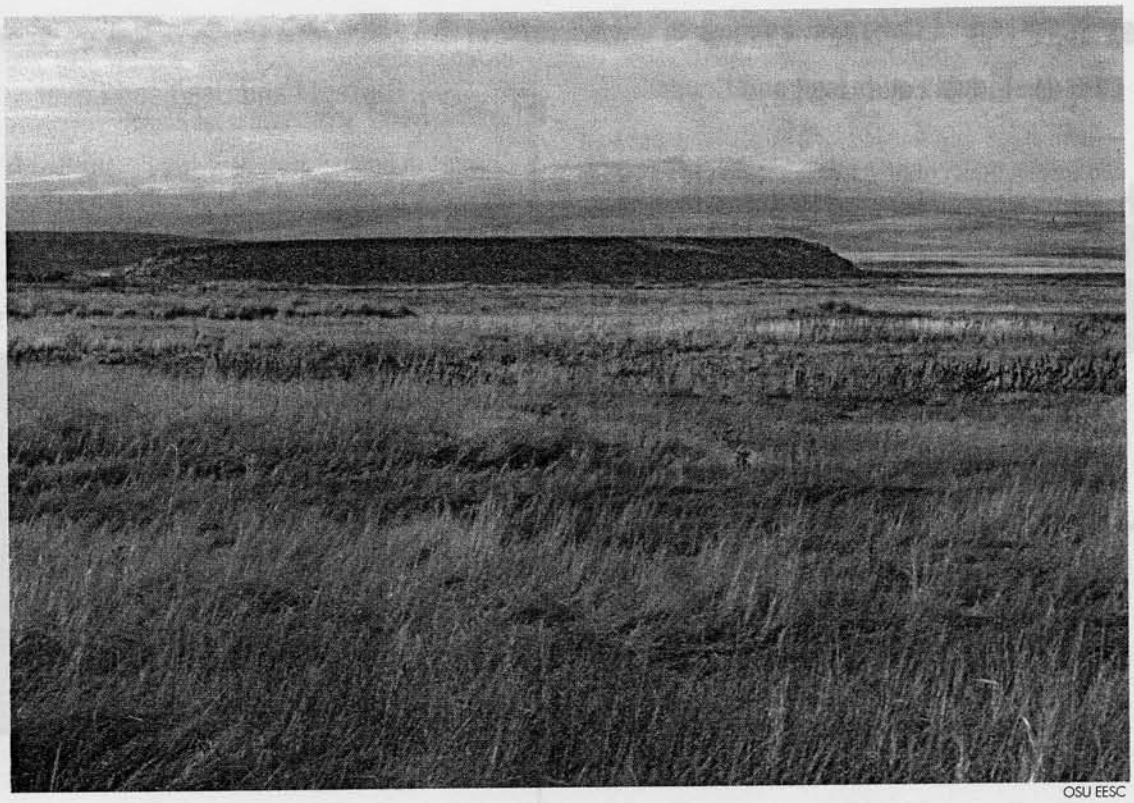
- Much of the upland sagebrush-steppe is recovering from the effects of overgrazing that occurred nearly a century ago.
- In areas with deep soils, much of the native tall sagebrush-bunchgrass communities has been converted to agriculture or diminished through fire suppression. This has reduced available habitat for many native species, including sage grouse, a species of current concern.

Biological communities

- Changes in riparian areas have reduced the health of stream life in the region. For example, numbers of redband trout, a resilient widespread species, have been reduced considerably due to impacts from grazing. Many of the region's historical wetlands and riparian areas have been converted to agriculture or are degraded through water diversions and improper grazing. Recovery will require restoration of hydrologic processes in places where a remnant of the natural community still survives. Mobile species will likely respond to hydrologic recovery, but it is much more difficult to recover resident less-mobile species. Therefore we should expect different responses to restoration.
- The invasion of exotic plant species threatens ecological integrity of the ecoregion, both in upland and in wetland and riparian areas.

Figure 36. Northern Basin and Range Ecoregion and Associated River Drainage Basins





OSU EESC

Open, wide, and dry, Oregon's high desert also contains some of the largest wetland systems in the West.

Production of goods and services

- Improvements to the health of upland rangeland suggests that grazing can be managed sustainably in many parts of this ecoregion. However, conflicts still occur in riparian areas, where long-term degradation has impacted water resources.
- Water quality in this ecoregion is among the poorest in the state. In most cases, improvement will require limiting or removing livestock from riparian areas for a period of recovery, followed by good grazing practices, including provision of alternative water supplies and proper timing and duration of grazing.
- Intensive use of fertilizers, herbicides, and irrigation during the 1960s through the 1980s led to groundwater contamination in northeastern Malheur County. Since then, improved agricultural practices have helped to reduce leaching and groundwater quality is beginning to improve.

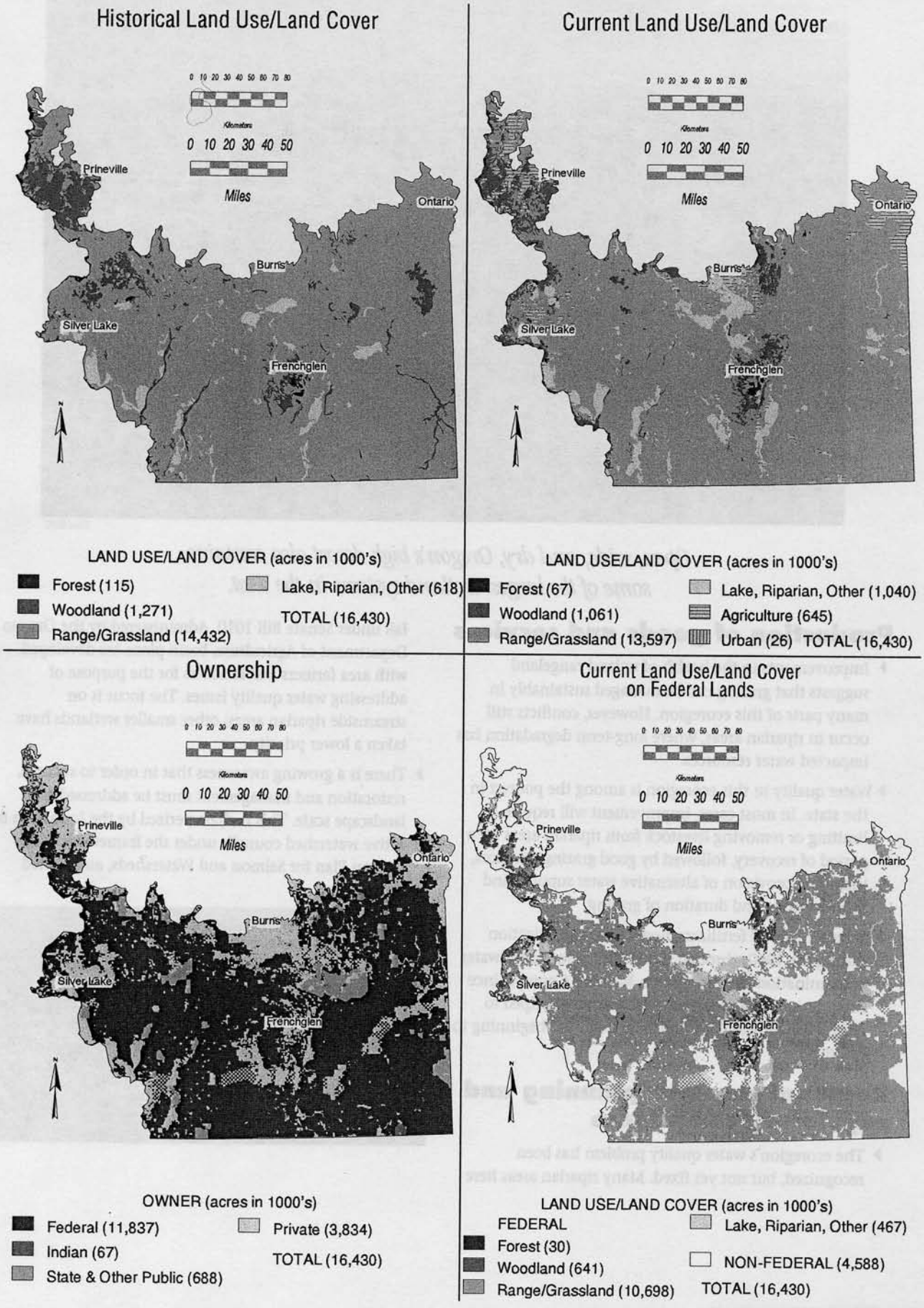
Regional resource planning and regulatory compliance

- The ecoregion's water quality problem has been recognized, but not yet fixed. Many riparian areas here fall under Senate Bill 1010. Administered by the Oregon Department of Agriculture, basin plans are developed with area farmers and ranchers for the purpose of addressing water quality issues. The focus is on streamside riparian areas; other smaller wetlands have taken a lower priority.
- There is a growing awareness that in order to succeed, restoration and management must be addressed on a landscape scale. This is characterized by the formation of active watershed councils under the framework of the Oregon Plan for Salmon and Watersheds, and related activities.

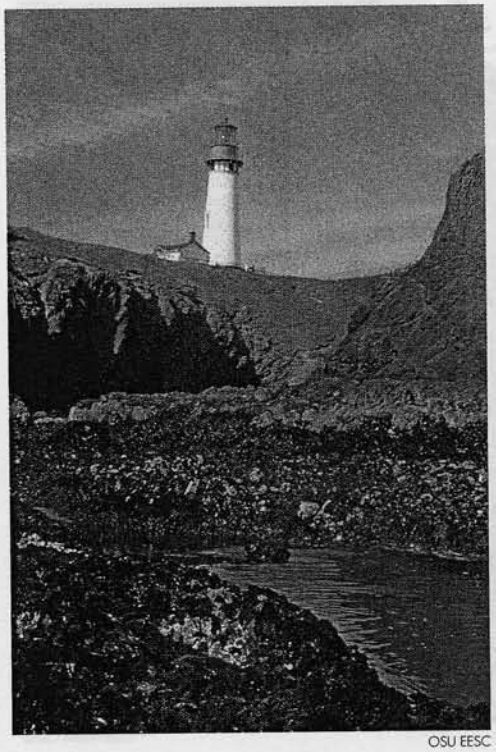
Conclusion

The ecoregion faces challenges from the invasion of exotic weeds and juniper and the need to revitalize the upland range with prescribed fire and to restore water quality and riparian condition. Intensive management will be needed to combat these problems, even though management activities may be costly and difficult in the short term.

Figure 37. Land Use/Land Cover & Ownership of the Northern Basin & Range Ecoregion



Section IV. Findings and Conclusions

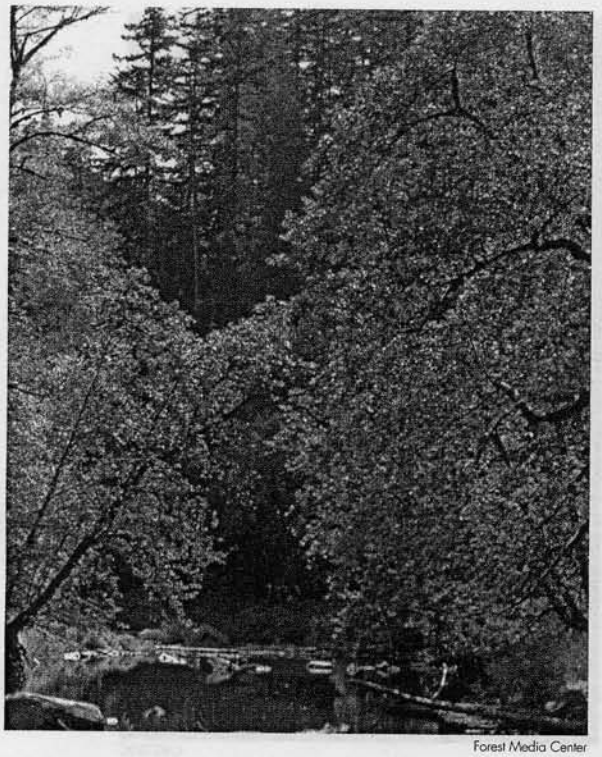


OSU EESC

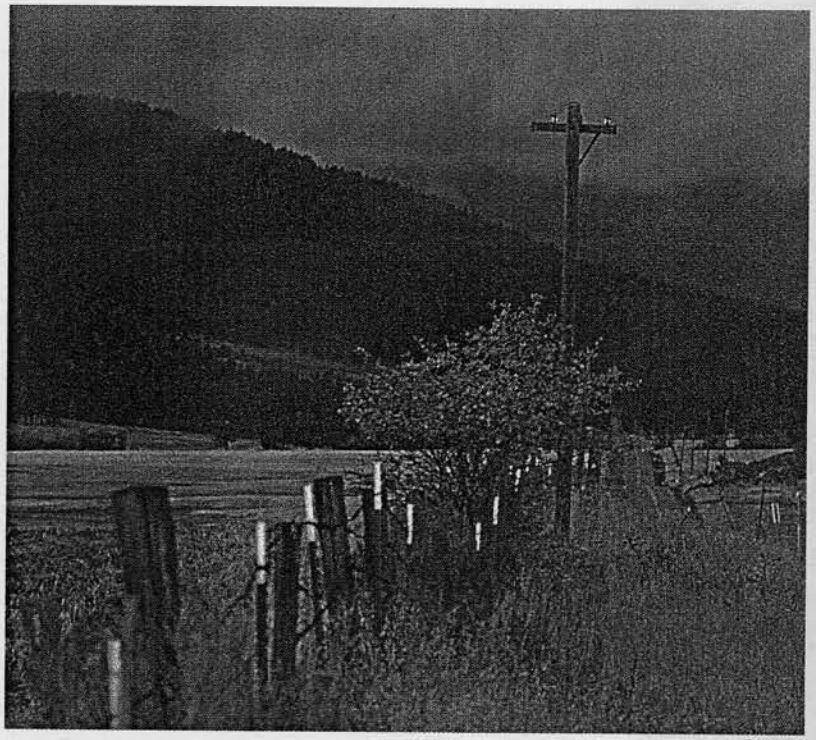
Water and Aquatic Resources

Water resources and aquatic ecosystems are among the state's resources that face the most serious risks.

- **Water quality is typically poor or very poor across the state during low flow periods,** except in heavily forested and high elevation areas, and shows only slight improvement in the last few years.
- **Available water supply during low flow periods is fully or over-allocated across the state.** There are more instream needs than stream flows to meet them.
- **The hydrologic regimes (such as high and low flows) have been disrupted in most river systems in Oregon.** These actions helped achieve flood control, irrigation, navigation, hydropower, and water supply benefits, but at a cost to naturally functioning systems.
- **Riparian conditions are typically poor or very poor across the state, with the exception of some high mountain streams.** Revised management plans now in place should enable improvement in riparian areas on federal and state lands over time, but improvement on private lands remains uncertain.
- **Wetlands have been reduced by up to 60 to 75% in some ecoregions**, numerous native wetland communities are at risk, and threats continue due to population growth and economic and agricultural expansion.
- **Historical loss of tidal wetlands is high, but restoration is reversing some losses.** Principal threats to estuaries today are shoreline modifications for upland development, dredging for navigation projects, invasions of aquatic nuisance species, sedimentation and pollution, and pressures from population and tourism growth.
- **Almost half of Oregon's freshwater fish, including many salmon stocks, have declined or are at risk of extinction,** ranking Oregon fifth in the nation in terms of the greatest number of listed fish species.
- **Some stocks of groundfish are overfished,** and the industry dependent on this fishery has little hope of quick recovery. Offshore rocky reefs that may be important as fish habitat have no special protection.
- **Ocean beaches are threatened by increasing placement of beachfront riprap.** Cut off from a supply of sand, these beaches will gradually narrow and be lost to recreation use.



Forest Media Center



OSU EESC

Forests

Overall timber harvest has declined by about 50% from the late 1980s due to concerns on federal lands over protection of species and ecosystems.

- **Private forests now provide almost all of the timber harvest.** Recent development has only slightly impacted forest land reflecting the influence of Oregon's land use laws. More changes may be needed on private forests to assist salmon recovery.
- **Old growth forests are at relatively low levels**, due to timber harvest, but have the potential to increase significantly under implementation of new federal policies.
- **Oregon's westside forests remain productive** except on the north coast where a native disease (Swiss needle cast) has greatly reduced growth. Early successional stages are extensive throughout the westside. Increasing structural diversity, especially large legacy trees and snags, remains a challenge on all lands.
- **In the future, Oregon's westside forests may become bifurcated,** with older forests on federally owned uplands and younger forests on privately owned lowlands, and little mid-aged mature forests represented except on state lands.
- **Changes in the structure of eastside forests have contributed to increased insect outbreaks and more intense fires.** New federal policies aim to reverse these trends, but controversies over active management of federal forests, especially concerns over impacts on threatened fish stocks, make full implementation of the policies problematic.

Rangelands

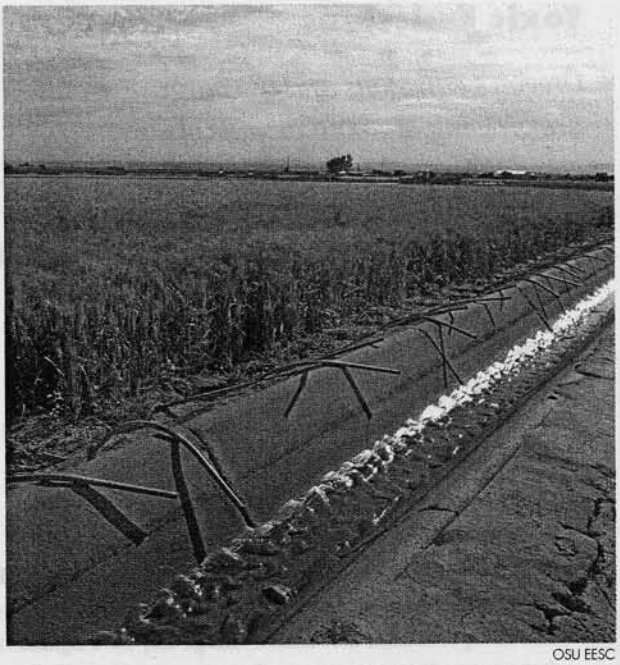
Oregon's upland rangelands have improved significantly since grazing reform in 1934, but problems persist.

- **Fire suppression and past grazing practices have contributed to an expansion of sagebrush and juniper woodlands and a decrease in grasslands.** However, on many rangelands sufficient natural character remains so that proper management practices could accomplish improvements in ecological condition without drastic changes in current uses.
- **Improper grazing in riparian areas remains a significant problem.** Little monitoring is occurring to measure the success or failure of improved grazing programs and range rehabilitation projects. Full implementation of new federal plans and approaches should help reverse rangeland degradation, but controversies over the role of active management in ecosystem restoration may stymie these efforts.

Biological Diversity

Although Oregon still retains much of its native biodiversity, many key elements are imperiled.

- **Grasslands, prairies and bottomland hardwood forests have experienced losses of more than 50% in all parts of the state (and as high as 98% in some) as a result of conversion to agriculture, urbanization, and invasions by exotic plants.** Almost all of the native vegetation in the Willamette Valley, and over half in the Columbia Plateau, have been converted to agriculture or urban uses; many native habitats have been almost entirely eliminated from these areas and others lie in the path of urban and suburban development.
- **Reintroduction of natural processes is important to sustaining biodiversity.** Preservation will not maintain the ecological function of many areas that need historical disturbance processes to thrive. Without revitalization of remaining rangelands and prairies, for example, we will lose species even if lands are not converted to other uses.
- **The shift in federal land management has the potential to help significantly in recovering many upland-dwelling species, but will not be sufficient to recover depressed salmon stocks.** Federal lands will take the lion's share of the responsibility for recovery of many old-growth dwelling species such as the northern spotted owl and other upland species such as the sage grouse. The life history of salmon combined with the ownership pattern in Oregon suggest that federal and state policy, while important, will need the assistance of private landowners to recover salmon and restore aquatic habitats.



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Agriculture

Productivity on agricultural lands remains good, but environmental challenges remain.

- **Conversion of agricultural lands to other uses declined significantly after enactment of Oregon's land use regulations in 1973,** however conversion continues to pose a threat to the viability of agriculture particularly in the Willamette Valley.
- **Agricultural yields are being sustained at present,** but detailed analysis of trends among commodities is needed to determine whether or not soil health and productivity is being impaired by erosion and loss of organic carbon.
- **The quality of soils has decreased in parts of Oregon under intensive row cropping** where more than 40% of soil organic matter has been lost in the last 100 years, yet technological inputs have resulted in increasing crop production levels.
- **Soil is eroding from parts of the Columbia Plateau three times faster than it can be replenished,** creating a very serious threat to long-term productivity and sustainability.
- **The effects of pesticides and fertilizers (especially nitrates) on water supplies and aquatic habitat remains a concern.** Water use and streamside practices remain a potential threat to salmon recovery.
- **Oregon has become a leader in the use of sustainable practices** such as conservation tillage, integrated pest management, cover cropping and nutrient management.

Toxic Emissions

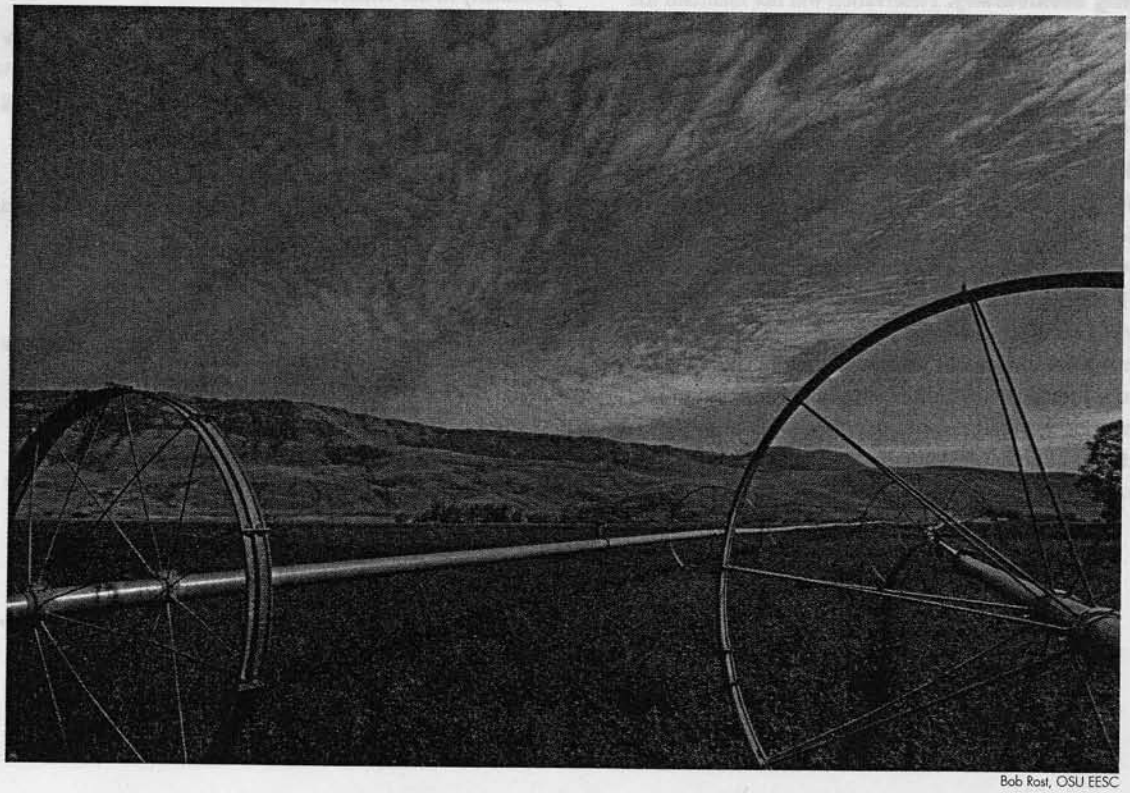
Oregon's emissions and discharges are growing at about the rate of population and economic growth.

- **Almost all categories of hazardous waste emissions, air and water pollution, toxic releases, and waste generation are growing.** These pressures create environmental risks and potential human health risks within Oregon's urban and residential areas and to associated ecoregions and watersheds.
- **Air quality has improved in compliance areas but is still at risk from vehicles.**
- **Recycling is increasing, along with the rate of waste being generated.**
- **Oregon's efforts to improve the environment could be significantly affected by climate change.** There is increasing awareness that climate change may have significant impacts on winter snow accumulation, seasonal runoffs, fire hazard in the summer, and the range of plant and animal species. The problem of climate change cannot be solved by Oregonians alone, yet it can destabilize our attempts to improve environmental conditions within the state.

Data Collection and Management

Measuring the status of Oregon's environment will require the state to update its existing data management in order to monitor conditions and trends in the environment.

- **Most existing data sources are based on regulatory requirements and may not be useful for measuring sustainability.** State agencies have a long and commendable tradition of tracking environmental conditions in Oregon, among their many responsibilities. Much of the data used in this report comes from those efforts. Yet, most existing data sources are based on regulatory requirements and few seek to measure environmental or economic sustainability necessary to provide a comprehensive picture of the status of Oregon's environment.
- **The State needs to develop and institutionalize a statewide environmental assessment framework and apply it at recurring intervals as part of an overall statewide sustainability strategy.** Statewide land use/land cover information can be developed as a source of data useful in tracking overall landscape change as well as a way to organize other data useful for monitoring a wide range of trends. This approach would complement the aquatic monitoring now being developed for the Oregon Plan for Salmon and Watersheds.



Bob Rost, OSU EESC

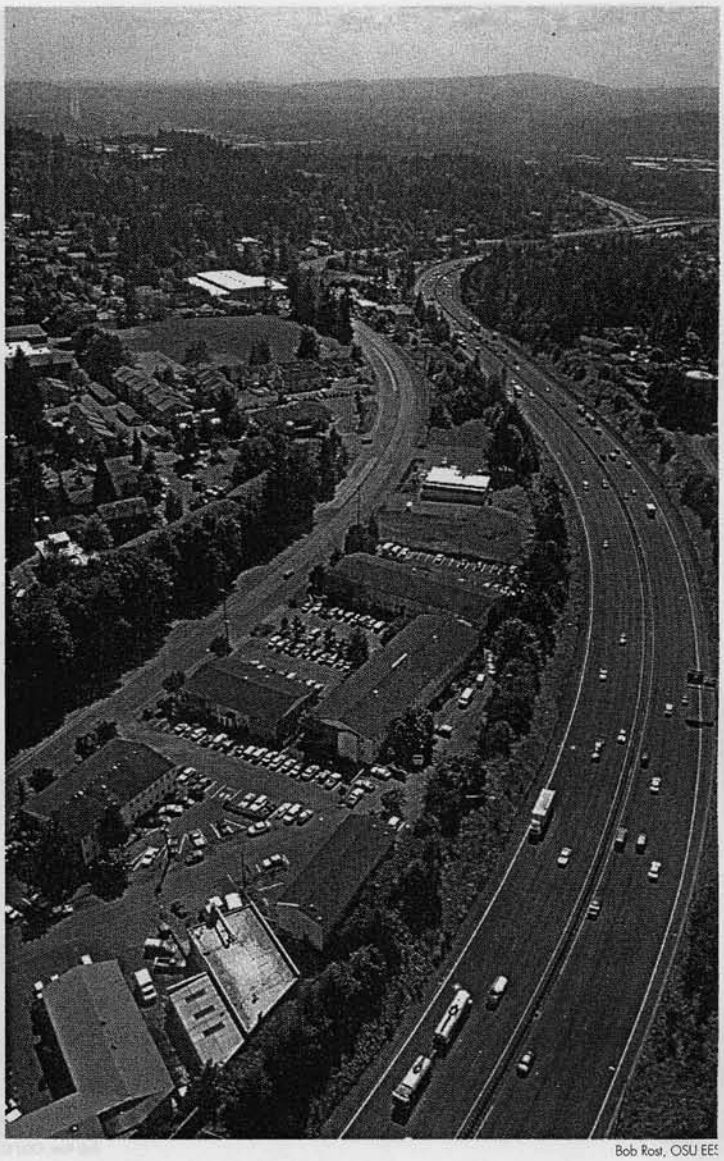
Conclusions

As the 21st century begins, the people of Oregon face new challenges in the management of natural resources. Past attempts to control the environment have had unanticipated costs. Natural occurrences such as fire, floods, and genetic diversity that seemed so unruly a half-century ago are now recognized as important aspects to maintaining the health of forests, rivers, and wildlife. Without these natural functions, we have found that forests may become diseased, wetlands disappear, and stocks of native fish decline.

The citizens of Oregon want assurances that the choices they make will keep their environment healthy enough to continue to produce a full range of environmental goods and services into the future. Such assurances are difficult to make. The products provided from a healthy environment include a sustainable supply of timber and forage, productive agricultural land, and cities with clean air and water. These, too, may come with unanticipated costs. Urban growth areas designed to limit sprawl may at the same time compromise the water quality of streams running through them. Increased wheat production that supports a vital regional economy and feeds the world may mean the steady loss of topsoil and the depletion of water.

This evaluation of the state of Oregon's environment reveals a system that is complex and interwoven. Because of this interconnectivity, managing natural resources may require trade-offs when deciding among competing demands. Intensive agriculture and forestry as well as industrialization and urbanization are highly valued economically, but they can result in significant threats to the environment. Some environmental threats make headlines, such as toxic materials washed from an industrial site. Other threats stem from small, everyday incidents, such as applying pesticides carelessly or clearing trees and brush along a river. And yet, even these small actions add up across the landscape to create significant cumulative threats.

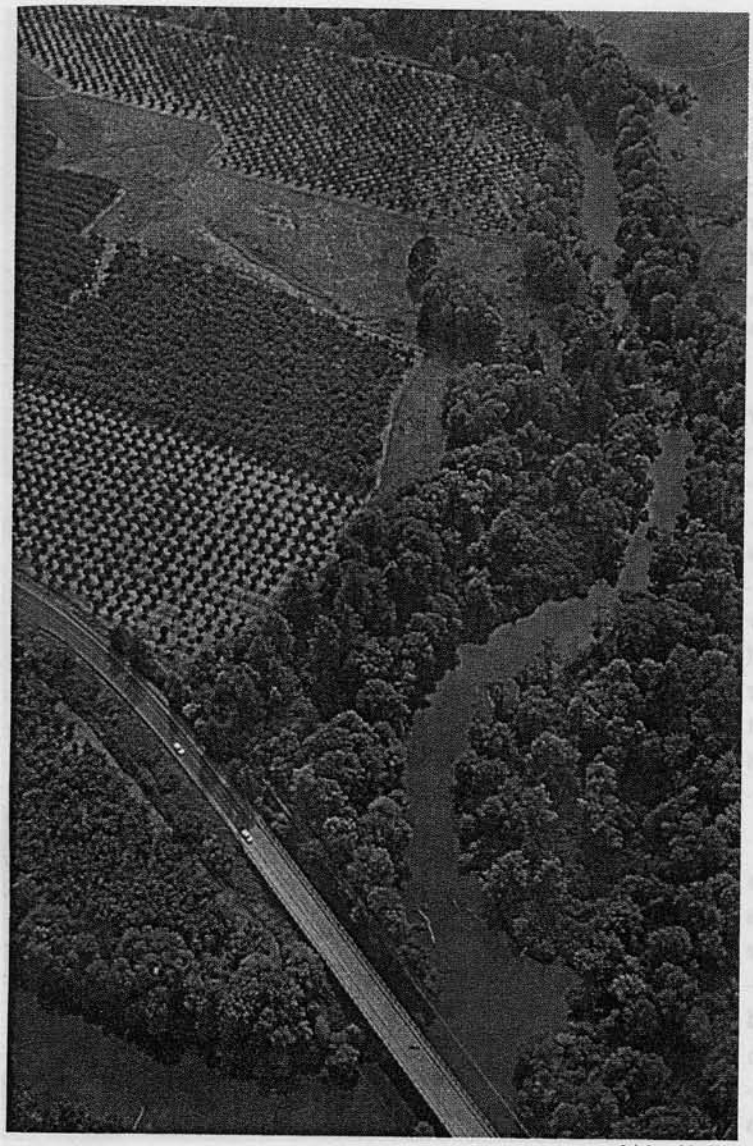
Managing Oregon's environment involves decisions that range from the actions of large industry to the weekend maintenance of one's own backyard. It involves activities high in a watershed and their consequences to river conditions farther downstream. It involves finding common ground among those who wish to preserve natural systems and those who wish to maximize economic productivity. For decisions, large or small, that Oregonians face every day, it is essential to understand the status and trends of the environment.



Bob Rost, OSU EES

▸ The state has made great strides in resolving critical environmental problems of the past, and now faces new challenges.

In response to environmental problems during the 1960s and 70s, Oregon became a leader in the nation in land-use planning, reduction of waste, and land protection. The quality of life made possible by a healthy environment continues to attract new people and industry to Oregon. On average since 1990, Oregon has added more than 50,000 new residents per year. This brings new pressures to the state's environment.



Bob Rost, OSU EESC

- **Many of Oregon's key environmental problems are concentrated in the lowlands where most Oregonians live and work.**

Many of the current problems identified in this report (poor water quality, degraded riparian areas, etc) are most critical in the lowlands of the major river basins—historically the wetlands, woodlands, and grasslands—that Oregonians have intensively developed for homes, cities, farms, and ranches. These lands are mostly privately owned, and the actions involved come from people and industries going about the ordinary business of life.

- **The greatest opportunity for improving Oregon's environment in this generation occurs on lands that Oregonians control: on state, county, and private lands.**

Much of what potentially can be achieved on federal lands is already reflected in new policies and plans for managing federal forest and range lands. Private lands have become an increasingly important element to solving many of Oregon's environmental problems for this generation. We are all part of the problem and will all have to assist with the solutions.

- **The current challenge on federal lands is to take action based on plans that are now in place or near completion.**

Federal lands have gone through great change in management in recent years. Implementation of these changes rests with federal managers as well as their citizen partners and neighbors in every Oregon community.

- **Oregon's current environmental problems reflect the cumulative effects of many small, diffuse, individual decisions and actions.**

Aquatic ecosystems, which integrate many diverse activities, are most impacted and most at risk. Developing policies and programs to address these cumulative effects is one of the greatest challenges for Oregonians.

- **The State's existing environmental data collection and management system must be improved to effectively measure ecological conditions, trends or risks.**

These problems are fundamentally different from the problems Oregon's environmental programs were initially established to address. Resolving them will require new approaches as described in this report, which are aimed at sustaining the health of naturally functioning landscapes and the productive capacity of the environment.

Science's role is to help us understand the health of Oregon's environment – democracy's role is to determine Oregon's future.

A Word from the Science Panel Chair...

To the people of Oregon,

A glance at the findings of the *State of the Environment Report* will remind us that there are limits to the natural function of Oregon's environment, limits to the productive capacity of our soil and water, and limits to the extent that we can correct problems through environmental laws and regulations.

Issues are complex. Problems are intertwined, and they cannot always be traced to a single pipeline or chimney stack. Problems with diminished water quality, for example, may be a symptom of larger problems, such as the loss of natural structure in the environment that serves as a filter to cleanse water. Such natural structure might also serve to hold soil in place, slow seasonal floods, and provide habitat for a variety of beneficial organisms. Regulating the specific pipeline source of pollution will certainly help improve water quality, but restoring the natural structure of that landscape will buffer against nonspecific sources of pollution from fields, roads, and septic tanks, as well as offering a host of other benefits.

As the state's population continues to increase, the limits of a healthy environment will continue to be challenged. Existing laws cannot protect the natural function and productive capacity of the landscape. It is imperative to understand the consequences of individual actions on the environment.

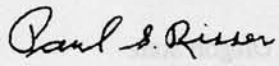
I invite you to learn about the status of Oregon's environment, and to consider its future. Work continues with the Oregon Progress Board to develop environmental benchmarks for the state. Work is about to begin to develop sustainability targets for the state, and to link environmental, social, and economic goals. Although the Science Panel has completed its task, many of its members will be pleased to contribute to the ongoing activities.

After reading this Report, if you have questions or comments, feel free to contact me at my office at Oregon State University, Office of the President, 600 Kerr Administration Building, Corvallis, Oregon, 97331, or call 541-737-2565.

The purpose of the *State of the Environment Report* has been to describe the health of Oregon's natural systems. That has been the work of the Science Panel. The next step is to establish goals, to envision the state of the environment we want to have in 25 years, and to compare that vision to trends outlined in this Report. That is the work of the citizens.

I hope to hear from you.

Sincerely,



Paul G. Risser
President, Oregon State University

Science Panel and Contributors

The State of the Environment Report was developed and written by a group of dedicated scientists and technicians, all of whom worked as volunteers.

Science Panel

The Science Panel was selected in 1998 and charged with the responsibility of producing the State of the Environment Report.

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The Science Panel worked in collaboration with a broad-based group of public officials, stakeholders, and interested citizens. These groups, with the Science Panel, make up the full State of Oregon Environmental Report Full Committee.

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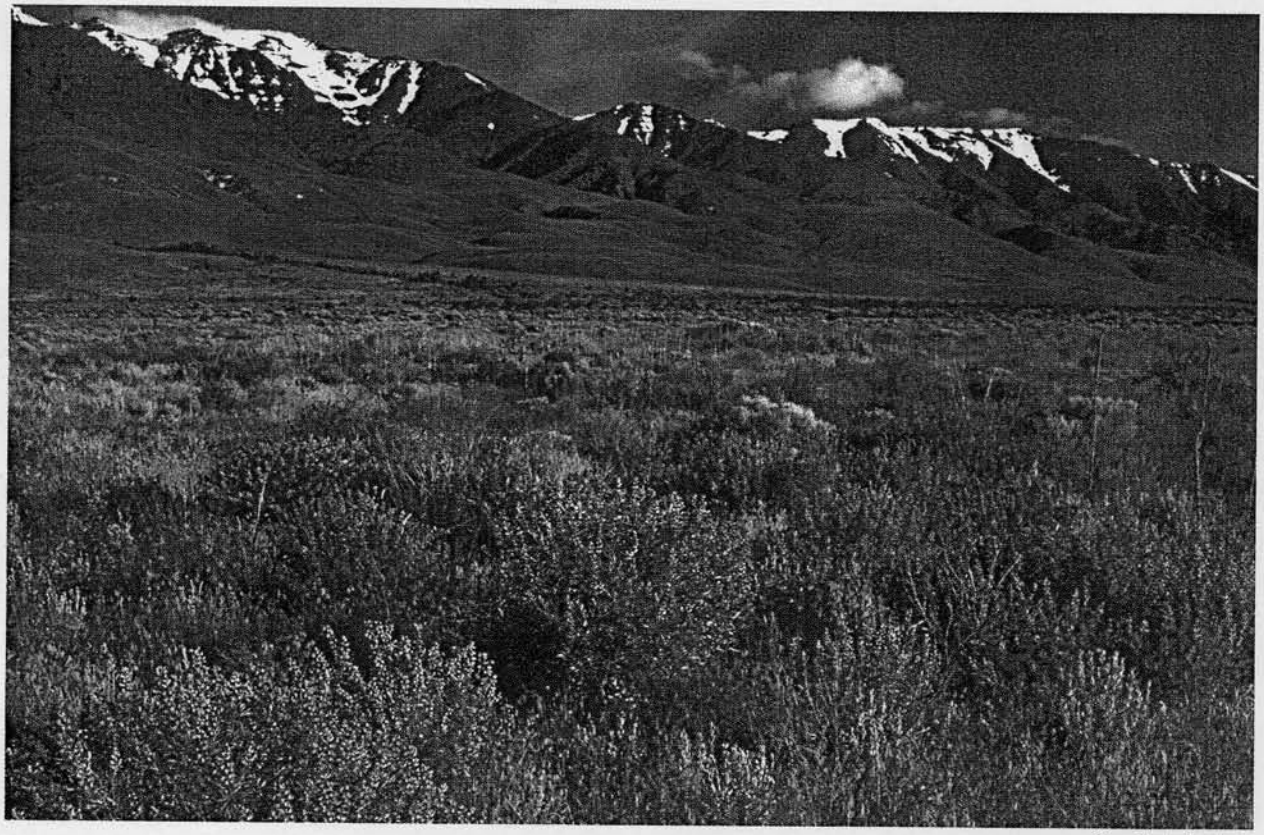
John Beuter, Consultant, Duck Creek Associates
John Tappeiner, Silviculturist, Forest Resources, OSU



Oregon Tourism Commission

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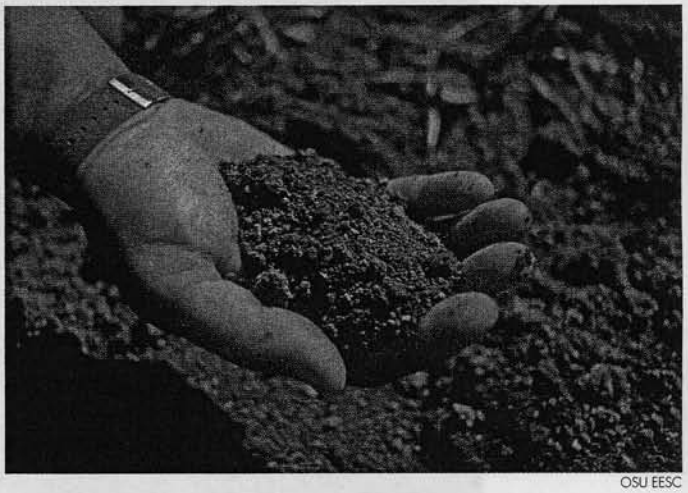

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College of Urban & Public Affairs, Portland State University
Center for Watershed and Community Health, PSU
Executive Leadership Institute, PSU

Oregon Progress Board
State of Oregon Governor's Office
Oregon Department of Agriculture
Oregon Department of Environmental Quality
Oregon Department of Fish & Wildlife
Oregon Department of Forestry
Oregon Department of Land Conservation and Development
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Oregon Economic and Community Development Department
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Defenders of Wildlife
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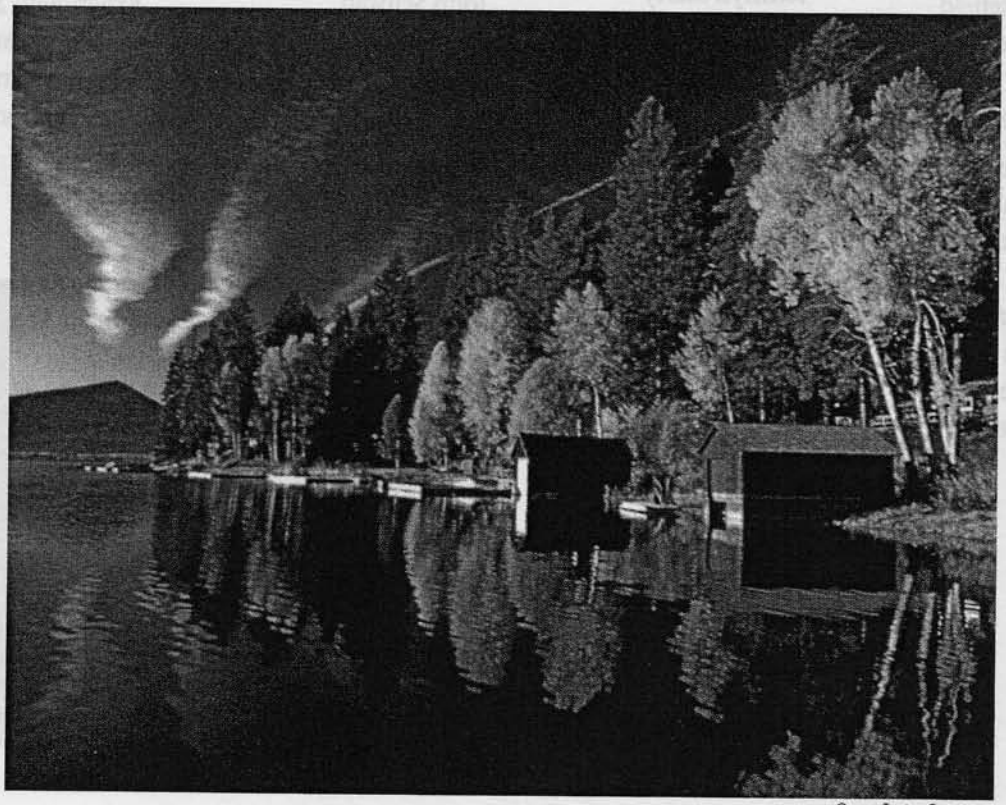
Eugene Water and Electric Board
John R. and Jane Emrick
PacifiCorp
Pacific Power and Light
Portland General Electric



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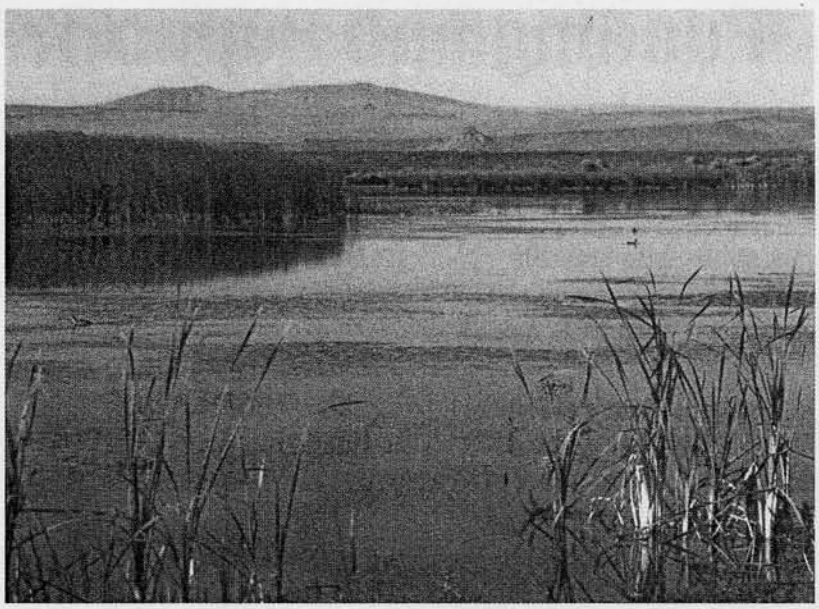
Upper Klamath Lake



Oregon Tourism Commission

Ordering copies of the State of the Environment Report

Individual copies of the *Oregon State of the Environment Report 2000–Statewide Summary* are available to Oregonians free of charge. Copies of the full-length *State of the Environment Report* and bulk orders of the *Statewide Summary* are available at cost.

For more information, contact Zoë Johnson at 503-986-0039 (phone), 503-581-5115 (fax), 503-986-0123 (voice/TDD). The *Oregon State of the Environment Report* is also available on-line at www.econ.state.or.us/opb.

Oregon Progress Board

The Oregon Progress Board is an independent state strategic planning agency. Created by the Oregon Legislature in 1989 to keep Oregonians focused on the future, the Board is responsible for maintaining the state's 20 year strategic plan, *Oregon Shines*. The ten-member board, chaired by the governor, consists of citizen leaders and reflects the state's social, ethnic and political diversity.

The Progress Board is best known for its Oregon Benchmarks, ninety indicators of economic, social and environmental health. Recommendations from the *Oregon State of the Environment Report* will be used by the Board to strengthen the benchmarks relating to environmental issues.

The members of the Progress Board are: Governor John Kitzhaber, Chair; Brett Wilcox, Vice-Chair; Lindsay Berryman, Ron Daniels, Bobbie Dore Foster; Dave Frohnmayer; Beverly Stein; and Ed Whitelaw.

For more information about the Oregon Progress Board, the Oregon Benchmarks, or the *Oregon State of the Environment Report*, please write to :

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