3.11 Summary of Current Status of Oregon's Biodiversity

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Report Card

- Grasslands, prairies and bottomland hardwood forests have experienced losses of more than 50 percent in all ecoregions (and as high as 98 percent in some) as a result of conversion to agriculture, urbanization, and invasions by exotic plants.

- Oregon could eventually lose most of its remaining native stocks of salmonid fishes unless major changes are made in how we manage our streams and waters.

- Some of the largest mammals in the state have an uncertain future unless carefully managed.

- More than half of the Willamette Valley and Columbia Basin ecoregions have been converted to agriculture or urban uses, and many native types of vegetation have been almost entirely eliminated from these ecoregions.

- Many Willamette Valley, Columbia Basin, and southwestern Oregon species that are restricted to areas that lie in the path of urban and suburban development are highly vulnerable to loss if current trends continue.

Indicators

1. Maintenance of habitats (statewide distribution of native habitats)

2. Protection of at-risk species (Status of Oregon's most vulnerable species)

Introduction

Biodiversity, short for biological diversity, is the variety and variability of living organisms and the ecological complexes in which they live (Primack, 1993). One of the more widely accepted definitions (Noss and Cooperrider, 1994) extends the concept of biodiversity to include "the ecological and evolutionary processes that keep [these systems] functioning, yet ever changing and adapting."

Scientists have identified a hierarchy of different levels within which biological diversity can be dissected (Noss, 1997). At the lowest level, biodiversity refers to the genetic variation within a local population of a plant or animal species. At the level of the ecosystem, biodiversity includes the number of native species that are present and their proportional representation. Biodiversity is also reflected in the pattern of habitats and species assemblages at the landscape or regional level. The application of the biodiversity concept to natural resource management issues is relatively straightforward. We can conserve biodiversity by minimizing loss of species and the habitats and ecological processes that sustain them.

Biodiversity is crucial for the normal functioning of ecological and evolutionary processes. Genetic variation within particular populations or species enables them to maintain adaptation to current conditions and to evolve in response to changing environmental conditions. Ecosystems with good representation of native species are better able to resist invasions by exotic species, regenerate in response to disturbance, and to provide such ecosystem services as erosion prevention, water purification and climate amelioration.

Biodiversity is important to us for many reasons besides ecosystem services. Biodiversity has utilitarian values. It supports natural resource industries that produce commodities such as fiber, food, fuel, and building materials. Native plants are still our richest source of new medicines and pharmaceuticals; by preserving our native flora we leave open the option of tapping this resource in the future. Intact ecosystems are also important to many people because of the sanctuary, inspiration and recreation that they provide. Finally, many Oregonians believe that we have a moral obligation to prevent the extinction of native species. There are many reasons to share the planet with other species.

Biodiversity conservation focuses on native species and habitats and natural processes because these elements of biological diversity are largely irreplaceable. Extirpation of an introduced species can be remedied by bringing in more individuals and establishing a new population. Habitats created by humans, such as croplands, can usually be replicated. But extinction of a native species is forever, and the complexities of natural systems defy easy reconstruction.

Biodiversity and ecological health

Healthy ecosystems, as defined in ecological terms, retain a large degree of their native biodiversity. At a local level, retention of biodiversity means that all native species of animals, plants and other organisms are represented within naturally functioning and sustainable ecosystems. Natural functioning requires that the habitats upon which native species depend be present as well. In addition, the component species in the ecosystem should have normal levels of genetic variation so that they can respond to and adapt to environmental change. Conservation of biodiversity at the landscape level requires patches of habitat of appropriate size and with appropriate connections to prevent regional extinctions. Ecological health at the state level requires that the full spectrum of Oregon's habitats are present and that all its constituent species show their natural extents of geographic range and native levels of genetic variation. Ecological health at all of these levels requires the continued function of natural ecological processes that sustain native biodiversity.

Other perspectives of ecological health that are cast in human rather than ecological terms are less adequate in addressing biodiversity. Sustainable use of ecosystems to achieve societal goals may be compatible with biodiversity conservation. However, simple compliance with the goals or technical requirements of current environmental law may not be adequate to conserve biodiversity. Although the Endangered Species Act provides a statutory basis for conservation of individual species, our current public policy framework is significantly weaker in addressing biodiversity at the level of habitats or ecological processes.

Indicators

In an ideal world we would know the current distribution of all native species in Oregon (from microbes to large mammals) and have data on the viability of a representative sample of populations for each species. With those data we could assess which species had experienced contraction in distribution or decline in population health. In other words, with complete data, we could directly assess the health of Oregon's biodiversity species by species. We do not have complete data, however, and so we must rely on indirect measures of health in biodiversity. Two such indirect measures, or indicators, for

which we have data are: (1) the areal extent of native habitat types and (2) how well the current distribution of species, in particular well-studied groups, are represented in protected areas.

Maintenance of habitats. One indicator of health is statewide distribution of native habitats. Because species depend upon particular habitats, by maintaining Oregon's characteristic range of habitats, we can maintain a broad representation of native species across the state. For example, some species of plants are found in Oregon only in alpine habitats, high in the Cascades. By maintaining the extent of alpine habitats, we can insure the perpetuation of almost all those species restricted to this habitat type. The time of reference for this indicator is the mapping of current Oregon and historic habitats provided by the Oregon Gap Analysis Report (Kagan et. al, 1999). Current data allows us only to assess the habitat loss between European settlement and 1991, which can be updated with large known habitat losses or restoration successes. The development of refined and revisable vegetation (land use-land cover) maps will allow the assessment of how fast habitats are being lost or how well they are being protected and restored over time.

Protection of at risk species. An important indicator of health is the status of Oregon's most vulnerable species. These are the species which are the best studied – the at-risk or the rare, threatened and endangered species. Due to the Endangered Species Act, relatively complete information on their distribution and health is available for this fairly small subset of plants and animals. These data are maintained by Oregon Natural Heritage Program. Accurate indicators can be computed that take into account the number of populations of these species that reside in areas managed to conserve biodiversity.

This indicator is a surrogate for the information that better represents biodiversity health, which is the extent of the geographic ranges of Oregon's flora and fauna. For some well-characterized groups (mammals, birds, amphibians, reptiles, fish and butterflies) we can use the present day as a point of reference (see discussion below), and we can compute the change in distribution since the time of European settlement (Kagan et al., 1999). A substantial contraction in distribution is both an indication that a species is at risk and a sign that biodiversity is being lost in some portions of the state. For example, using a range contraction of 10% or more since the time of European settlement as an indicator of species risk, we find that 45 species of mammals meet this criterion (**Table 3.11**-**1**). A better land use-land cover map is essential for this more detailed assessment, since species distributions are mapped based on the distribution of their appropriate habitat. Better data are also essential for understanding the distri-

Table 3.11-1. Mammals that have experienced 10% or more contraction of range in Oregon since the time of European settlement.

SPECIES NAME	Hectares 1991	Hectares 1851	% Habitat Lost
Bison	0	4,100,886	-100.00%
Gray Wolf	0	14,546,417	-100.00%
Grizzly Bear	0	6,942,075	-100.00%
Wyoming Ground Squirrel	0	427,543	-100.00%
Spotted Bat	248,421	12,333,300	-97.99%
White-Tailed Deer	504,630	4,342,889	-88.38%
Washington Ground Squirrel	139,885	879,899	-84.10%
Canada Lynx	1,605,120	7,963,754	-79.84%
White-Footed Vole	73,243	333,194	-78.02%
White-Tailed Jack Rabbit	3,118,541	12,709,206	-75.46%
Mountain Lion	3,251,446	12,546,074	-74.08%
Townsend's Big-Eared Bat	6,669,178	24,621,243	-72.91%
Kit Fox	646,914	1,522,811	-57.52%
California Kangaroo Rat	438,553	1,029,810	-57.41%
Pacific Jumping Mouse	374,298	672,241	-44.32%
Fisher	6,385,136	11,154,679	-42.76%
American Marten	6,596,928	10,995,427	-40.00%
Wolverine	2,925,837	4,836,520	-39.51%
Brazilian Free-Tailed Bat	403,755	640,978	-37.01%
Little Pocket Mouse	1,139,381	1,574,307	-27.63%
Pronghorn	7,685,865	10,618,212	-27.62%
Ringtail	2,611,322	3,607,196	-27.61%
Snowshoe Hare	8,498,909	11,673,707	-27.20%
Pinon Mouse	1,906,062	2,613,628	-27.07%
Western Gray Squirrel	5,195,956	7,018,139	-25.96%
Broad-Footed Mole	2,939,084	3,931,461	-25.24%
Common Gray Fox	6,016,481	7,875,320	-23.60%
Western Small-Footed Bat	11,023,870	14,369,340	-23.28%
Western Pocket Gopher	5,800,895	7,530,520	-22.97%
Shrew-Mole	6,558,282	8,467,962	-22.55%
Bobcat	18,770,074	23,640,676	-20.60%
Western Red-Backed Vole	6,493,411	8,162,032	-20.44%
Belding's Ground Squirrel	11,609,995	14,253,776	-18.55%
Siskiyou Chipmunk	2,594,982	3,173,347	-18.23%
Long-Tailed Vole	759,490	915,751	-17.06%
Northern Flying Squirrel	9,657,869	11,566,880	-16.50%
White-Tailed Antelope Squirrel	3,553,224	4,248,210	-16.36%
Pacific Shrew	3,308,182	3,947,711	-16.20%
California Vole	539,837	639,682	-15.61%
Ermine	10,371,537	12,154,273	-14.67%
Creeping Vole	6,922,419	8,101,765	-14.56%
Douglas' Squirrel	9,305,384	10,814,292	-13.95%
Black Bear	10,829,992	12,559,810	-13.77%
Allen's Chipmunk	2,451,673	2,836,336	-13.56%
Red Tree Vole	3,927,676	4,530,106	-13.30%
Baird's Shrew	3,267,530	3,767,444	-13.27%
Desert Woodrat	3,942,685	4,541,588	-13.19%
Columbian Ground Squirrel	2,859,624	3,278,470	-12.78%
Common Porcupine	21,600,502	24,634,304	-12.32%
Townsend's Ground Squirrel	8,506,962	9,698,825	-12.29%
Trowbridge's Shrew	7,711,958	8,783,023	-12.19%
Townsend's Chipmunk	5,506,652	6,241,434	-11.77%
Merriam's Shrew	5,961,546	6,729,072	-11.41%
Mountain Beaver	6,485,673	7,268,413	-10.77%
Dusky Shrew	3,267,214	3,636,568	-10.16%

butions of Oregon's mammals, birds, amphibians, reptiles and fish. The maps created as part of the Gap report are static. The updating of observation and museum collection data will allow us to monitor increases or decreases in all of these species ranges.

Current status and trends

Current rates of extinction are thought to be the highest in 100,000 years and are largely a consequence of human activity (Wilson and Peter, 1988). Human involvement in the extinction of species is not new. Over the past 50,000 years, extinctions of large mammals and birds repeatedly coincided with the arrival of humans in successive regions of the world. Human artifacts (e.g., projectile points, scraping tools, etc) associated with the remains of extinct animals such as mammoths provide compelling evidence for human impact on large species in North America (Martin, 1973). The predominant scientific view is that the arrival of humans in North America about 20,000 years ago resulted in the extinction of 40 genera of large mammals on the continent (Martin, 1967, 1989; Webb, 1989).

By the time Lewis and Clark arrived in the early 1800s, Oregon had already lost a significant number of its largest species (e.g., Jefferson's mammoth, giant short-faced bear, Harland's ground sloth, yesterday's camel, llama, sabertooth) (Kurten and Anderson, 1980). In the last 200 years, at least 19 species have been extirpated from Oregon (Oregon Natural Heritage Program, 1998; see sidebar). Factors behind their demise include hunting and predator control (gray wolf, grizzly bear, California condor), habitat loss (yellow-billed cuckoo, valley silverspot butterfly, Columbian sharptail grouse), introduction of non-native species (Alvord cutthroat trout), and poisoning (Miller Lake lamprey). Most of these species were lost as a result of a combination of factors (Oregon Biodiversity Project ,1998).

Dramatic changes in Oregon's vegetation patterns over the last 150 years have been documented by the Oregon Biodiversity Project (1998). This project created a historic vegetation map (see: "Historical land use/land cover map" in *SOER Statewide Summary*) that is less than perfect but nonetheless provides a benchmark against which we can view and evaluate current vegetation patterns statewide (see: "Current land use/land cover map" in *SOER Statewide Summary*). Several trends are apparent from a comparison of these maps:

- Some ecoregions have been greatly affected by human activity. For example, more than half of the Willamette Valley and Columbia Basin ecoregions have been converted to agriculture or urban uses, and many native types of vegetation have been almost entirely eliminated from these ecoregions.

- The extent of old growth forests has been greatly reduced throughout the state due to logging, disease, and changes induced by fire suppression; remaining older forests have been heavily fragmented by timber harvest.

- Grasslands, prairies and bottomland hardwood forests have experienced losses of more than 50 percent in all ecoregions (and as high as 98 percent in some) as a result of conversion to agriculture, urbanization, and invasions by exotic plants.

Loss of biodiversity has gone hand-in-hand with loss of native habitats. Because of the strong dependence of animal species on particular habitats, we can use the reconstruction of historical landcover patterns to reconstruct the presettlement distribution of particular animal species whose habits are well known. These kinds of reconstructions have been accomplished by the Oregon Gap Analysis Project (Oregon Natural Heritage Program 1999) for most species of mammals, birds, amphibians, reptiles, fish and butterflies in the state of Oregon. Comparison of total animal species then and now, as well as comparisons of individual groups and species, reveal a number of trends over the last 150 years.

- Some of the largest mammals in the state have either been lost (grizzly bear, wolf) or have experienced large reductions in range (wolverine, lynx).

- The biggest losses in vertebrate species diversity have occurred in those regions with the greatest change in native vegetation.

- Some animal groups are affected more than others. Mammals, for example, show more reduction in species diversity in western Oregon than do amphibians or reptiles.

Human impacts often cause biodiversity to be lost one species at a time, and the loss of a species often follows a predictable sequence of events. First, geographic extent is reduced as local populations shrink and go extinct. Next, a species is represented by just one or a few local colonies. Finally, a single colony remains and gradually shrinks in size until reproduction ceases and the last individual dies. Because this sequence is so predictable, we can gauge which species are most vulnerable to extinction in the future by analyzing recent histories of range contraction.

- Oregon could eventually lose most of its remaining native stocks of salmonid fishes unless major changes are made in how we manage our streams and waters.

- Some of the largest mammals in the state have an uncertain future unless carefully managed. Wolverine, fisher, and martin need attention to assure their survival. However, with attention, Oregon can not only keep these species, but restore populations of critical carnivores such as wolf and lynx.

- Many Willamette Valley, Columbia Basin, and south-western Oregon species that are restricted to areas that lie in the path of urban and suburban development are highly vulnerable to loss if current trends continue.

- Sage grouse have experienced an almost 25 percent reduction in its historic range.

Threats

The greatest threats to Oregon's biodiversity from human activities can be grouped into three broad and inter-related categories: habitat loss, fragmentation, and degradation; overexploitation; and introduction of exotic species.

- Habitat loss poses a major threat to Oregon's biodiversity because the restriction and loss of a habitat can eliminate many species at once. Conspicuous, ongoing threats of this kind include loss of old growth forests, coastal and valley grasslands, vernal pools, bottomland hardwood forests and riparian shrublands, and oak woodlands.

- Habitat degradation is often less visible but may lead to subtle changes in the composition, structure, or function of an ecosystem. Pollutants that reduce air and water quality can also have widespread impacts on terrestrial and aquatic habitats, although the long-term, cumulative nature of these effects make them hard to measure.

- Habitat fragmentation is the process of creating patches of habitat that are disconnected from other patches. Small patches pose a threat because they may not be large enough to sustain viable populations and because species cannot escape from aggressive species that frequent habitat edges. Disconnection of patches threatens recolonization after local extinction, gene flow among populations of the same species, and normal migratory or seasonal movements. Fragmentation is a particular problem in Oregon for some forest-dwelling species, including spotted owl, martin, fisher, and wolverine. Other species threatened by habitat fragmentation include some songbirds that use oak woodlands in the Willamette, Rogue, and Umpqua Valleys; and some of the wildlife species found at the western juniper-ponderosa pine interface in central Oregon.

- Overexploitation is hunting or harvesting at levels that cannot be sustained and endanger the future of a native stock. Many fisheries in the Pacific Northwest have collapsed due to overexploitation or poor management, and many that have not already collapsed may be in danger.

- Exotic species threaten Oregon's biodiversity by displacing native species, especially in disturbed habitats. Examples abound in every ecoregion. Aggressive thistles from Europe and Asia have invaded the grasslands of eastern Oregon and made many thousands of acres unsuitable for both grazing livestock and native species.

Non-native fish are a serious threat to the future of native fish, especially in the Willamette basin. Introduced pathogens are decimating the Port Orford cedar forests in southwestern Oregon and the whitebark pine woodlands of northeastern Oregon.

Strengths

Oregon retains much of its native biodiversity at the state level, despite 150 years of increasingly intensive human manipulation of habitats and ecological processes and more than a few attempts to extirpate native species outright. Vast areas of the state retain much of their natural character.

Some of Oregon's species will require special care to ensure their survival, but the problems are rarely insurmountable. In some cases, endemic species have no close relatives, so that Oregon – or the Pacific Northwest – is the last stronghold of an entire lineage. These special species pose an extraordinary obligation to the state, for once they are lost in Oregon, they are lost from the planet. The obligation is not a heavy burden in the case of the Oregon giant earthworm, a species known from only a few locations in the Willamette Valley or the Hutton Springs tui chub, a rare fish known from two tiny springs near Wagontire, Oregon. Its more difficult for other Oregon endemics with wider ranges. These include the Oregon slender salamander found in the western part of the Willamette Valley and the adjacent Cascades, the Lost River sucker from Klamath County, or the Oregon semaphore grass, known from a few mountain meadows between Lakeview and Adel, and between La Grande and Baker City.

What data are available and how complete are they?

Knowledge of biodiversity depends on knowing how particular species are distributed and whether their populations are viable. Relatively few species in Oregon are closely monitored so that we know precisely their geographic range and the status of their populations. Only species that are fished or hunted or species whose protection is mandated by state and federal statute fall in this category. A second category includes species that have received enough attention from botanists and zoologists that we can predict their distribution with reasonable accuracy from their habitat requirements or by direct inventory. Species in this category include trees, mammals, birds, amphibians, reptiles, fish, butterflies and many vascular plants. The vast majority of species, however, are unknown with respect to the extent of range and status of populations. The individuals of species in this category are almost invariably small in size and include nearly all insects and other arthropods, invertebrate animals of all kinds, some vascular plants, mosses, lichens and all microorganisms. Thus, our confidence in biodiversity assessments depends on the technique for predicting range from habitat requirements and the accuracy of our direct inventories.

The most comprehensive attempt to map distributions of habitats and species in Oregon was undertaken by the Oregon Gap Analysis Project (Kagan et al. 1999), a joint federal-state effort to identify "gaps" in current protection for biodiversity. This project estimated current species distributions from habitat requirements, the known species ranges and the distribution of vegetation types. The Gap Analysis Project has developed two vegetation maps for Oregon, and has produced species distribution maps for all of the state's native birds, mammals, amphibians and reptiles. Coarse-scale distributions exist for fish, trees and butterflies

In the best data for species distribution, each locality record is associated with a voucher specimen that is preserved in a herbarium, museum or some other well-curated, permanent research collection. Such specimen-validated data are important because the identity of particular specimens can be confirmed or re-evaluated. Re-examination of actual specimens is a routine activity in biodiversity research, because new techniques such as DNA analysis often reveal new species and sets of relationship. Although many wildlife specimens from Oregon are housed in research collections at Oregon State University and in museums throughout the country, the data in these collections have not been assembled into a statewide picture of how the state's biodiversity is distributed. The exception is information on endangered species, which has been aggregated at the Oregon Natural Heritage Program. In addition, the Flora of Oregon Project and Oregon State University are well on the way to achieving this goal for all vascular plants.

Acknowledgements

References

Oregon Biodiversity Project. 1998. *Oregon's Living Landscape, Strategies and Opportunities to Conserve Biodiversity.* Defenders of Wildlife, Lake Oswego OR.

Kagan, J. S., J. C. Hak, B. Csuti, C. W. Kiilsgaard, and E. P. Gaines. 1999. Oregon Gap Analysis Final Report: A geographic approach to planning for biological diversity. Oregon Natural Heritage Program, Portland, OR.

Kurten, B. and E. Anderson. 1980. *Pleistocene Mammals of North America.* Columbia Univ. Press, New York, NY.

Martin, P. S. 1967. Prehistoric overkill. Pp. 75-120 IN: P. S. Martin and H. E. Wright, Jr. (Eds.), *Pleistocene Extinctions: The Search for a Cause.* Yale Univ. Press, New Haven, CT.

Martin, P. S. 1973. The discovery of America. Science 179: 969-974.

Martin, P. S. 1989. Prehistoric overkill: the global model. Pp. 354-403 IN: P. S. Martin and R. G. Klein (Eds.), *Quaternary Extinctions.* Univ. Arizona Press, Tucson, AZ.

Noss, R.F. 1997. Hierarchical indicators for monitoring changes in biodiversity. Pp. 88-89 in: Meffe, G.F. and C.R. Carroll, *Principles of Conservation Biology* (Second edition). Sinauer Associates Inc., Sunderland, MA.

Noss, R.F., and A.Y. Cooperrider. 1994. *Saving nature's legacy: protecting and restoring biodiversity.* Island Press, Washington, DC.

Oregon Natural Heritage Program. 1998. Rare, threatened and endangered species of Oregon. Oregon Natural Heritage Program, Portland, OR.

Primack, R. B. 1993. *Essentials of Conservation Biology.* Sinauer Assoc., Sunderland, MA.

Vitousek, P. M., H. A. Mooney, J. Lubchenco, and J. M. Melillo. 1997. Human domination of earth's ecosystems. Science 277:494-499.

Webb, D. S. 1989. Ten million years of mammal extinctions in North America. Pp. 189-210 IN: P. S. Martin and R. G. Klein (Eds.), Quaternary Extinctions. Univ. Arizona Press, Tucson, AZ.

Wilson, E. O. and F. M. Peter. 1988. *Biodiversity.* National Academy Press, Washington, DC.