

Eastside

Chapter 2

Affected Environment

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Introduction

Key Terms Used in This Section

Historical range of variability (HRV) ~ The natural fluctuation of components of healthy ecosystems over time. In this EIS, refers to the range of conditions and processes that are likely to have occurred prior to settlement of the project area by people of European descent (approximately the mid-1800s), which would have varied within certain limits over time. Historical conditions and processes portrayed in this EIS include such variables as: vegetation types, compositions, and structures; fish and wildlife habitats and populations; and fire regimes. For purposes of comparison to current conditions, historical conditions in this EIS represent an estimated mid-point within the historical range of variability. HRV is discussed only as a reference point, to establish a baseline set of conditions for which sufficient scientific or historical information is available to enable comparison to current conditions.

Ecological integrity ~ In general, ecological integrity refers to the degree to which all ecological components and their interactions are represented and functioning; the quality of being complete; a sense of wholeness. Absolute measures of integrity do not exist. Proxies provide useful measures to estimate the integrity of major ecosystem components (forestland, rangeland, aquatic, and hydrologic). Estimating these integrity components in a relative sense across the project area helps to explain current conditions and to prioritize future management. Thus, areas of high integrity would represent areas where ecological function and processes are better represented and functioning than areas rated as low integrity.

Planning area ~ Refers to either the Eastside EIS area or the Upper Columbia River Basin EIS area.

Project area ~ Refers to the entire Interior Columbia Basin Ecosystem Management Project area, encompassing both EIS planning areas.

Regional ~ Generally refers to either the planning area or the project area. In watershed discussions, also refers to 1st field Hydrologic Unit Codes; such as the Columbia Basin.

Purpose and Organization of This Chapter

The purpose of this chapter is to describe the existing environment, including conditions and trends, that will be affected by management alternatives in Chapter 3. Descriptions focus on lands administered by the Forest Service or Bureau of Land Management (BLM) in eastern Oregon and Washington (the *planning area*); however, discussion of the entire *project area* (covered by both the Eastside and Upper Columbia River Basin [UCRB] EISs) is often necessary to provide context.

Information about the physical, forestland, rangeland, aquatic, social, and economic setting is provided to:

- ◆ Show specific changes from historical to current times within the project/planning areas,
- ◆ Describe more fully the statement of needs explained in Chapter 1, and

- ◆ Lay the foundation for understanding and evaluating the alternatives discussed in Chapters 3 and 4.

Where possible, information is organized by potential vegetation group and summarized by Ecological Reporting Units (ERUs). At the end of the chapter this information is integrated and reorganized into geographical clusters of areas within the project area where overall ecological conditions, opportunities, and risks are similar.

This chapter focuses on portions of the environment that are directly related to conditions addressed in the alternatives (see Chapter 3). The description of the affected environment is not meant to be a complete portrait of the project area. Rather, it is intended to portray, at a regional scale, the significant conditions and trends of most concern to the public, the Forest Service, and the BLM with regard to lands administered by these two agencies within the project area.

A detailed description of the project area is provided in the *Integrated Scientific Assessment for Ecosystem Management in the Interior*

Columbia Basin and Portions of the Klamath and Great Basins (Quigley et al. 1996a; hereinafter referred to as the *Integrated Assessment*) and *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins* (Quigley and Arbelbide 1996b; hereinafter referred to as the AEC) which is comprised of several Staff Area Reports or chapters. Both these documents comprise what is referred to as the *Scientific Assessment or Assessment*.

The Affected Environment is based primarily on the individual chapters of the AEC (*Introduction, Biophysical Environments, Landscape Dynamics, Aquatics, Terrestrial Ecology, Economic, Social, and Information System [GIS]*). The *Scientific Assessment* characterizes the entire project area, regardless of ownership, to set a context within which individual Forest Service or BLM administrative units can plan and conduct ecosystem-based management. *Assessment* findings are best used to understand trends on the overall landscape. Descriptions of site-specific conditions generally can be found in current land use plans available at local Forest Service or BLM offices.

Readers should be aware that local conditions may reflect healthier or more degraded conditions than are discernible at the larger or regional scale addressed by this Environmental Impact Statement (EIS).

Approximately half of the project area is administered by either the Forest Service or the BLM; the remaining area is shared among other ownerships. Five other federal agencies (National Park Service, U.S. Fish and Wildlife Service, Department of Energy, Bureau of Reclamation, and Department of Defense) administer lands in the project area (see Map 2-1). However, as stated previously, management strategies of the Eastside EIS discussed in Chapter 3 and evaluated in Chapter 4 apply only to approximately 30 million acres of land administered by the Forest Service or BLM in eastern Oregon and Washington. Table 2-1 lists the affected BLM Districts and National Forests. Note that three National Forests in Idaho are listed; the Pacific Northwest Regional Forester is the deciding official for portions of these three National Forests, therefore, they are part of the Eastside EIS planning area.

Ecological Processes and Functions

The terms “ecological processes” and “ecological functions” in general refer to the flow and cycling of energy, materials, and organisms in an ecosystem. Nitrogen, carbon, and hydrologic cycles, as well as energy flow in terrestrial systems, are among the ecological processes discussed in other sections of this chapter. Nitrogen and carbon cycles are shown in the Soils section, hydrologic cycle in the Aquatics section, and energy flow in the Terrestrial section. The following are additional functions and processes that are important to ecosystem health:

Water capture. Water is effectively captured when sites maintain high infiltration rates and a high capacity for surface capture and storage of water.

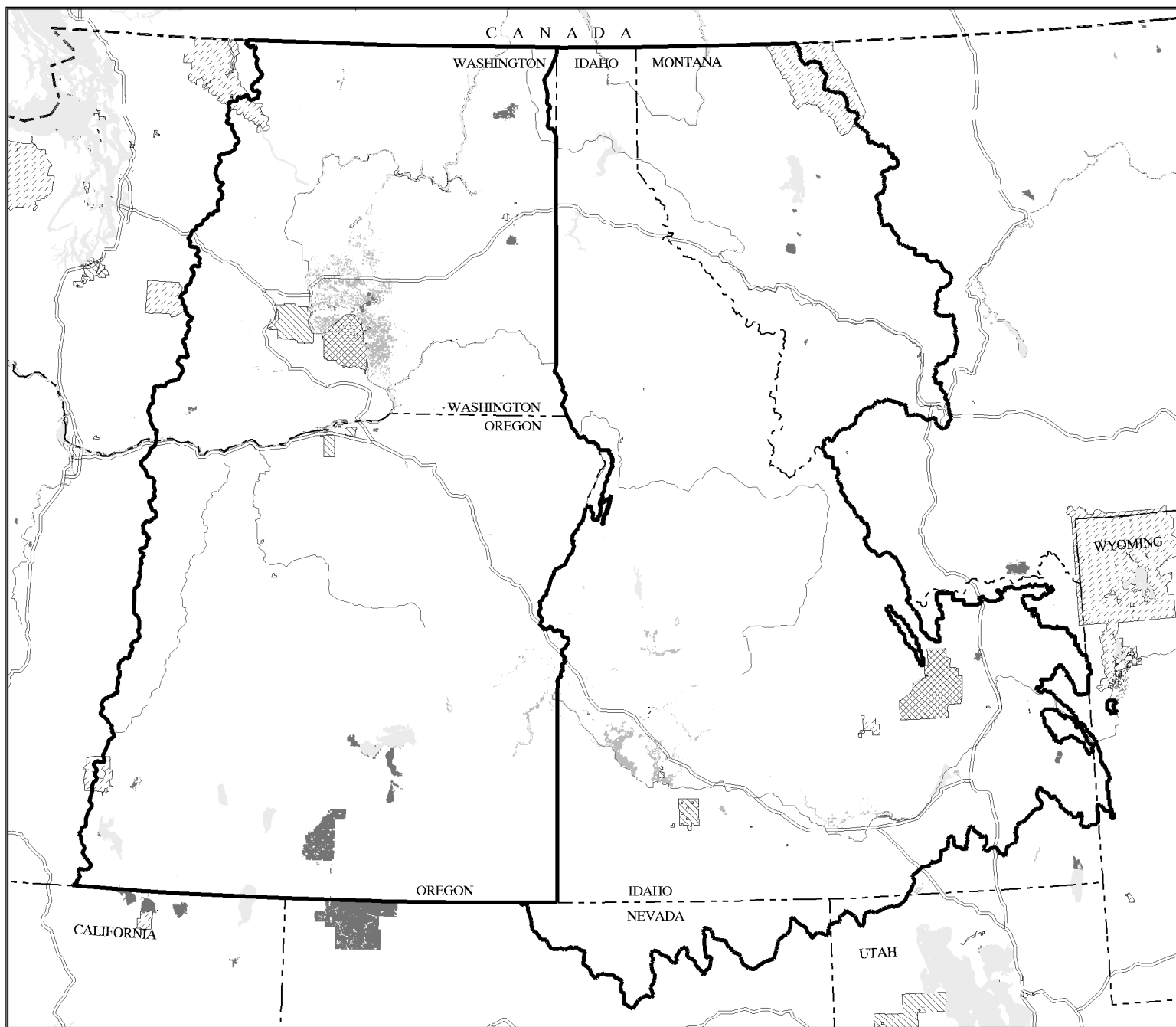
Water storage. Water is stored effectively when soil is stable and able to retain moisture; and when soil organic matter, well dispersed litter, and plant canopies that reduce evaporation losses from the soil are maintained.

Water cycling. Water is cycled more effectively when it is released from a site in such a way that (1) low amounts of sediment are transported in runoff, (2) there is sufficient subsurface flow of water, and (3) plants and animals are able to use water for physiological functions.

Nutrient and energy cycling. In healthy ecosystems, nutrients cycle and energy flows through a system in a pattern that is appropriate for the geoclimatic setting.

Energy capture (photosynthesis). With historical disturbance regimes, plants are able to store resources necessary for drought survival, overwintering, and new growth initiation. They retain canopy cover, litter, and root systems sufficient to protect them from death or loss of vigor during stress periods.

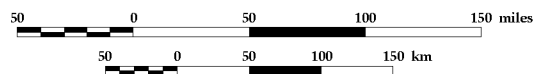
Adaptation. Animals have evolved along with their environments and have adapted to conditions on the landscape. Healthy ecosystems have sufficient food, cover, and other habitat attributes to maintain sufficient populations for reproduction, genetic interactions, and long-term survival.



Map 2-1.
Other Federal Agency-
Administered Lands

INTERIOR COLUMBIA
 BASIN ECOSYSTEM
 MANAGEMENT PROJECT

Project Area
 1996



- | | |
|------------------------|-----------------|
| National Park Service | Water |
| U.S. Fish and Wildlife | Major Rivers |
| Dept. of Energy | Major Roads |
| Bureau of Reclamation | EIS Area Border |
| Dept. of Defense | |

Historical Conditions

Throughout this chapter, reference is made to “historical conditions” or the “historical range of variability.” “Historical” in this EIS is intended to represent conditions and processes that are likely to have occurred prior to settlement of the project area by people of European descent (approximately the mid-1800s). Historical conditions and processes are portrayed in this EIS for a number of variables such as forestland and rangeland vegetation types, compositions, and structures; fish and wildlife habitats and populations; and fire regimes. These historical conditions would have varied over time. For purposes of comparison to current conditions, historical conditions referenced in this EIS represent an estimated mid-point within the historical range of variability.

The historical period of pre-Euroamerican settlement was selected for this EIS only as a reference point, to establish a baseline set of conditions for which sufficient scientific or historical information is available to enable comparison to current conditions. Such a comparison is valuable to understand how ecological processes and functions operated with human uses, but prior to high human populations and contemporary technology. This can provide clues and blueprints for designing management strategies that maintain the integrity of those ecological processes under future management strategies. In many cases, it is neither desired nor possible to return to actual historical conditions.

Positive Ecological Trends

The nature of the Interior Columbia Basin Ecosystem Management Project has been to focus on what is going wrong with ecosystems, then to determine what changes to management activities are necessary to improve ecological conditions. Much of the discussion in Chapter 2 emphasizes these needed changes.

Although some ecosystems have declined in health, many ecological conditions and trends have improved in the past two decades. Some areas where improvement has been achieved over the last 10 to 20 years on Forest Service- or BLM-administered lands are as follows:

- ◆ Soil productivity ~ best management practices in use today reflect improved understanding of the sensitivity of soils to various treatments, especially at the fine scale, or local level.
- ◆ Road construction and management ~ best management practices in use today reflect an improved understanding of negative effects of roads. New road construction and maintenance of permanent roads occurs with greater understanding of drainage, erosion potential, fish passage concerns, slumpage problems, and other hazards. Much remains to be addressed in the future especially with secondary and closed roads.
- ◆ Range management and rangeland conditions ~ the current condition of rangelands appears to be the best it has been since the turn of the century. However, this is not agreed upon by all (National Research Council 1994). The declining condition of riparian areas has, for the most part, been slowed or stopped, and managers are acquiring a better understanding of how to alleviate the negative effects of management practices on riparian areas. The BLM and Forest Service are placing a heavy emphasis on proper management of riparian areas in land use plans.
- ◆ Many high-profile threatened or endangered species are protected ~ species such as the grizzly bear and bald eagle have recovery plans in place, which are being implemented. Attention has shifted to those species with less public attention. Probably no vertebrate species have become regionally extinct in historic times.
- ◆ Landscape approach recognition ~ overall, land managers within the project area have recognized the need for a landscape approach to management of resources; that is, considering all components of a landscape, not just the trees or the riparian habitat, for example. On-the-ground managers appear ready and willing to initiate the change.
- ◆ Prescribed fire techniques ~ techniques available for prescribed fire within the project area have improved. A variety of conditions can now be achieved from the application of prescribed fire using different treatments.

Table 2-1. National Forests and BLM Districts Affected by the Eastside EIS.

State	National Forest or BLM District	Acres Affected¹
Oregon	Burns BLM District	3,417,000
	Columbia River Gorge National Scenic Area (FS)	6,000
	Crooked River National Grassland	117,000
	Deschutes National Forest ²	1,584,500
	Fremont National Forest	1,140,000
	Lakeview BLM District	3,382,000
	Malheur National Forest	1,459,500
	Medford BLM District	500
	Mount Hood National Forest	330,500
	Ochoco National Forest	847,000
	Prineville BLM District	1,648,000
	Umatilla National Forest	1,068,500
	Vale BLM District	5,043,000
	Wallowa-Whitman National Forest ³	2,249,000
	Winema National Forest	1,037,500
Oregon Total		23,330,000
Washington	Columbia River Gorge National Scenic Area (FS)	8,000
	Colville National Forest	1,088,000
	Gifford Pinchot National Forest	187,500
	Okanogan National Forest	1,497,500
	Spokane BLM District	347,000
	Umatilla National Forest	311,000
	Vale BLM District	10,500
	Wenatchee National Forest	2,192,000
Washington Total		5,641,500
Idaho	Nez Perce National Forest	4,500
	Payette National Forest	4,000
	Wallowa-Whitman National Forest	131,000
Idaho Total		139,500
Eastside EIS Total		29,111,000

Abbreviations used in this table:

BLM = Bureau of Land Management
 EIS = environmental impact statement
 FS = Forest Service

¹ Acres listed are only those administered by the BLM or the Forest Service.

² Newberry Crater National Volcanic Monument acres included.

³ Hells Canyon National Recreation Area acres included.

Source: ICBEMP GIS data (converted to 100 x 100 meter grid and rounded to nearest 500 acres). These totals will not match official government land office (GLO) totals or those shown elsewhere in document that were calculated from a 1000 x 1000 meter grid (1 km²).

- ◆ Forest management approaches ~ the last 10 years have seen substantial change in the treatments applied to forested areas, both in harvest techniques and silvicultural treatments. Managers have a wider array of options to select as treatments with more benign effects.
- ◆ Recognition of exotic species and their influence ~ the relatively recent and rapid expansion of exotic species and their impact on ecosystems is receiving more attention by resource managers, who recognize that management aimed at preventing the spread and reducing the extent of exotics is necessary. Scientists are testing and developing combinations of control methods that are promising for control of exotic plant species.
- ◆ Interaction with a wide array of publics ~ recent trends have been for managers to have more open discussions earlier in planning processes with a wide array of publics.

Ecological Reporting Units, Hydrologic Unit Codes, and Clusters

Ecological Reporting Units

The project area was divided into 13 geographic areas called Ecological Reporting Units (ERUs; see Map 1-1) to provide a consistent way for the Science Integration team to report their findings in the *Integrated Assessment* (Quigley et al. 1996a) and the various chapters of *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins* (AEC) (Quigley and Arbelbide 1996b). The ERUs were developed specifically for consistent reporting purposes, not for analysis or implementation. The 13 ERUs were identified by a process that integrated human uses and terrestrial and aquatic ecosystem data. They are the basis for reporting information on (1) the description of biophysical environments, (2) the characterization of ecological processes, (3) the discussion of past management activities and effects, and (4) the identification of landscape management opportunities.

The Eastside EIS planning area contains part or all of eight ERUs. The Northern Cascades (ERU 1), Southern Cascades (ERU 2), Upper Klamath

(ERU 3), and Northern Great Basin (ERU 4) are completely within the Eastside planning area. The Columbia Plateau (ERU 5), Blue Mountains (ERU 6), Northern Glaciated Mountains (ERU 7), and Owyhee Uplands (ERU 10) are within both the Eastside and Upper Columbia River Basin planning areas. Further characterizations of these eight ERUs can be found in the Physical Environment section of this chapter. When possible, descriptions of the Affected Environment are described by ERU; however, not all socio-economic or ecological processes conform to ERU boundaries. Where this occurs, discussions are within the appropriate context. Land ownership (BLM/Forest Service-administered, state, other federal, tribal, and private) for each ERU in the Eastside planning area is in Table 2-2.

Hydrologic Unit Codes

For the purposes of analyzing and summarizing much of the physiographic (the formation and evolution of landforms), aquatic, and vegetative information collected in the *Scientific Assessment*, a hierarchy of watersheds and watershed boundaries was identified by the Science Integration Team (see Table 2-3 and Figure 2-1). The identification system follows the numeric hydrologic unit coding system used by the U.S. Geological Survey (USGS). For larger watersheds, "Regions," "Subregions," "Basins," and "Sub-basins" (4th field), boundaries and their numeric hydrologic unit codes were adopted without change from those identified by the USGS. For smaller watersheds, "Watersheds" (5th field) and "Subwatersheds" (6th field), were identified as part of the Interior Columbia Basin Ecosystem Management Project process. Within eastern Oregon and Washington, there are 3,500 subwatersheds averaging approximately 20,000 acres each. These subwatersheds (6th field) are the basic characterization unit for the *Scientific Assessment*, and were the basic mapping unit for identifying ERUs. Therefore, the boundaries of ERUs coincide with subwatershed boundaries. The subwatersheds mapped as part of this project do not necessarily match those that have been previously mapped by administrative units of the Forest Service or BLM.

Clusters

As a final step in the analysis, to provide an understanding of the bigger picture, the Science Integration Team integrated and regrouped initial information to evaluate the relative integrity of ecosystems in the project area. Forested, rangeland,

Table 2-2. Eastside EIS Land Ownership by ERU.

Ecological Reporting Unit	BLM/FS	State and Other Federal	Tribal	Private
		<i>in thousands of acres</i>		
Northern Cascades (ERU 1)	3,438	658	730	1,510
Southern Cascades (ERU 2)	1,966	73	314	1,098
Upper Klamath (ERU 3)	1,812	133	0	1,950
Northern Great Basin (ERU 4)	7,573	617	17	2,145
Columbia Plateau (ERU 5)	2,584	1,946	685	16,317
Blue Mountains (ERU 6)	6,251	94	4	5,567
Northern Glaciated Mountains (ERU 7)	1,468	497	1,562	3,526
Owyhee Uplands (ERU 10)	3,967	373	0.2	1,318

Abbreviations used in this table:

BLM = Bureau of Land Management
 EIS = Environmental Impact Statement
 ERU = Ecological Reporting Unit
 FS = Forest Service

Source: ICBEMP GIS data (converted to 1 km² raster data).

Table 2-3. Hierarchy of Watersheds.

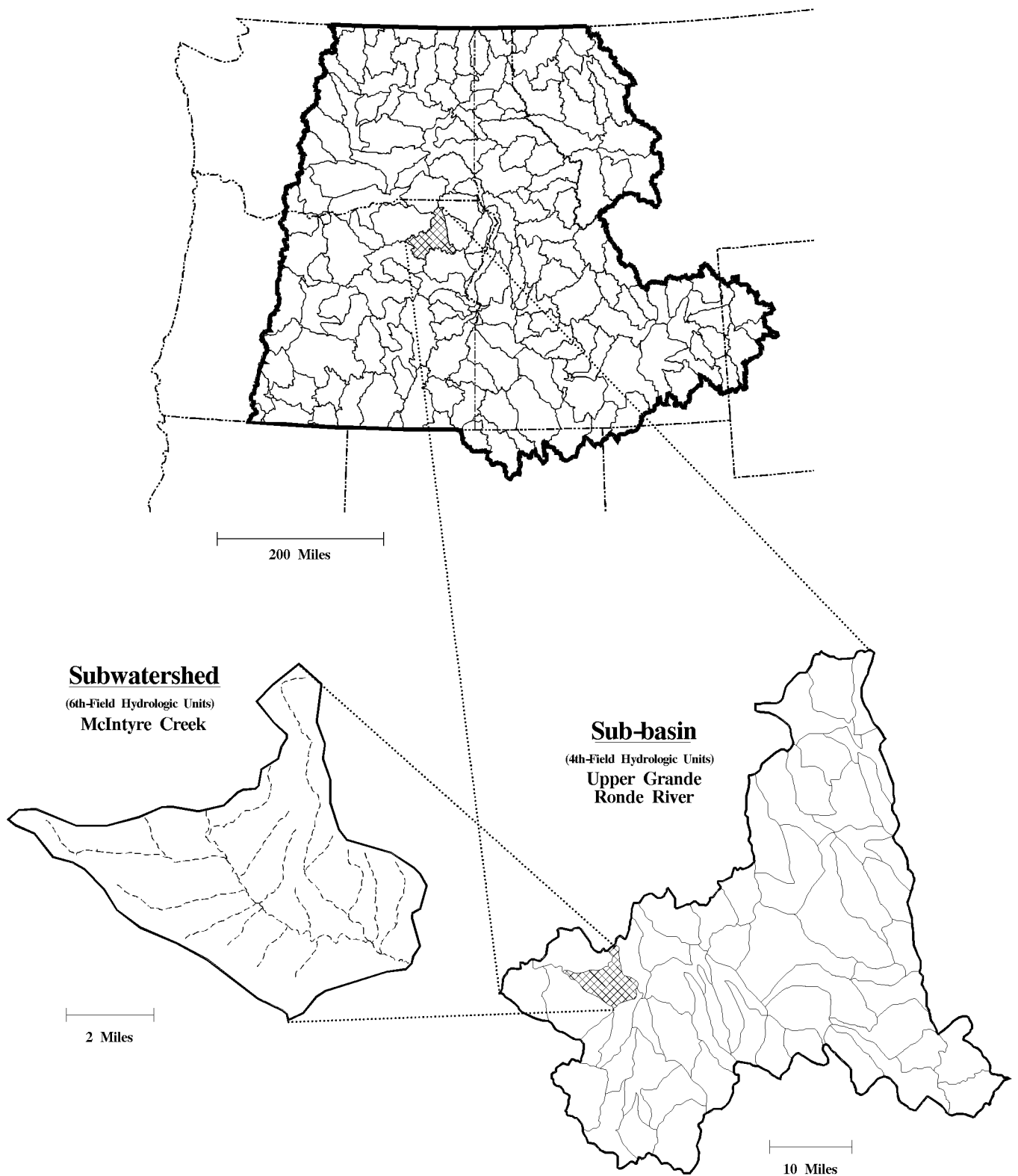
Hierarchy Term	Hydrologic Unit Code (HUC) ¹	Number in Planning Area ²	Example Watershed	Size of Example (acres)
Region	1st-field	3	Columbia River	165,757,151 ³
Subregion	2nd-field	10	Lower Snake River	22,399,615
River Basin	3rd-field	16	Lower Snake River	7,487,871
Sub-basin	4th-field	93	Upper Grande Ronde River	1,049,582
Watershed	"5th-field"	1,308	McIntyre Creek	47,999
Subwatershed	"6th-field"	3,500	McIntyre Creek	17,920

¹ 1st-field thru 4th-field HUCs were formally designated by the U.S. Geological Survey. "5th-field" and "6th-field" HUCs were designated for the project area (Hann et al. 1996).

² Includes all watersheds that are entirely or partly within the Eastside planning area.

³ The area of the Columbia River watershed includes the entire basin, including portions outside the project area west of the crest of the Cascade Range and in Canada.

Figure 2-1. Hydrologic Hierarchy



LEGEND

- | | | |
|------------------|----------------------------|----------------------------|
| State Boundaries | Outer HUC Boundary | 6th-Field Hydrologic Units |
| Project Area | 4th-Field Hydrologic Units | 100k Stream Layer |

Ecological Integrity and Ecosystem Health

The Science Integration Team (SIT) used the term “integrity” to refer to the ecological conditions of an ecosystem. Integrity generally means the quality or state of wholeness or being complete and unimpaired. Ecological integrity specifically was used by the SIT as a measure of the presence of physical and biological processes, patterns, and functions.

Because there are not direct measures of integrity, “proxies” or substitutes were selected to represent the broad array of functions, processes, and conditions. For example, the proportion of the area where fire severity and frequency had changed between historical and current periods was used as one of the proxies to represent such elements as consistency of tree stocking levels with long-term disturbances and the effect of wildfire on the composition and patterns of forest types. Proxies such as these were used to estimate current conditions and project trends in integrity into the future.

Ecological integrity is difficult to measure directly for several reasons. First, we can never know exactly what is in any particular ecosystem, because of the size, complexity, and ambiguous nature of most of their parts and processes. Second, the structure, function, and composition of ecosystems are always changing. Third, ecosystem changes are only partially predictable; they respond to a combination of internal processes and outside influences. And finally, the boundaries we put on ecosystems are artificial lines, making it hard to know when you are looking at an entire system or a part of one or more systems.

Therefore, integrity was estimated in a relative sense. Where forest, rangeland, and aquatic system processes and functions were present and operating best in the project area, integrity was rated higher than areas where these functions and processes were not operating. These estimates represented such elements as water cycling, energy flow, nutrient cycling, and maintenance of viable populations of plants and animals.

The notion of ecological integrity is part of the broader concept of ecosystem health used in the Draft EIS. The EIS Teams used the term “health” to refer to the capacity of forest, rangeland, and aquatic ecosystems to persist and perform as expected or desired in a particular area. Varying degrees of “wholeness” or integrity may be needed to enable a particular place to be used in the manner desired by society both now and in the future. Some uses will demand different mixes of fire regimes, water cycles, and energy flow resulting in differences in productivity, resilience, and renewability. The mix of these elements of “integrity” that would allow us to achieve a particular management objective in a particular place will define what is “healthy” for that area.

For example, in some areas such as near developed recreation sites or areas with scattered homes, restricting the presence of fire as a process may be important to achieving the broad goals for an area. The result may mean lower ecological integrity than if the fire regimes were allowed to operate fully, but might be judged as healthy from an ecosystem perspective because it is meeting the expectations of society. Another example might be managing to restrict riparian flooding, which from an ecological frame of reference would reflect lower integrity than if the flooding were to be present, yet this area might contribute to the overall ecosystem health because it is favorably contributing to society’s goals.

Ecosystem “health” thus can be thought of as encompassing both ecological integrity and what people want to do with the land. Ecosystem health includes not only how “intact” the ecological processes and functions need to be compared to their capabilities in order to accomplish current and future management objectives, but it also includes measures of social and economic resiliency, management philosophies and goals, and other human factors.

hydrologic, and aquatic systems were considered in deriving measures of integrity (see the last section of this chapter). Rather than simply describe the vegetation and other resources, this effort attempted to answer three questions:

1. Where are the areas of relatively high or low ecological integrity across the project area?
2. Where are the opportunities to improve integrity?
3. What risks to integrity exist from management actions?

New groupings or “clusters” of sub-basins were mapped, identifying forest and rangeland ecosystems where the condition of the vegetation and ecological functions and processes are similar, and where opportunities and risks are similar. These clusters form the basis of discussion in the last part of this chapter, and for the development and evaluation of alternatives in Chapters 3 and 4.

Humans and Land Management: Snapshots in Time

Humans have been a part of the project area's ecosystems for many centuries. The story of how the environment has influenced people and how people have influenced the environment provides a valuable context for the alternatives in Chapter 3. It has taken decades for the condition of the environment to be what it is today, and it may take decades to change conditions to what people desire them to be. This concise overview was written to provide readers with an introduction to the chapter and snapshots of this history. More detailed accounts are included in the rest of this chapter, and in the *Scientific Assessment* (Quigley et al. 1996a,b).

First Settlement (pre-1800s)

Survival dictated movements of the project area's first human inhabitants more than 12,000 years ago. These first people adapted culturally and socially to major climatic, environmental, and resource distribution changes, forming attachments to places they visited seasonally. Archeological evidence indicates that they were hunting nomads who followed big game herds and maintained settlements in riverine, lake, and

wetland environments. As the climate moderated over the past 4,000 years, their settlement, land use, and seasonal migration strategies and patterns apparently shifted to more diversified systems with a greater use of upland and mountainous environments. These migratory settlement patterns allowed landscapes to recover during periods of non-use.

Natural resources were, and still are, culturally significant to these people because they were an integral part of all aspects of their culture. Hundreds of plant and animal species, landscapes, minerals, and natural processes (such as weather) developed cultural significance through subsistence, religion, traditional stories, commerce, social values, and other mechanisms.

These first people actively participated and interacted with ecosystems in many ways. They routinely started fires to aid their hunting and encourage growth of certain culturally-significant plants. These fires differed from lightning-caused fires in terms of season, frequency, and intensity (Lewis 1985). Tribes kept large herds of horses, which were introduced in the 1700s and early 1800s by Euroamericans. These non-native species grazed large portions of the project area. The intensity and frequency of these grazing patterns differed from those of native big game species.

Pioneer Settlement (1800s)

The earliest Euroamerican contact with native cultures in the project area occurred during the Lewis and Clark Expedition in 1804 to 1805; soon thereafter, the region opened up to further exploration, fur trade, military posts, missionary work, and settlement. The United States government encouraged western settlement. Private citizens, railroad companies, and timber and mining interests were granted free land in exchange for meeting various development requirements. The evolution of transportation from walking, to horses and wagons, to locomotives, played a major role in commercial development of the area. By the 1880s it was possible to arrive in the Pacific Northwest in five days by rail, instead of the five months it took by wagon train.

Survival was the European settlers' driving force; however, their survival tactics had little in common with those of native people. The European settlers felt their survival depended on conquering nature. For example, the Hudson's

Bay Company held a near-monopoly on the fur trade in the project area, trapping fur-bearing animals of the Snake River plains to extinction to discourage potential competitors. Many European settlers also had little concept of limits, particularly where natural resources were concerned--they saw the west as a vast area with a limitless supply of raw materials.

To settlers accustomed to the lush landscapes of eastern hardwood forests, the Snake River plains seemed too dry, rocky, and forbidding to consider staying. From 1840 to 1860 most overland migrants passed through the Columbia Basin and continued onto the Willamette Valley's greener pastures and proximity to navigable waters. This began to change with the discovery of gold in the project area.

As the land became settled and developed, the natural environment began to change. For example, waterways were altered when beaver dams washed away when beavers were trapped out of the area. Further changes occurred when settlers built dams for irrigation, and later, to generate power. Fish habitats were forever altered. Other changes occurred when settlers trapped predators, such as wolves, cougars, and coyotes, that were preying on their livestock. As a result, predators' traditional prey, such as elk, deer, and antelope, experienced rapid population growth. Overgrazing by both wild and domestic animals altered vegetation. Anecdotal reports and photographs showed summer ranges so laden with sheep that they appeared to be snow drifts.

Euroamericans changed native people's cultures as well. Effects included: disease, epidemics, population shifts, cultural changes, accommodations to new trade systems and goods, new native religious movements, and competition for lands, traditional places, and resources. The notion of land ownership was foreign to American Indians, and therefore was a source of conflict. This period of direct competition and conflict between native and Euroamerican people resulted in a treaty-making period that ended in 1871. Treaties between Indian tribes and the United States government gave tribes exclusive title to reservation lands. Indian reservations were seen by both parties as a way to limit conflicts and allow tribes to "have their own land." Treaties also established trust responsibilities for the federal government, in which the government promised access to lands for traditional uses, such as hunting, fishing, gathering, and livestock grazing.

Recognizing Limits (early to mid-1900s)

In the early 1900s, tribal negotiations with state and federal agencies met with mixed results concerning treaty reserved rights to subsistence activities. Newly created federal agencies developed management actions and policies that applied to public lands. American Indians' way of life and use of the land and its resources began being altered. They seasonally sought out familiar resources and places, regardless of ownership, developing understandings and trade opportunities with landowners. Traditional lifeways persisted even as Indians increasingly conformed to regional non-Indian lifestyles. During economically depressed periods, renewed reliance on traditional foods and other practices helped sustain many tribal economies.

The way European settlers used and viewed the land began being altered as well. By the 1900s, resource extraction was a major part of the west's economic base. After discovery of valuable mineral deposits throughout the West, the Mining Law of 1872 set direction for mining activity on public lands. Establishment of the Reclamation Service in 1902 led to construction of a vast network of dams, canals, and ditches that hastened settlement of the arid lands of the project area ~ paid for with profits from the sale of western lands. As resources were used and land was settled, people began to realize that natural resource supplies were limited. They clamored for a public land management strategy that would ensure future supplies of natural resources. The Congress responded by creating federal land management agencies responsible for managing public lands for sustainable natural resource production. The Forest Reserves, the Forest Service's predecessor, was formed in 1891. The Bureau of Land Management's predecessor, the Grazing Service, was established in 1934. In 1916, the National Park Service was created to administrate the growing set of National Parks and monuments.

The agencies began to set and enforce land use limits. Many settlers were outraged. Their independence, judgement, and momentum ~ all the characteristics that had made them successful ~ were now being questioned and curtailed by the federal government.

The early Forest Service was guided by the Organic Act (1897) which stated that “dead, matured, or large growth of trees” could be designated and sold for the appraised value. The act further specified that harvest would preserve living and growing timber, and promote younger growth. The agency’s mission was also defined by a multiple-purpose policy adopted in 1905: “Provide the greatest good for the greatest number in the long run.”

Similarly, the Taylor Grazing Act (1937) gave specific direction to the Bureau of Land Management. By leasing public lands to stockraisers, the act sought to “stop injury to the public grazing lands (excluding Alaska) by preventing overgrazing and soil deterioration; to provide for their orderly use, improvement, and development; (and) to stabilize the livestock industry dependent upon the public range.” After nearly a century of policies to dispose of public lands, the federal government began to view the remaining public domain as a storehouse to sustain productive values.

Commodity Production (mid-1900s)

Public priorities shifted as the United States went through two World Wars and the Great Depression. The Depression brought an unexpected benefit to public land management, the Civilian Conservation Corps, a federal program designed to put men back to work. Participants built an infrastructure for public lands including hundreds of Forest Service roads, stock watering projects, ranger stations, campgrounds, and telephone systems. When public demand for natural resources increased exponentially, the agencies were able to meet expectations.

Both wars brought economic prosperity and a heightened demand for resources such as timber, livestock, and minerals. Three things caused the federal land management mission to change: the post-war housing boom; the prediction that there would be a rising, long-term demand for timber; and private timber shortages. In 1944 the Administration decided that forested federal lands would become active timber sources rather than timber reserves. Timber production skyrocketed. From 1945 to 1970, timber harvest on federal lands in the project area increased about 5 percent per year, or 50 percent faster than the growth of the national economy.

Environmental Awareness (late 1900s)

The 1960s brought increasingly complex and conflicting demands on public land management within the project area. This change was symbolized by the debate over dams in Hells Canyon; the issue became not just how many dams should be constructed or who should build them, but whether the river was more valuable undeveloped and free-flowing. Wilderness enthusiasts and others sought to put recreation on an equal footing with extractive uses. Traditional users ~ loggers, ranchers, and miners ~ argued for greater allocation to their particular needs. Members of a growing environmental movement wanted land management decisions to be based on interdisciplinary scientific information. The public had one common opinion: they wanted to be actively involved in land management decisions.

In recent years the Forest Service and BLM have experienced a transition in management emphasis, resulting from additional scientific knowledge, increased public environmental awareness, new legislation enacted by the Congress, and challenges in court. The Forest Service and the BLM are still required to supply resources for public use and allow access to commodity resources. Both agencies are also required to protect and improve natural resources.

Recent and long-standing legislation pertaining to natural resources and federal land management enacted by the Congress has created a complex collection of regulations that often result in conflicting management applications. Early legislation concerning federal land management activities primarily emphasized production and use of resources (General Accounting Office Report on Ecosystem Management, August 1994). The Congress enacted legislation creating incentives to provide specific levels of certain natural resource commodities and other uses from public land administered by the Forest Service or the BLM. Both agencies are required to share receipts from the sale or use of natural resources with the states or counties within which the activities occur. For many years congressionally appropriated funds have been linked to managing and harvesting timber, minerals, and livestock forage, as the

Congress specified “target” levels of timber sales, along with the production of other goods and services from these lands.

More recently, increasing scientific and public concern about declining conditions of natural resources led the Congress to enact laws to protect specific natural resources. These laws include the Clean Water Act (1948), the Clean Air Act (1955), and the Endangered Species Act (1973). The Congress encouraged research on National Forests by enacting the Forest and Rangeland Renewable Resources Research Act of 1978, and the Cooperative Forestry Assistance Act of 1978.

Recognizing that activities on federal lands relate to protection of natural resources, the Congress also enacted a series of procedural laws requiring federal agencies to identify and disclose the potential effects of their activities. Primary among these laws is the National Environmental Policy Act (1969), which requires federal agencies to identify and consider the direct, indirect, and cumulative effects of activities on federal land, both alone and in conjunction with the activities of other agencies and landowners. The Forest and Rangeland Renewable Resources Planning Act (1974), the National Forest Management Act (1976), and the Federal Land Policy and Management Act (1976) all contain requirements for the Forest Service and/or BLM to develop long-term land management plans.

These laws continue to be interpreted through federal courts, sometimes requiring adjustments in how the Forest Service and BLM plan for and administer these lands.

Physical Environment

Key Terms Used in This Section

Alluvial (alluvium) ~ General term for clay, silt, sand, or gravel deposited in recent geologic time as a result of a river. Includes the sediments laid down in river beds, flood plains, lakes, and fans at the foot of mountain slopes.

Climate ~ The composite or generally prevailing weather conditions of a region throughout the year, averaged over a series of years.

Fluvial ~ Of, or pertaining to, rivers; produced by river action, as a fluvial plain.

Geology ~ The science that deals with the physical history of the earth.

Geologic/geomorphic processes ~ The actions or events that shape and control the distribution of materials, their states, and their morphology, within the interior and on the surface of the earth. Examples of geologic processes include: volcanism, glaciation, streamflow, metamorphism (partial melting of rocks), and landsliding.

Geomorphology ~ The geologic study of the shape and evolution of the earth's landforms.

Igneous ~ Rocks formed by molten lava becoming solid. Basalt is an igneous rock.

Fuel ladder ~ Vegetative structures or conditions such as low-growing tree branches, shrubs, or smaller trees that allow fire to move vertically from a surface fire to a crown fire.

Metamorphic ~ Rocks formed in response to pronounced changes of temperature, pressure, and chemical environment.

Microbiotic (crust) ~ Thin crust of living organisms on the soil, composed of lichens, mosses, algae, fungi, cyanobacteria, and bacteria. These crusts play a role in nutrient cycling, soil stability and moisture, and interactions with vascular plants.

Physiography ~ Pertaining to the study of the formation and evolution of landforms.

Soils ~ The earth material which has been so modified and acted upon by physical, chemical, and biological agents that it will support rooted plants.

Soil productivity ~ (1) Soil productivity: the capacity of a soil to produce plant growth, due to the soil's chemical, physical, and biological properties (such as depth, temperature, water-holding capacity, and mineral, nutrient, and organic matter content). (2) Vegetative productivity: the total quantity of organic material produced within a given period by organisms. (3) General: the innate capacity of an environment to support plant and animal life over time.

Tectonic ~ Relating to, causing, or resulting from structured deformation in the earth's crust.

Till ~ Nonsorted, nonstratified sediment carried or deposited by a glacier.

Introduction

Geology, geologic processes, and climate form the physiographic framework in which ecologic processes operate. For the most part, geologic and climatologic conditions, processes, and disturbances cannot be modified by management activities. Watershed, soil, and atmospheric conditions and processes, also part of the physiographic setting, can and have been

significantly modified by management activities. All of these elements, whether they can be affected by management activities or not, must be accounted for when designing management strategies that will have a high likelihood of achieving desired outcomes.

The material presented here focuses on those geologic, soil, climatologic, and air quality issues that are relevant for regional- and subregional-level ecosystem management. Much of the

information forming the basis of this section is derived from the *Landscape Dynamics* (Hann et al. 1996) and *Aquatics* (Lee et al. 1996) chapters of the *Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins* (AEC; Quigley and Arbelbide 1996b), reports of the *Eastside Forest Ecosystem Health Assessment* (Everett [ed.] 1994), and additional sources as cited. Consult these reports for more detailed information.

Geology and Physiography

The present geology and physiography of the project area is the culmination of millions of years of geologic, climatologic, and ecologic processes. This legacy has provided the template for current ecologic conditions and has shaped and directed human uses of the varied terrains and resources within the project area.

Geologic Processes, Functions, and Patterns

At the regional scale (project area) and subregional scale (Ecological Reporting Units), geology, physiography, and topography are controlled by the past 1.5 billion years of plate tectonics, volcanoes, glaciers, and the resultant weathering, erosion, and sedimentation processes. Physiography in the project area is shown on Map 2-2. It is the history and interaction of these processes that have resulted in present locations of mountain ranges, large river courses, watershed divides, and rock types exposed at the surface. These geologic and physiographic attributes exert considerable influence over climate, hydrology, and drainage pattern development. At the local scale (6th-field Hydrologic Unit Code or smaller; see Table 2-3), primarily processes during the Pleistocene ice ages (the last 1.6 million years) have influenced surface topography and soils. At the finest scale of channels and hillslopes, physiography is controlled primarily by recent (the last 10,000 years) and present geomorphic processes and disturbances, such as floods, landslides, and volcanoes. The diversity of geologic environments, along with active tectonic, volcanic, and glacial processes, has been a controlling influence on the evolution and distribution of ecologic systems, including patterns of human development and use.

The physiographic environment also dictates ecologic potential and management options. For example, glaciated terrain commonly has steep slopes covered with soil and glacial sediments susceptible to erosion; areas near volcanoes such as the former Mt. Mazama (Crater Lake) and Glacier Peak, commonly have thick, ash-rich soils that are highly productive, but susceptible to compaction.

Erosion, sediment transport, and deposition are the geologic processes most relevant in day-to-day management of ecosystems in the project area. Moreover, the rates at which erosion, sediment transport, and deposition are now increasing have been significantly affected by human activities. Detailed discussion of these processes are in the Aquatic Ecosystems section, because they are better viewed in the context of overall watershed processes.

Geology of Ecological Reporting Units

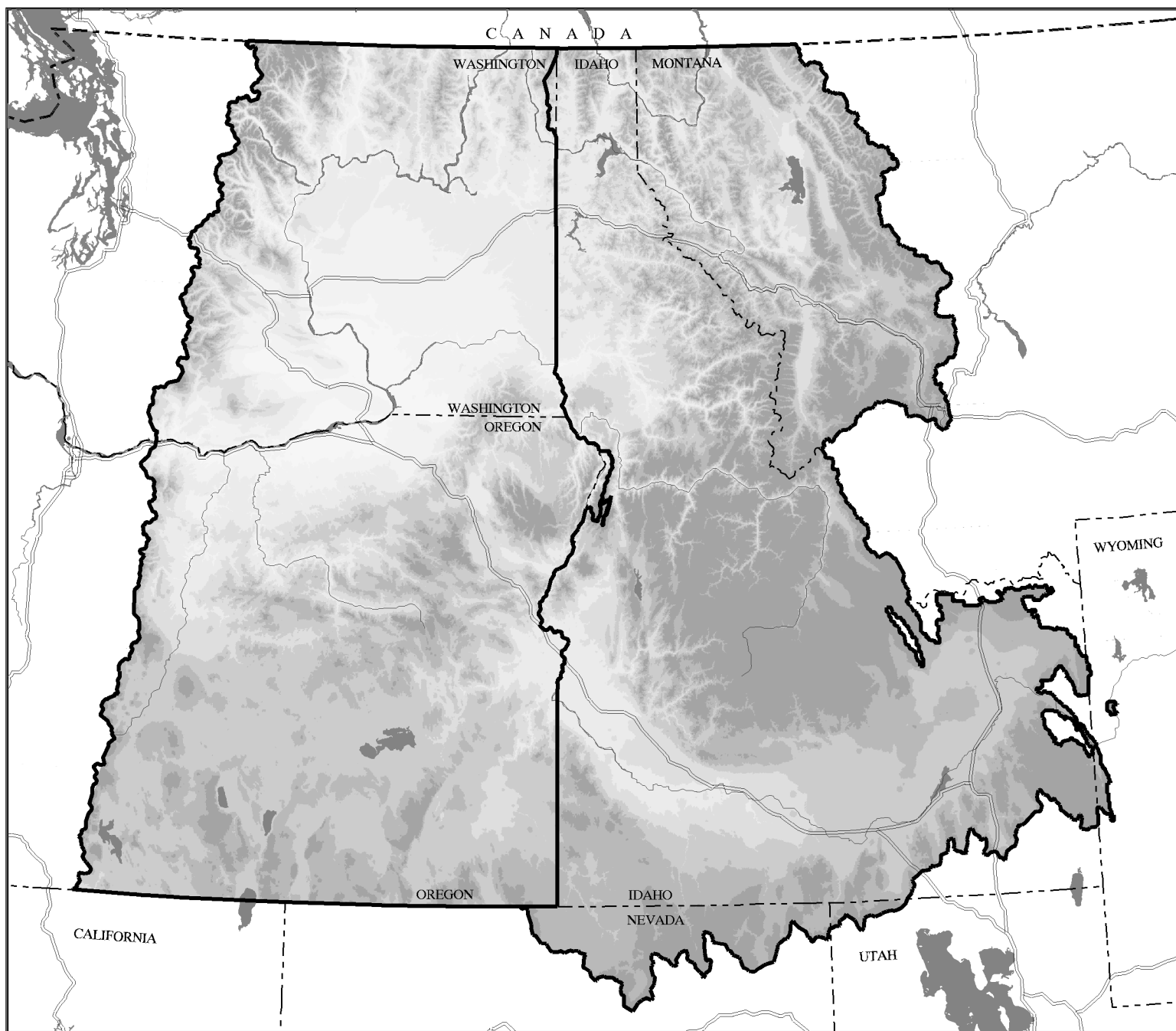
Geology of the entire project area is summarized in the *Landscape Dynamics* (Hann et al. 1996) chapter of the AEC, so only brief descriptions are provided here by Ecological Reporting Unit (ERU). The geologic time scale in Figure 2-2 lists the geologic time periods used in the following descriptions, as well as some of the geologic processes that were occurring during those periods.

Northern Cascades (ERU 1)

The northern part of the Cascade Range is dominated by a spine of young, glaciated volcanoes. Volcanic rocks overlie metamorphic and igneous rocks north of Snoqualmie Pass in central Washington. The Northern Cascades ERU was extensively glaciated during the Pleistocene age by mountain and valley glaciers, and north of Lake Chelan by the Cordilleran ice sheet that invaded south from Canada, resulting in steep alpine valleys and ridges rising above large river valleys. Soils in the Northern Cascades contain large amounts of ash from eruptions of Glacier Peak approximately 11,000 years ago.

Southern Cascades and Upper Klamath (ERUs 2 and 3)

Broad-scale geologic/physiographic features include the chain of High Cascade volcanoes that taper eastward to volcanic and sedimentary plateaus. During the Pleistocene age, extensive

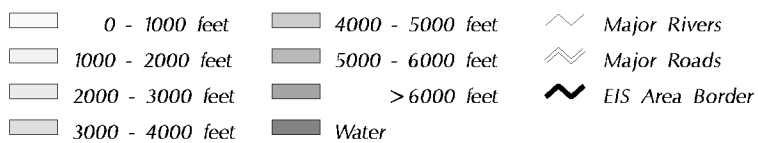


**Map 2-2.
Topography**



INTERIOR COLUMBIA
BASIN ECOSYSTEM
MANAGEMENT PROJECT

Project Area
1996



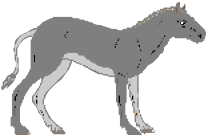
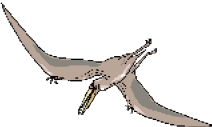
Absolute Age (millions of years)	Era	Period	Epoch	Life Forms	Major Events
1.6	Cenozoic 	Quaternary	Recent or Holocene	Spread of modern humans Extinction of many large mammals and birds <i>Homo Erectus</i> Large carnivores Earliest hominid fossils (3.4 - 3.8 million years ago) 	Eruption of volcanoes in the Cascades Worldwide glaciation Fluctuating cold to mild in the "Ice Age" Uplift of the Sierra Nevada Linking of North and South America Beginning of the Cascade volcanic arc Beginning of Antarctic ice caps Volcanic activity in Yellowstone region and Rockies 
66.4			Pleistocene	Whales and apes Large browsing mammals; monkey-like primates; flowering plants begin Primitive horse and camel; giant birds; formation of grasslands Early primates Extinction of dinosaurs and many other species (65 million years ago)	
245	Mesozoic			Placental mammals appear (90 million years ago) Early flowering plants Flying reptiles Early birds and mammals First dinosaurs 	Formation of Rocky Mountains Opening of Atlantic Ocean
570	Paleozoic			Variety of insects First amphibians First reptiles First forests (evergreens) Early land plants Invertebrates dominant First primitive fishes Multi celled organisms diversify Early shelled organisms 	
-4600	Precambrian			First multi celled organisms Early bacteria and algae Origin of life? 	Formation of early supercontinent (-1.5 billion years ago) Primitive atmosphere begins to form (accumulation of free oxygen) Earth begins to cool Oldest known rocks on Earth (-3.96 billion years ago) Oldest moon rocks (-4 billion years ago) (-4 to -4.6 billion years ago) Earth's crust being formed
Formation of the Earth					

Figure 2-2. Geologic Time Scale

valley glaciers advanced from ice caps that formed on higher terrains, carving glacial valleys and locally depositing glacial sediment. Parts of the Southern Cascades and Upper Klamath ERUs have a thick cover of pumice and ash from the eruption of Mt. Mazama 7,000 years ago. The Crater Lake area is the present remnant of Mt. Mazama.

Northern Great Basin (ERU 4)

The topography and geology of the northern Great Basin is dominated by north- to south-oriented block-faulted ranges of Tertiary age volcanic and intrusive igneous rocks, separated by alluvial deposits, playas (shallow lakes), and marshes. Recent and continued uplift of these mountain ranges has resulted in the present complex of wetlands and closed basins filled with alluvium (river) and lacustrine (lake) sediment. These basins presently contain Lake Abert, the Warner Lakes, Harney-Malheur Lakes, and Alvord Lake. During the Pleistocene age, many of these now-isolated, ephemeral lake bodies were connected into larger freshwater lake systems.

Columbia Plateau (ERU 5)

Thick sequences of Tertiary age basalt flows are locally covered by late-Tertiary and Quaternary sediment. During the ice ages of the Pleistocene, the region was covered with windblown sediment, known as loess. Loess makes up the Palouse Hills and covers most of the upland surfaces. Rivers swollen with glacial meltwater and large Pleistocene floods inundated much of the Columbia Plateau, cutting into the basalt surfaces and forming the cliff-bounded valleys that contain the Columbia, lower Snake, and Deschutes rivers.

Blue Mountains (ERU 6)

The Blue Mountains are composed of a diverse suite of uplifted rocks, including Paleozoic, Mesozoic, and Tertiary age sedimentary and igneous rock types. Higher mountains, such as the Seven Devils, Wallowa, and Elkhorn mountain ranges, were shaped by alpine glaciers during the Pleistocene age.

Northern Glaciated Mountains (ERU 7)

The mountains across the northern part of the project area are underlain by a complex assemblage of Precambrian to Tertiary age metamorphic, igneous, and sedimentary rocks. These rocks have been folded and faulted,

resulting in broad, northwest trending ranges, commonly separated by wide downwarps such as the Okanogan and Spokane valleys. The Northern Glaciated Mountains ERU was extensively glaciated during the Pleistocene, resulting in unconsolidated glacial till covering many hillslopes, and thick fills and terraces of glacial outwash in the river valleys. During the Pleistocene, Lake Missoula was glacially dammed and inundated the valleys in the area to an elevation of 4,600 feet. This resulted in accumulations of fine-grained and unconsolidated lacustrine (lake) sediment in many valley bottoms.

Owyhee Uplands (ERU 10)

The Owyhee Uplands ERU is composed of two distinct physiographic provinces~ the western Snake River Plain and the Owyhee Uplands. The western Snake River Plain is a structural depression that has been filled with horizontal sheets of Tertiary age basaltic lava flows that are interbedded with fluvial and lacustrine sediment. Aside from the canyon of the Snake River, there is little relief on the surface except for small shield volcanoes, volcanic buttes, and lava flows. The surface is covered with loess, and alluvial sand and gravel from surrounding mountains. Southwest of the Snake River, the Owyhee Uplands is a partly dissected and folded plateau, underlain by Tertiary volcanic rocks, and covered with alluvial silt, sand, and gravel.

Soils and Soil Productivity

Summary of Conditions and Trends

- ◆ Soil productivity across the project area is generally stable to declining. Determination of the exact status of soil condition for any given area is difficult because of a lack of inventory and monitoring data. Generally, greater declines in soil quality and productivity are associated with greater intensities of vegetation management, roading, and livestock grazing.
- ◆ Soil organic matter and coarse wood (woody material larger than three inches) have been lost or have decreased as a result of displacement and removal of soils, and removal of whole trees and branches.

- ◆ There has been a loss of soil material from direct displacement of soils, as well as from surface and mass erosion. Erosion can result from changed water runoff patterns from increased bare soil exposure, compaction, and concentration of water from roads.
- ◆ Changes in the physical properties of soils have occurred in conjunction with activities that increase bulk density through compaction. These changes have largely resulted in impaired soil processes and function, such as decreased porosity and infiltration, and increased surface erosion.
- ◆ In rangeland soils, the function and development of microbiotic crusts have been reduced in areas where surface-disturbing activities have been high. Microbiotic crusts provide soil stability and retention, and are essential for nutrient availability and cycling.
- ◆ Sustainability of soil ecosystem function and process is at risk in areas where redistribution of nutrients in terrestrial ecosystems has resulted from changes in vegetation composition and pattern, removal of the larger sized wood component, and risk of uncharacteristic fire.
- ◆ Floodplain and riparian area soils have a reduced ability to store and regulate chemicals and water in areas where riparian vegetation has been reduced or removed, or where soil loss associated with roading in riparian areas has occurred. In these areas, water quantity may be reduced during low flows, and water quality may have less buffer from pollution.

Soils are an ecologically rich and active zone at the interface between geologic materials and the atmosphere. Most soils in the planning area are young and thin, and critical soil processes, such as nutrient cycling, infiltration and percolation occur in the upper few inches or feet. Soil-forming and soil-recovery processes are slow; therefore, disruption of soils can lead to long-term changes in ecologic conditions, including biologic and hydrologic processes. Much of the following material is summarized from the *Landscape Dynamics* (Hann et al. 1996) chapter of the AEC, Harvey et al. (1994), and Henjum et al. (1994).

Soil Processes, Functions, and Patterns

Geology and geologic processes, topography, climate, plants, animals, and organisms all interact over time to form soils. Soils are critical regulators of biologic productivity, hydrologic response, and site stability. Vegetation anchors soils and contains mineral nutrients and water required for plant growth. Soils also contain a vast variety of microorganisms that promote decomposition of organic material, such as leaves, twigs, and large wood. This decomposition process is a critical link in the nutrient cycling process, especially for critical plant nutrients such as carbon, nitrogen, potassium, phosphorous, and sulfur (see Figures 2-3 and 2-4). The diverse geology and climate of the planning area, in conjunction with natural and human disturbance, has resulted in a spatially complex pattern of soils that differ in appearance, function, and response to management activities.

Most soils in the planning area have formed since the last ice age, and are composed of several horizons, or layers. At the surface, there is commonly a thin (generally less than two inches), and sometimes discontinuous cover of decaying organic matter, such as leaves and twigs. Under this cover of litter and duff is a layer (less than a few inches) of dark, highly decomposed organic matter (humus) which covers a mineral layer of up to several feet thick. This mineral layer may contain organic matter, clay minerals, calcium carbonate, and other salts that are transported down the soil column by percolation or burrowing activities. In general, forested environments have more continuous and thicker layers of organic matter than rangeland environments, but the thickness and amount of organic material varies considerably depending on local vegetation characteristics, climate, relief, and disturbance history (including human uses and fire). These soil horizons together cover weathered and unweathered parent materials, such as bedrock or old stream gravel. Volcanic material is a major component of many soils in the area.

Physical properties of soils, such as bulk density (dry weight per unit volume), porosity, texture, hydrologic conductivity, soil depth, and mineral content, are all factors controlling hydrologic response, water-holding capacity, and surface stability. Soil water-holding capacity is a critical factor in the planning area where growing season

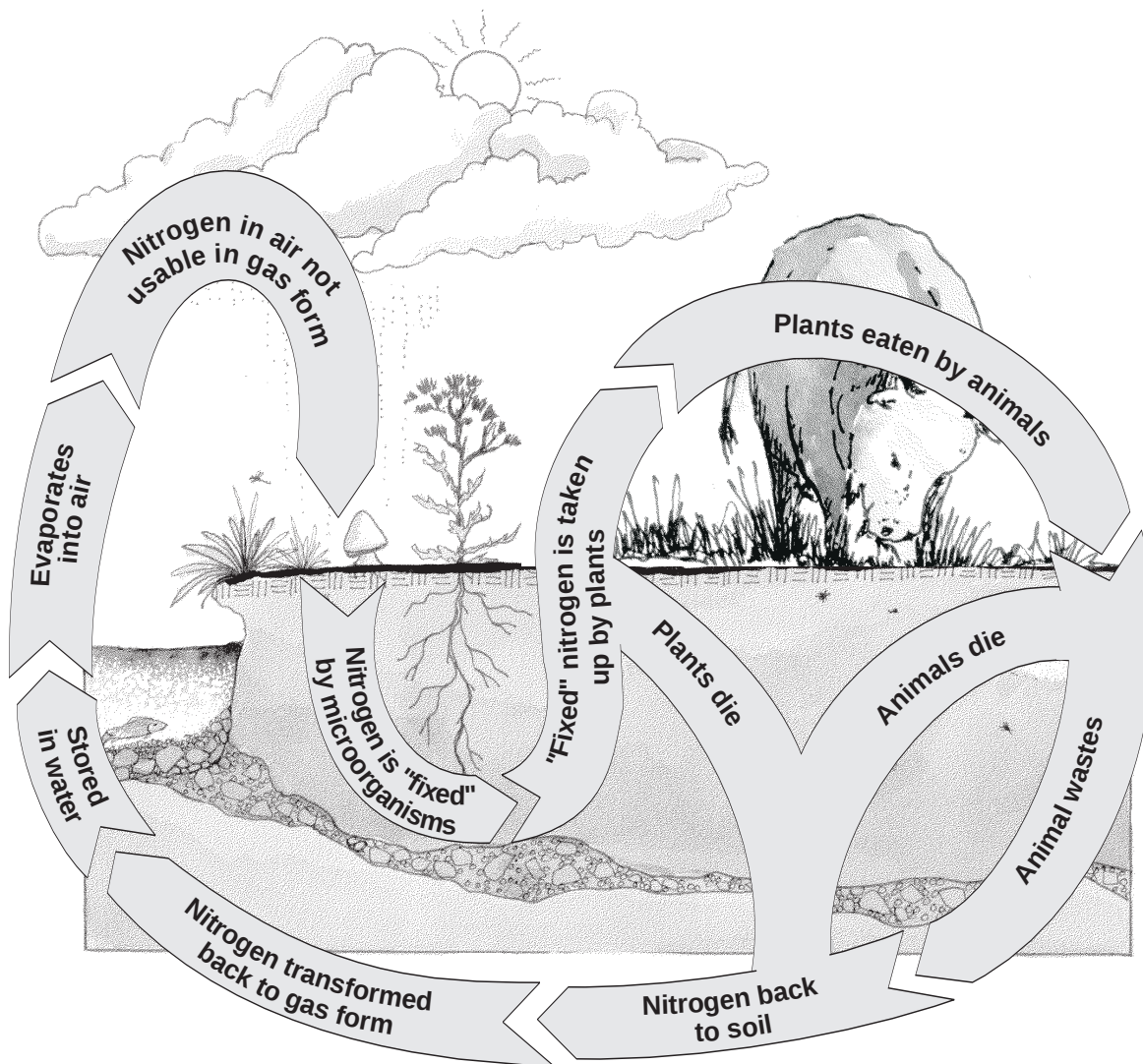


Figure 2-3. Nitrogen Cycle ~ Nitrogen is essential for life. Roughly 80 percent of the earth's atmosphere is made up of gaseous nitrogen, which is a form that can be used by a few bacteria, but cannot be used by animals. Animals, however, need nitrogen, because nitrogen is the building block for amino acids and proteins in their bodies. The process of converting the gaseous nitrogen to amino acids and proteins, in plant and animal bodies, and back to gaseous nitrogen, is called the nitrogen cycle. The nitrogen cycle depends upon microorganisms, such as blue-green algae and various kinds of soil bacteria, to (1) "fix" the gaseous nitrogen in the atmosphere, and convert it to organic nitrogen compounds, like amino acids, (2) convert the organic nitrogen to inorganic nitrogen: for example, ammonium, nitrites, and nitrates, of which nitrates is a form that can be taken up by plants, and (3) convert the inorganic nitrogen back to gaseous nitrogen. Without these microorganisms, and the soil in which they live, we would not be able to survive.

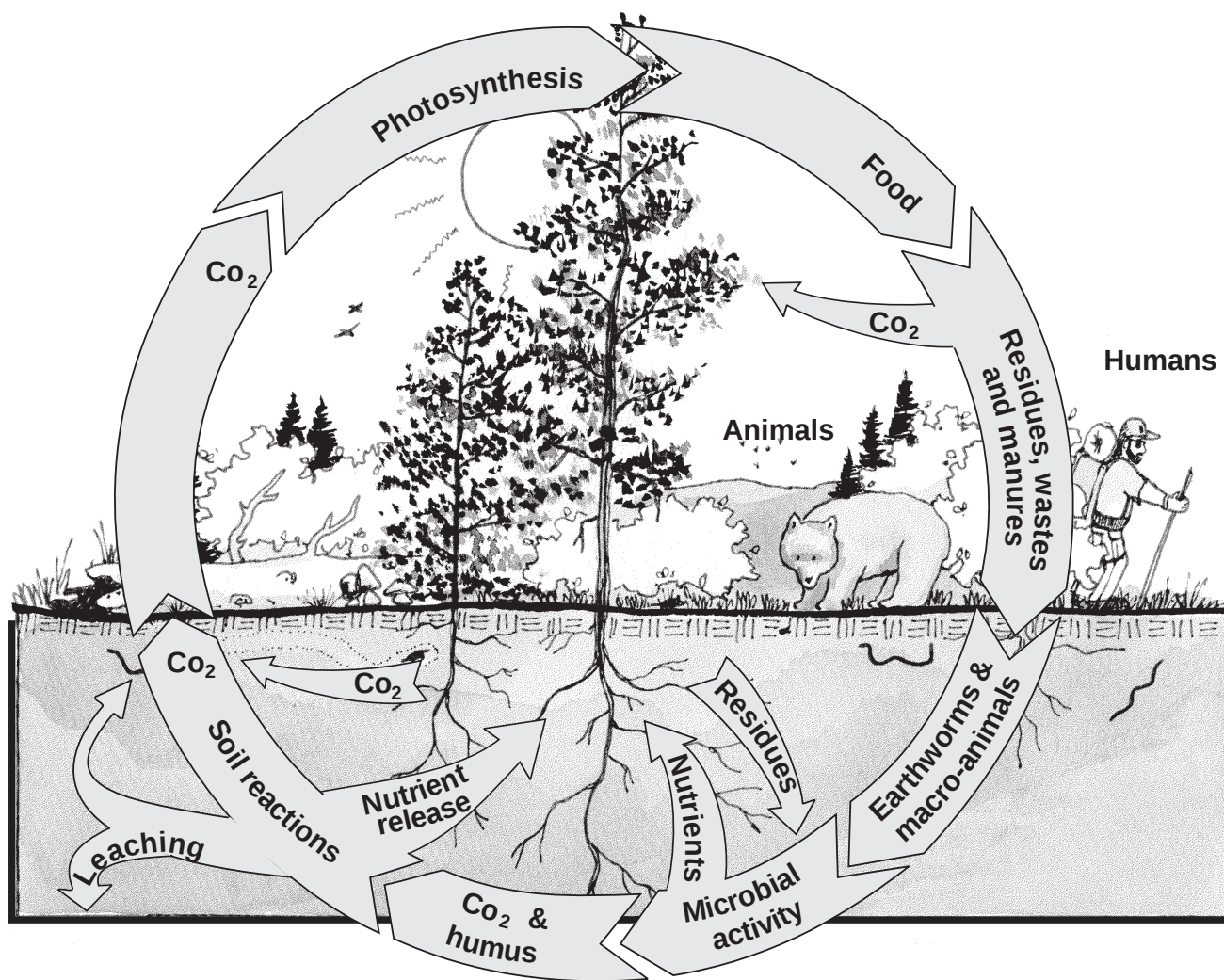


Figure 2-4. Carbon Cycle ~ Carbon is one of the main elements that forms the tissue of organisms and as such, is required for life. Energy flow (see Figure 2-10) through the earth's ecosystems is interrelated with the flow of carbon through ecosystems, because carbon is such an integral element of plant and animal tissue. Whereas roughly 80 percent of the earth's atmosphere is composed of gaseous nitrogen (see Figure 2-3), only roughly 0.04 percent of the earth's atmosphere is composed of carbon dioxide. This carbon dioxide is critical for life on earth because plants extract it from the atmosphere by photosynthesis and incorporate it into formation of plant tissue. Carbon dioxide is returned back to the atmosphere through (1) respiration by plants and animals, and (2) bacteria and fungi which decompose dead plant and animal bodies and convert the carbon in the bodies to carbon dioxide.

precipitation is low. Soils with high organic matter contents generally have high porosities and high water-storage capacities. Soils with high volcanic pumice and ash contents generally also have high porosities and high water-storage capacity, but are susceptible to compaction.

The physical properties of soils can be significantly altered by disturbances such as erosion and compaction. Soil compaction results from concentrated activity, including use of heavy equipment, vehicles, pedestrian activity, and improper livestock grazing. Where soils are compacted, porosity, permeability, and hydrologic conductivity are reduced, resulting in altered runoff patterns and increased surface erosion. Natural recovery of surface compaction can take 50 to 200 years, depending on the soil type, degree of compaction, frequency of freeze-thaw cycles, and input of organic matter.

Soil biological properties also affect productivity. Soil is a reservoir of fungal spores and other organisms important for decomposition and nutrient cycling. These organisms and their interactions affect forest site productivity through assimilation of nutrients, protection against pathogens, maintenance of soil structure, and buffering against moisture stress (Amaranthus and Trappe 1993). Erosion or removal of soil surface layers, where most microorganisms reside and where most of the critical nutrient cycling processes occur, can significantly affect productivity for several decades.

Organic matter, both above and below ground, is an important component for maintaining soil productivity. In general, the higher the total soil organic matter, the higher the site productivity. Throughout most of the planning area, decomposition of organic matter is often slow, leading to accumulations of surface organic matter. This accumulated litter and woody debris is potential fuel for wildfire, an important factor controlling soil conditions in forestlands and rangelands of the planning area, especially in drier environments where fire frequency is high (Harvey et al. 1994). The combined processes of biological decomposition and fire regulate nutrient availability and cycling.

Fire can substantially change surface soil characteristics and erosion rates, and can influence patterns of vegetation on the landscape. Fire can have consequences on soil productivity by consuming organic matter and

vegetation. Nutrients, such as nitrogen, can be evaporated by fire, resulting in an immediate loss of soil productivity as well as limiting future inputs of nutrients. However, nutrients are also made available by fire, especially by converting large woody debris into smaller, more readily decomposed material (DeBano 1990). Forests in the inland west are dependent on a combination of biological and fire decomposition processes to regulate nutrient availability and cycling (Harvey et al. 1994).

Fire can also affect soil productivity by creating bare soil or hydrophobic (water-repelling) conditions that alter infiltration, runoff, and erosion processes. In general, the more soil heating that occurs, the greater the potential for water repellency. Dry, coarse textured soils are most susceptible to hydrophobicity, especially after high intensity fires.

Current Conditions

Overall, soil conditions in the planning area are stable or declining, depending on past levels of management activity. Soil conditions are generally stable in wildernesses, but are decreasing in intensively managed areas. In general, decreases in soil productivity are associated with soil erosion and removal, loss of soil organic matter, changes in vegetation composition, removal of whole trees and branches, and increased bulk density from soil compaction.

Human-caused changes in fire frequency have also affected soil organic matter. Where humans have effectively put out wildfires for the last several decades, the present content of the soil organic matter is typically higher than it was historically, resulting in greater productivity. More above-ground vegetation, however, now renders many of these sites at risk to more intense fires, which can lead to long-term reduction in soil organic matter and soil fertility because of excessive evaporation of important nutrients such as nitrogen and potassium (Harvey et al. 1994).

Soils of Ecological Reporting Units

General soil characteristics for the planning area are summarized from Bailey et al. (1984) and the General Soils Map of Oregon (USDA 1964).

Northern Cascades and Southern Cascades (ERUs 1 and 2)

Soils east of the Cascade Range are generally cold and stony. They are influenced by volcanic ash, and some have low bulk density, high organic-matter content, and high clay content. Soils in these ERUs are usually dry for a significant time during the summer. Soils in the Northern Cascades ERU have been significantly influenced by volcanic ash from Glacier Peak and other Washington Cascade Range volcanoes. Soils in the Southern Cascades ERU commonly have thick accumulations of pumice and ash from the eruption of Mt. Mazama.

Upper Klamath (ERU 3)

Soils in the upper Klamath Basin generally consist of cold, dry soils on pumice-covered plateaus, with organic-matter-rich surface layers. Soils in basins and valley floors are wet, and cool or cold. Soils on floodplains and terraces, and in grass-shrubland environments are generally warm and dry, commonly with dark-colored surface layers and high organic-matter contents. Soils in grass-shrubland environments are generally shallow with high organic-matter contents in surface layers and subsurface clay accumulations.

Northern Great Basin (ERU 4)

Northern Great Basin soils are typically cool-to-warm and dry, and have low organic-matter contents. Soil horizons are commonly the result of movement and accumulation of salts, carbonates, and silicate clays, locally resulting in caliche layers (hardpan). Large areas of low precipitation have saline-sodic soils.

Columbia Plateau (ERU 5)

Soils in the Columbia Basin and Palouse area have primarily formed with thick accumulations of silt and sand (loess) deposited by ice-age winds. Generally these soils are warm and dry, with thin, dark organic horizons (layers) over clay and carbonate-enriched lower horizons.

Blue Mountains (ERU 6)

Most soils in the Blue Mountains are influenced by volcanic ash from Mount Mazama. The ash layer is relatively undisturbed on gentle and forested north slopes. On south-facing slopes,

the ash has been mostly removed by erosion, and redeposited and mixed with loess and alluvium in valley bottoms and lake basins. At high altitudes, soils are generally cold and moist, dark-colored, and have high organic-matter contents. At lower altitudes, soils are generally cool and moist, with thick ash layers and high clay contents. On the lowest mountain slopes and valley floors, soils are dry for parts or most of the summer.

Northern Glaciated Mountains (ERU 7)

Soil conditions range from cold and stony soils in the higher mountains to warm and dry soils within the major valleys. Further east, away from the Cascade Range, the volcanic ash content is less and soils are generally less productive. Steep slopes covered with glacial deposits are susceptible to erosion.

Owyhee Uplands (ERU 10)

Soils in the Owyhee Uplands ERU are generally warm and dry, with moisture being a significant limiting factor to plant growth. In wetter riparian and wetland areas, organic matter content is higher and soil productivity is greater. Some areas of low precipitation have saline or sodic soils.

Climate

The varied topography and geographic position of the planning area, relative to global ocean and atmospheric circulation patterns, result in very different climates throughout. The climate, in turn, strongly influences ecologic processes such as biologic productivity, fire regime, soils, streamflow, erosion, and human uses of the land and resources.

Precipitation and Temperature

Most precipitation in the planning area falls in the winter when eastward moving storms enter the area. Typically, more than 80 percent of the annual precipitation falls from October to May. Expansion of the North Pacific high pressure system in the early summer effectively blocks the flow of moisture into the Pacific Northwest, resulting in generally stable, warm, and dry summers. The most profound influence on precipitation patterns is the Cascade Range, which causes a significant rain-shadow effect in

eastern Oregon and Washington. The Cascade Range separates eastern Oregon and Washington from the maritime climate west of it, leaving the interior Columbia River Basin with a continental climate of cold winters and warm, dry summers. The Columbia River Gorge, which has a climate uniquely influenced by interaction of air masses between the east and west sides of the Cascade Range, is home to unique assemblages of plant and animal fauna.

Average annual precipitation ranges from more than 100 inches per year at the crest of the Cascade Range to less than 8 inches per year in the low-elevation basins and plains (see Map 2-3). Substantial portions of the planning area, especially in the rangelands, receive less than 12 inches of precipitation per year. In these areas, recovery of vegetation and soil from human and natural disturbance takes place much more slowly than in areas with greater rainfall. The greatest amount of precipitation is in the mountain ranges, notably the Cascade Range and the Blue Mountains. Most precipitation falls during winter and accumulates as snow, with mean annual snowfall of 100 to 200 inches along the crest of the Cascade Range and in the Blue Mountains. Spring, summer, and fall storms provide growing season rainfall in the mountains.

The planning area experiences a wide range of temperature variation. High mountainous areas have cold winters and short, cool summers with growing seasons that are locally less than 30 days in the highest alpine areas. Intermontane valleys and plateaus have cool to cold winters and hot summers, resulting in growing seasons that exceed 150 to 200 days in parts of the Columbia Plateau (ERU 5).

Drought

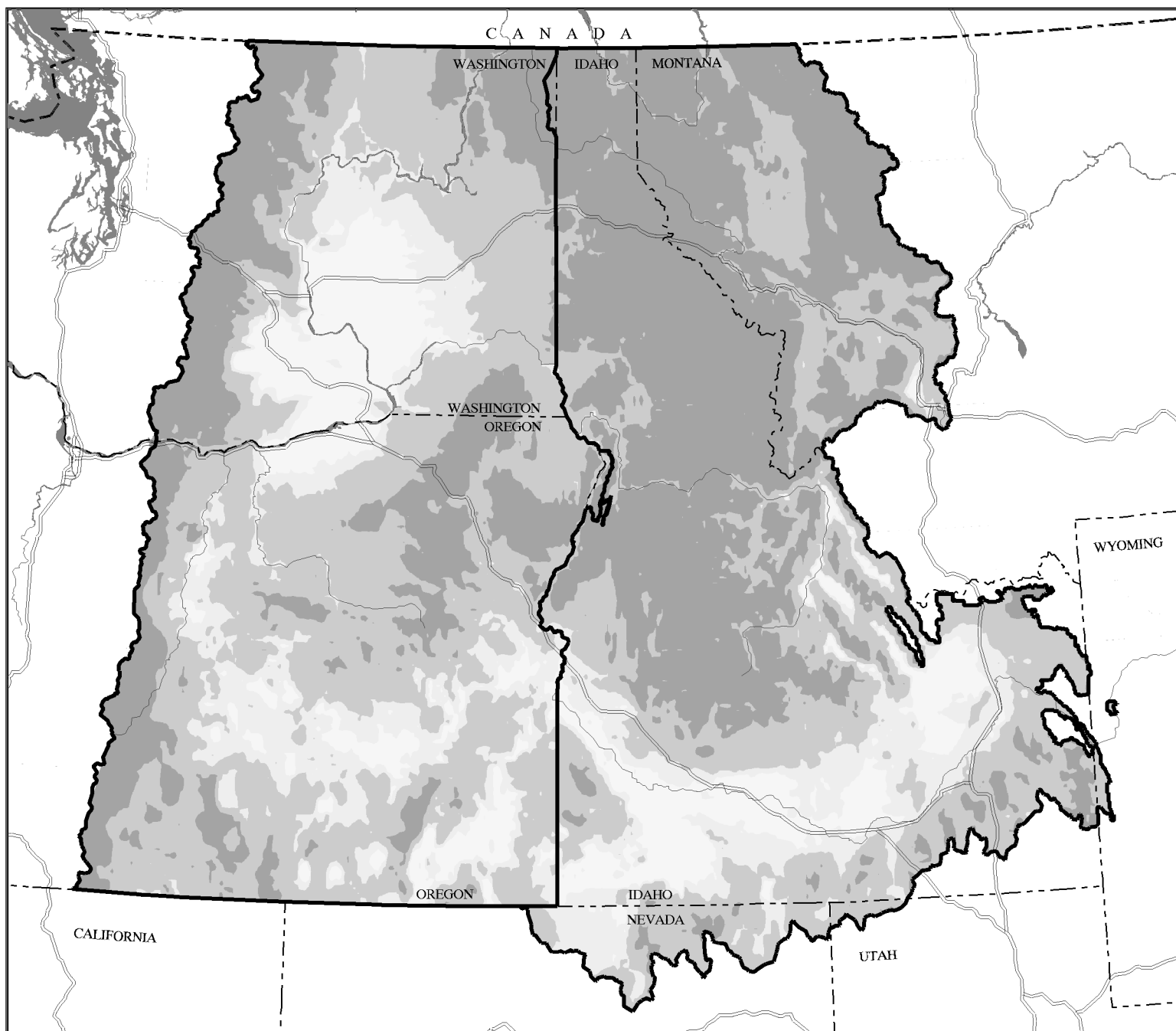
Drought and climate change are important processes that affect ecosystems. Drought is defined as an absence of usual precipitation (less than 80 percent of normal) for a long enough period that there is decreased soil moisture and stream flow, thereby affecting ecologic processes and human activities. All regions experience temporary, irregularly-recurring drought conditions, but dry climates are generally affected most (Barry and Chorley 1982). Year-to-year climate variability generally increases with aridity. In areas with average annual precipitation of less than 12 inches, drought years occur 20 to 40 percent of the time.

Drought affects fire and rangeland management. Dry years, such as 1988 and 1994, commonly result in widespread wildfire in forested environments, especially if there have been several preceding dry years. In the past, wildfires have required considerable resources to control, and have led to significant ecologic consequences. Drought significantly reduces forage production on rangelands, which can lead to degradation of upland and riparian areas if livestock grazing is not properly managed (Vallentine 1990). Drought can also increase the susceptibility of forestlands to insect infestation. The regional drought of 1920 to 1940 in the Pacific Northwest created substantial insect infestation problems, particularly for pine species (Agee 1994).

Climate Change

Climate change has been prevalent throughout history in the planning area, resulting in continuing adjustments by aquatic (water) and terrestrial (land) ecosystems. Changes in temperature and precipitation have direct effects, such as on efficiency of photosynthesis and length of growing season, and also indirect effects, such as changes in fire and flood frequency. Past climate changes have ranged from global-scale changes, such as the transition between glacial and interglacial periods approximately 10,000 years ago, which resulted in about a 10° Fahrenheit increase in mean annual temperature; to smaller, yet still significant, changes, such as the period of generally cooler temperatures that began approximately 4,000 years ago and culminated in the Little Ice Age of the 1700s and early 1800s. Over the last several decades in the Pacific Northwest and globally, there has been significant warming (1 to 3° Fahrenheit) that some scientists have attributed to increased carbon dioxide emissions and the “greenhouse effect.”

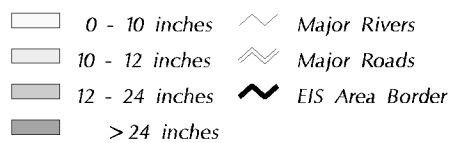
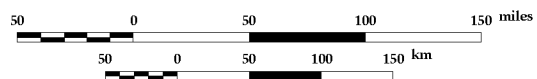
Vegetation is especially sensitive to climate change. Upper and lower forest boundaries in the planning area have moved up and down in elevation by hundreds of feet during the last several centuries in response to temperature changes of 1 to 3° Fahrenheit (Mehring 1995, Neitzel et al. 1991). In general, plants on the fringes of their distributions respond most sensitively and rapidly to climate change. Within eastern Oregon and Washington, such changes are expected to continue to greatly influence the area and extent of vegetation types, especially changes



Map 2-3.
Annual Precipitation

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in altitude of the overlapping conifer and steppe communities (Mehring 1995). Vegetation responds to climate change in different directions and at different rates, reassembling in new and sometimes unpredictable associations that are constantly changing (Graham and Grimm 1990).

Air Quality

Summary of Conditions and Trends

- ♦ The current condition of air quality in the project area is considered good, relative to other areas of the country.
- ♦ Wildfires significantly affect the air resource. Current wildfires produce higher levels of smoke emissions than historically, because fuel available to be consumed by wildfire has increased.
- ♦ Within the project area, the current trend in prescribed fire use is expected to result in an increase of smoke emissions.

Presettlement Conditions

Air quality in the project area was not pristine before it was settled by Europeans in the 1800s. Layers of charcoal found in the Sheep Mountain bog near Missoula, Montana and the Williams Lake Fen north of Cheney, Washington provide evidence of wildland fire at varying intervals from 10,000 years ago to the present (Johnson et al. 1984). Fires from as long as 4,000 years ago are evident from charcoal found at Blue Lake, near Lewiston, Idaho. Several sites show significantly increased levels of charcoal starting approximately 1,000 years before present, attributed to burning by American Indians.

Many historical accounts refer to the presence of smoke and burned areas in the interior Columbia Basin, the Harney Basin, near the mouth of the Umatilla River, on the western slope of the Blue Mountains, and along the section of the Oregon Trail from the juncture of the Boise and Snake Rivers to the Columbia River (Robbins and Wolf 1994). Some accounts merely noted the presence of burned areas, while others attributed fire to

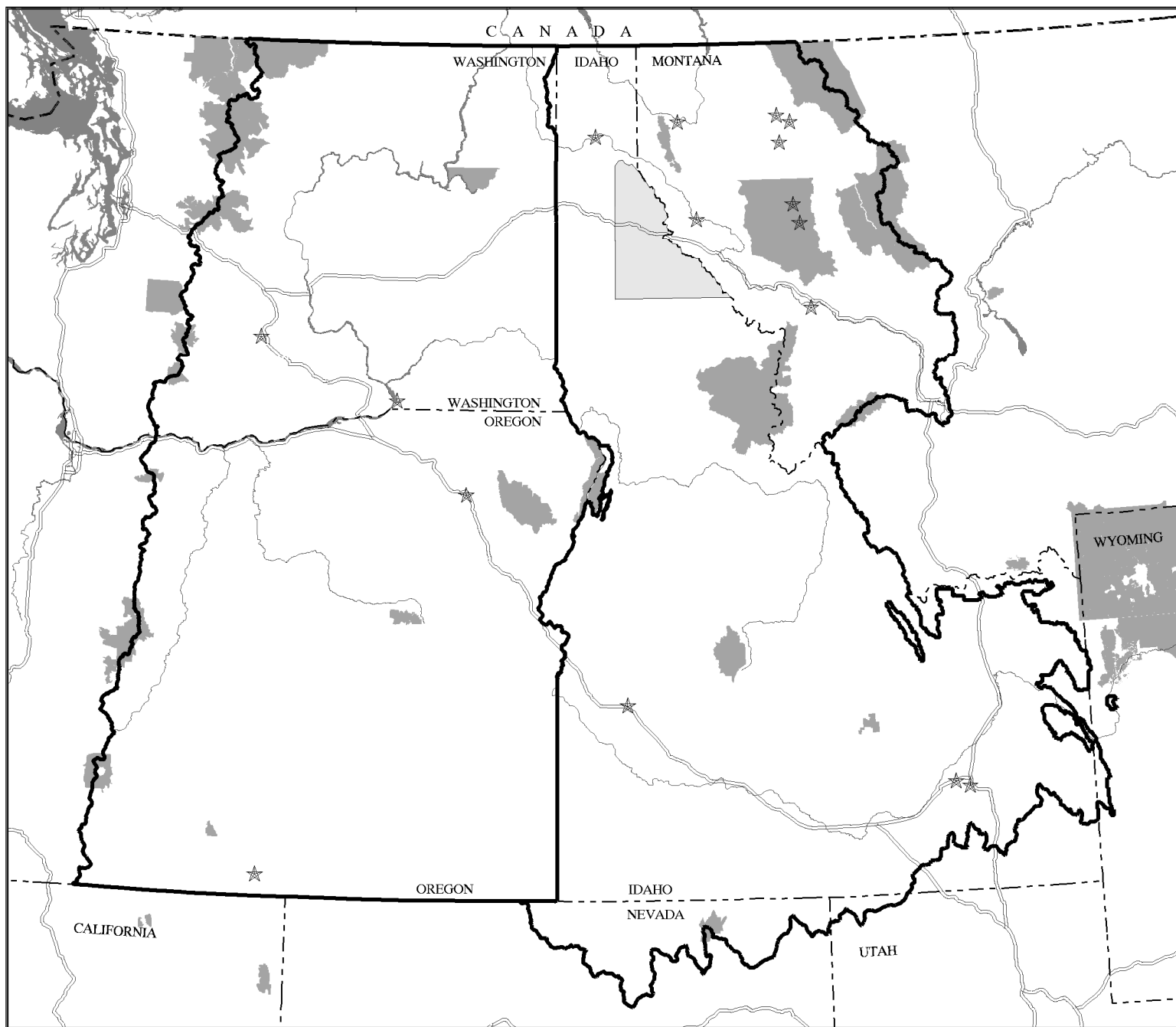
burning by American Indians (ibid.). Levels of smoke have declined as fire was excluded from forests, particularly after the advent of organized fire suppression in the 1930s. Brown and Bradshaw (1994) concluded that levels of smoke in the Bitterroot Valley, Montana were 1.3 times greater prior to settlement in the 1800s than they have been recently.

Fire return intervals for the Pacific Northwest have been documented in many publications; one of the most recent that gives an in-depth history is Agee (1993). Agee clearly demonstrates the role fire has played as a disturbance agent in the development of Pacific Northwest ecosystems. Over the past few centuries the average area burned per year for Oregon is 795,662 acres and in Washington 326,172 acres (Agee 1993).

Overview of the Clean Air Act

The Clean Air Act, passed in 1955 by the Congress and amended several times, is the primary legal instrument for air resource management. The Clean Air Act required the Environmental Protection Agency (EPA) to, among other things, identify and publish a list of common air pollutants that could endanger public health or welfare. These commonly encountered pollutants, referred to as "criteria pollutants," are listed by the EPA along with the results of studies documenting the health effects of various concentrations of each pollutant. For each criteria pollutant, the EPA has designated a concentration level above which the pollutant would endanger public health or welfare. These levels are called the National Ambient Air Quality Standards (NAAQSs).

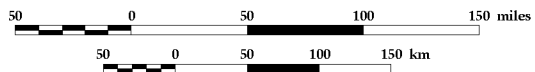
To date, NAAQSs have been established for six criteria pollutants: sulfur dioxide (SO₂), particulate matter (PM₁₀), carbon monoxide (CO), ozone (O₃), nitrogen oxides (NO_x), and lead (Pb). There are exceptions, but generally these standards are not to be violated anywhere that the public has free access to within the United States. If NAAQSs are violated in an area, the area is designated as a "non-attainment area," and the state is required to develop an implementation plan to bring it back into compliance with these standards. Non-attainment areas for PM₁₀ are shown on Map 2-4. To help protect air quality, Section 118 of the Clean Air Act requires federal agencies to comply with all federal, state, and local air pollution requirements.



Map 2-4.
Air Quality
Class I Airsheds and
PM10 Non-attainment Areas

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- Class One Airsheds
- PM10 Non-Attainment Areas (Counties)
- PM10 Non-Attainment Areas (Municipalities)
- Major Rivers
- Major Roads
- EIS Area Border

Pollutants such as oxides of nitrogen, sulfur, and ozone are a concern to federal land managers because of their potential to cause adverse effects on plant life, water quality, and visibility. However, the sources of these pollutants are generally associated with urbanization and industrialization, rather than with natural resource management activities. Therefore, these pollutants will not be considered in this EIS. On the other hand, particulates, carbon monoxide, and ozone are criteria pollutants that can be created by fire (wildfire and prescribed fire); these pollutants are discussed here. The pollutant of greatest concern for management activities in the planning area is particulate matter.

Three elements in the Clean Air Act generally apply to management activities that produce emissions in the planning area: (1) Protection of National Ambient Air Quality Standards (Section 109), (2) conformity with State Implementation Plans (Section 176(c)), and (3) protection of visibility in Class I areas (Section 169a).

Protection of National Ambient Air Quality Standards

Particulate matter produced by land management activities or natural events on federally-administered lands originates from wildfire, prescribed burning, road or wind-blown dust, volcanic eruptions, and vehicle use. However, most particulate matter of concern is produced from fire, and most of this is less than 10 microns (one millionth of a meter in diameter, PM₁₀)

Because fire and smoke are a natural part of forestland and rangeland ecosystems, PM₁₀ produced from fire does not significantly affect these ecosystems. However, they do have effects on human health. Particulates PM₁₀ can be drawn deep into the lungs, the part of the respiratory system most sensitive to chemical injury (Morgan 1989 in Sandberg and Dost 1990). Numerous studies have been conducted on human health implications of small particulates. It is known that individuals with respiratory disease are at serious risk when exposed to even low concentrations of particulates. The lung function of healthy children without respiratory disease is lowered when they live in areas with high particulate concentrations, as compared to children who live in areas with lower concentrations. Wood smoke also contains carcinogenic (cancer-causing) compounds, so chronic exposures to concentrations of wood smoke have effects similar to long-term cigarette smoking.

Ozone is a photochemical pollutant formed on warm sunny days from nitrogen dioxide and hydrocarbon emissions. The chemistry of ozone formation is poorly understood; however, it is known from measurements that ozone is present in the smoke plume downwind of large fires. It is also known, but very difficult to quantify, that organic emissions from vegetation are also ozone scavengers, so forested areas are both sources and sinks of ozone. The occurrence of fires is generally dispersed geographically and temporally (over time); therefore, ozone exposures resulting from fire are infrequent, even if plumes of smoke do not rise. Smoke plumes that do not rise are generally from low intensity fires with much lower emissions of ozone.

Although ozone is produced as a byproduct of wildland fire, because of fire frequency and smoke plume elevation, it is generally not a significant problem for human health or vegetation resources. It is also significant to note that fire is a natural event within forestland and rangeland areas. Therefore, to some extent, ozone produced by fire is also a natural event, and ecosystems have some natural adaptation to its effects.

Carbon monoxide is primarily generated by incomplete combustion of carbon. There have been few, if any, measured effects to the ecosystem from carbon monoxide. It is generated during wildland burning, but is rapidly diluted at short distances from a fire and, therefore, poses little or no risk to community health (Sandberg and Dost 1990). However, it can be a concern to firefighters on the fire line depending on concentration, duration, and level of activity. Carbon monoxide can cause headaches, fatigue, decreased concentration, impaired judgement and in high concentrations, death. Long-term exposure may also contribute to arteriosclerosis (hardening of the arteries), and increased risk of cardiovascular disease (Forest Service and John Hopkins University 1989).

Many other non-criteria, but potentially toxic, pollutants are emitted by wildland fire, including polynuclear aromatic hydrocarbons (sometimes referred to as PAHs) and aldehydes. Effects on human health vary by levels of exposure to these pollutants emitted during combustion. Some polynuclear aromatic hydrocarbons are known to be potential carcinogens; other components, such as aldehydes, are acute irritants. Many of these air toxins dissipate or bind with other chemicals soon after release, making it difficult to estimate

human exposure and consequential health effects. Additionally, the health and welfare effects of air toxics released by prescribed burning or wildfires have not been directly studied.

Conformity with State Implementation Plans

The Clean Air Act requires each state to develop, adopt, and implement a State Implementation Plan to ensure that the National Ambient Air Quality Standards (NAAQSs) are attained and maintained for the criteria pollutants. These plans must contain schedules for developing and implementing air quality programs and regulations. State Implementation Plans also contain additional regulations for non-attainment areas.

The general conformity provisions of the Clean Air Act (Section 176(c)), prohibit federal agencies from taking any action *within a non-attainment area* (emphasis added) that causes or contributes to a new violation of the National Ambient Air Quality Standards, increases the frequency or severity of an existing violation, or delays the timely attainment of a standard. As stated earlier, Section 118 specifically states that federal agencies must ensure that their actions conform to applicable State Implementation Plans.

The Environmental Protection Agency developed criteria and procedures for demonstrating and ensuring conformity of federal actions to State Implementation Plans. The EPA finalized these regulations in the Federal Register on November 30, 1993 (58 FR 63214). However, as written, they only apply to federal actions that occur within non-attainment areas, and, as of the printing of this EIS, no National Forests or BLM Districts in the planning area lie within non-attainment areas. Therefore, requirements of the conformity regulations do not apply to management actions proposed in this EIS; however, federal actions must still comply with State Implementation Plans.

Protection of Visibility in Class I Areas

The Congress, through the Clean Air Act, declared as a national goal “the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from manmade air pollution” (Section 169A). Class I areas include wildernesses 5,000 acres or larger and National Parks 6,000

acres or larger which were in existence prior to 1977 (Section 162(a)). Map 2-4 shows the federal Class I areas in the project area.

Class I areas are subject to the most limiting restrictions regarding how much additional pollution can be added to the air. To assure protection of visibility in Class I areas, the states of Oregon and Washington have adopted visibility protection plans as part of their State Implementation Plans, which dictate when and how much burning can take place.

Fine particulate matter, generally less than 2.5 microns in diameter, is the primary cause of visibility impairment. Prescribed burning emissions, which stay suspended for many miles, are in the 0.1 to 2.5 micron size class, and can be expected to reduce visibility.

Visibility has been monitored and documented for many of the Class I areas in Oregon and Washington from 1983 to 1992 (Boutcher 1994). A review of this study shows that visibility has improved in and around Class I wildernesses west of the Cascades, and has remained stable east of the Cascades (see Table 2-4). This can be attributed to a reduction in prescribed burning and to Oregon and Washington State Implementation Plans.

Results of a 1990 National Park Service study of visibility in National Parks and wildernesses in the Washington Cascade Range (Malm et al. 1994) indicated that burning vegetation contributed approximately 17 percent of the impairment, with 53 percent from sulfates, 9 percent from nitrates, and 20 percent from soil and other causes. These parks are on the western edge of the planning area, but information on particle composition and source regions is relevant because these fine particles are transported over long distances. It is logical to expect that emissions from land management activities would cover a larger portion of the planning area because of lower industrial and urban emissions, when compared to the Puget Sound emissions that impacted the National Park Service study area.

Managing Emissions From Prescribed Fire

Under the Clean Air Act, state and local governments have the authority to adopt their own air quality rules and regulations. These rules are incorporated into their State

Implementation Plans if they are equal to, or more protective than, federal requirements. For example, some states have incorporated smoke management provisions for prescribed burning into their State Implementation Plans. As stated earlier, to help protect air quality, the Clean Air Act requires federal agencies to comply with all federal, state, and local air pollution requirements which include state-enacted visibility protection and smoke management programs. Oregon and Washington have officially adopted smoke management programs into their State Implementation Plans.

Tracking Emissions

An emissions information system is used by the states of Oregon and Washington to quantify prescribed fire emissions and track changes in emission productions within their jurisdictions. Federal land managers have an obligation to complete smoke management reports and apply appropriate mitigation measures to reduce potential impacts on air quality (EPA 1992). Managers use available computer software to

estimate fuel consumption, emissions, and smoke dispersion from prescribed burns.

Monitoring Air Quality

Several different monitoring networks currently measure air quality in the planning area. The most extensive of these are the State and Local Air Monitoring Stations/National Air Monitoring Stations. Operated by the states, this monitoring network is used to determine whether the National Ambient Air Quality Standards are met. Monitors in this network are concentrated in population centers.

Federal agencies are also operating monitors at five sites within or near the planning area. These monitoring sites measure PM₁₀ and PM_{2.5} and changes in visibility, and have filters that can be analyzed to determine the relative contribution of different sources of particulate matter. In addition to monitoring pollutant concentrations, state and federal agencies collect and archive the following type of data about prescribed fires:

Table 2-4. Visibility Comparison.

Wilderness	Representative Monitoring Site	Standard Viewing Range		
		10th Percentile	50th Percentile	90th Percentile
in miles				
Pasayten	Slate Peak	50	114	221
Alpine Lakes	Maloney Mt.	52	119	213
Goat Rocks	Burley Mt.	53	103	200
Mt. Adams	Red Mountain	58	112	186
N/A	Vista House	43	81	181
Mt. Hood	Hickman Butte	39	89	174
N/A	Badger Creek	49	91	162
Hells Canyon	Mt. Howard	47	111	185
Hells Canyon	Hells Canyon	60	111	198
Eagle Cap	Pt. Prominence	53	114	191
Strawberry Mt.	Dixie Butte	57	113	184
Mt. Jefferson	Sisi Butte	49	101	181
Three Sisters	Black Butte	60	104	172

The estimates of visibility in this table rely on a "rank-order cumulative frequency (count) method." The 10th percentile indicates the visibility range occurring at the representative monitoring site 90% of the time (poor visibility), the 50th percentile 50% of the time (medium visibility), and the 90th percentile 10% of the time (good visibility).

Source: Boutcher (1994).

location, acres burned, moisture content of fuels, tons to be consumed, and emissions to be released.

Air Quality Tradeoffs Between Prescribed Fire and Wildfire Emissions

Wildfires currently have a significant impact on the air resource, degrading ambient air quality and impairing visibility. The wildfire regime is significantly different than it was historically because of increased fuel loading, development of fuel ladders, and increases in stand density. Approximately 10 percent of acres burn with non-lethal underburns, compared to approximately 31 percent historically. Stand-replacing fires consume much more fuel and produce much more smoke than non-lethal fires, which usually burn with fairly low surface fire intensities in the understory. Brown and Bradshaw (1994) found that emissions were greater from current fires, even though they burned fewer acres in total than historically, because consumption of fuel per unit area burned has been greater in the current period.

Prescribed fires are ignited under fuel moisture conditions that reduce total fuel consumption (see Table 2-5). Prescribed fires are ignited when mixing height and winds are most favorable for dispersal of smoke away from populated areas, and are not conducted during inversions. Summer inversions are a major cause of bad ambient air conditions associated with wildfires.

While increased levels of prescribed fire can have temporary negative impacts on air quality, in the long term, acute impacts to air quality from wildfires can be reduced (Schaaf 1996). Over the last ten years, state air regulators and scientists have measured concentrations of PM_{10} from wildfires in urban areas that were well over the NAAQSs, and they found it common for these episodes to last several days. For example, the 1994 wildfires near Wenatchee, Washington produced 24-hour concentrations of PM_{10} that were more than double the federal health standard, and these conditions persisted for days. Impacts to populated areas from prescribed fire emissions can be more frequent, but the level of impact is well below established health standards for PM_{10} (Earth Tech. 1996).

Table 2-5. Smoke Emissions Produced by Wildfires and Prescribed Fires.

Potential Vegetation	Fuel Loading	Smoke Emissions PM_{10}		
		Wildfires Dry Fuels	Prescribed Fires Moist Fuels	Prescribed Fires Average Fuels
	<i>tons/acre</i>		<i>lbs/acre</i>	
Cold Forest	30	514	303	385
Cool Shrub	7	119	75	85
Dry Forest	27	464	267	345
Dry Grass	3	62	28	34
Dry Shrub	6	137	87	97
Moist Forest	35	607	359	453
Woodland	10	175	121	140

Abbreviations used in this table:

PM_{10} = particulate matter smaller than 10 microns

Source: Ottmar et al. (1996).

Terrestrial Ecosystems

Introduction

This section provides descriptions of ecosystems separated into forestlands and rangelands. Riparian areas are described in the Aquatic Ecosystems section. Discussion of plant and animal species that inhabit forestlands and rangelands is provided to help complete the picture of what makes up terrestrial (land-based) ecosystems. Broad-scale and landscape-level descriptions of vascular plants, non-vascular plants (bryophytes), fungi, and lichens in the project area are also included. Changes in vegetation and habitat, with explanations of how these changes affect management decisions today, are discussed to set the stage for the management alternatives described in Chapter 3.

Unless otherwise noted, material for this section was derived from the *Landscape Dynamics* (Hann et al. 1996) chapter of *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins* (AEC; Quigley and Arbelbide 1996b).

Forestlands and rangelands in the planning area are highly diverse, ranging from moist areas near the crest of the Cascades to dry areas in the northern Great Basin. The varying soils and climates of forestlands, rangelands, and riparian areas support a diversity of plant species. Included are those that require moist sites, such as western hemlock, western redcedar, and huckleberries, and arid land species like sagebrush and Idaho fescue. Lodgepole pine and ponderosa pine forests are also found throughout much of the area.

Huckleberries, buck brush, alder, and sagebrush are some of the shrubs found in forested areas. Juniper, bitterbrush, and associated bunch grasses occupy many drier sites. Riparian areas are located throughout forestlands and rangelands, and the wetter sites typical of riparian habitats support willow, brome grass, and other similar species. In addition, plant species important to American Indians for food or spiritual reasons are found in many locations. Plants used as food include camas, bitterroot, chokecherry, onion, cattail, and elderberry.

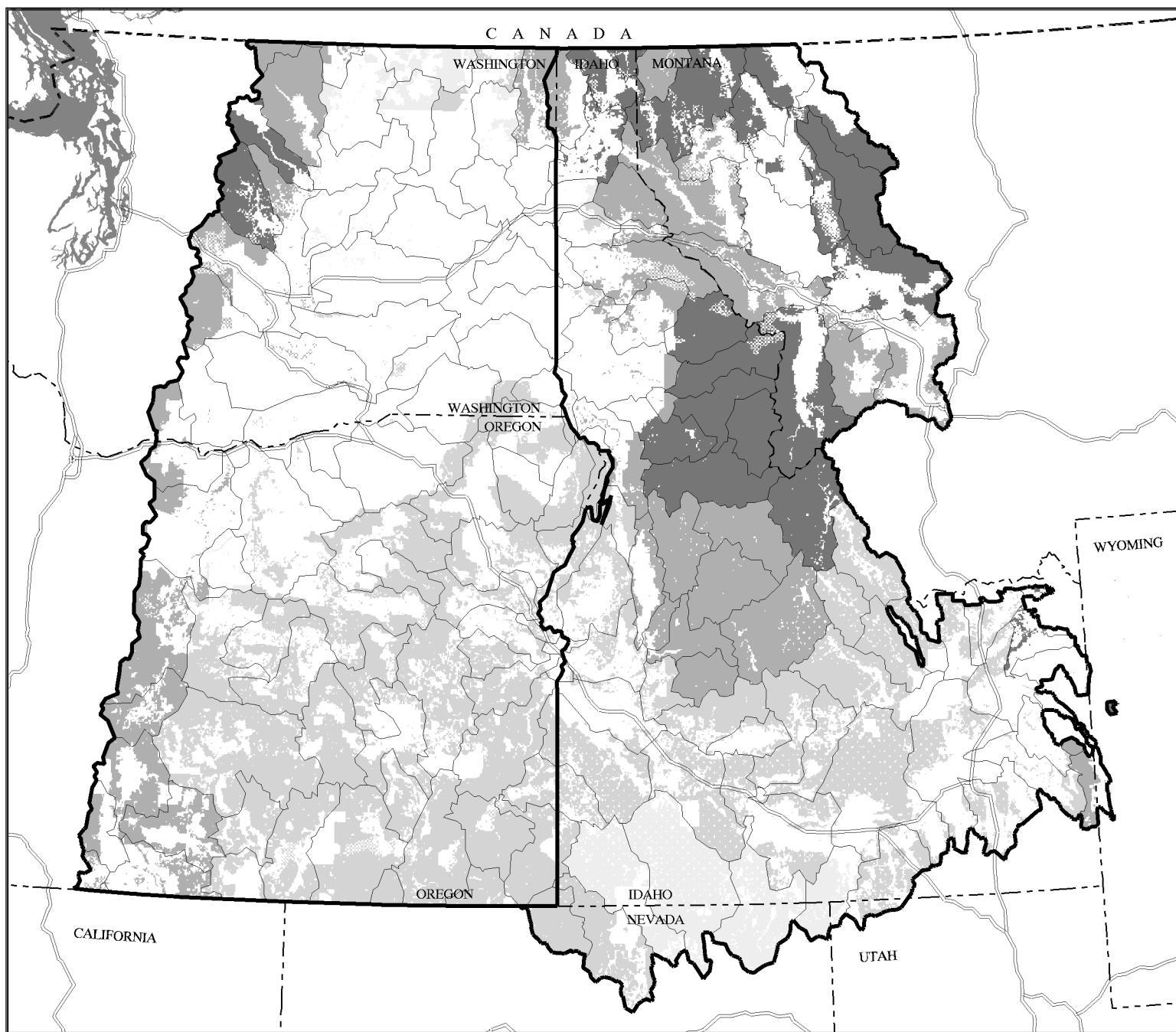
In addition to mountain landscapes, there are vast plains, prairies, deserts, and rolling hills in the planning area. Their landscapes vary depending on soils and climate, and are often highly productive. In the absence of cultivation, sagebrush and grasses dominated the prairies and plains. Palouse prairie vegetation today is scarce in eastern Washington, where exotic grasses (primarily cheatgrass) now dominate large areas.

Due to the wide variety of plant species and landscape forms distributed throughout the planning area, there is a diversity of animal species found within forestlands and rangelands. An assortment of animal species live in these areas, from the grizzly bear in the northern Cascades to the Townsend's big-eared bat in southern Oregon. There are 13,000 terrestrial animal and plant species addressed in the *Terrestrial Ecology* (Marcot et al. 1996) chapter of the AEC, of which 547 are vertebrates. Terrestrial wildlife species in the planning area that are listed by the federal government under the Endangered Species Act (1976) include: bald eagle, grizzly bear, northern spotted owl, and marbled murrelet, which are listed as threatened; peregrine falcon, woodland caribou, and gray wolf, listed as endangered; and spotted frog, which is a candidate for listing. Listed fish are described in the Aquatic Ecosystems section.

Approximately 12,790 plant species are known in the project area; of these two are threatened, two are endangered, four are proposed for listing, and 439 are Forest Service or BLM sensitive species. In the planning area, two plants are threatened, two are endangered, and three are candidates.

To account for the primary aspects of terrestrial integrity, the Science Integration Team developed three broad concepts to assess terrestrial ecosystems, which contributed to preparation of the Terrestrial Ecosystems section of this chapter. The three concepts, have management implications at multiple scales, and are as follows:

◆ **Species viability.** *Includes threatened or endangered species, vertebrate candidate species, locally rare plants, and rare plants listed in natural heritage databases. This concept represents species that are commonly thought to be of concern from a viability standpoint. In Map 2-5, occupied habitats for seven threatened or endangered terrestrial vertebrates were overlayed to display the areas of overlap among the species (peregrine*



Map 2-5.
Terrestrial Vertebrates
Threatened or Endangered Species

*BLM and Forest Service
Administered Lands Only*

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Number of Species
With Habitat Overlap:



4th HUC Boundaries
Major Roads
EIS Area Border

falcon, bald eagle, gray wolf, grizzly bear, woodland caribou, northern spotted owl, and whooping crane).

◆ **Long-term evolutionary potential.**

Includes rare and endemic species habitats, and high biological diversity “hotspots” (see Map 2-6). This concept represents species that may require additional management emphasis to achieve their long-term evolutionary potential. These groups of species occur only in specific localized places and are highly susceptible to local extinction. One such species group, disjunct vertebrate species, are shown on Map 2-7.

◆ **Multiple ecological scales and evolutionary time frames.**

Includes species assemblages and ecosystems that are at the edges of their range. Species at the edges of their range often develop attributes or adaptations that result from local ecological conditions not present in the center of their range. Such “fringe” areas often are important to species’ evolutionary processes. An example of this, amphibians of the Columbia Gorge, is shown on Map 2-8.

Change on the Landscape

Change has always been a part of forestland and rangeland ecosystems. This chapter provides descriptions of changes in the recent past, and present conditions on the landscape. As observed by Mehringer (1995), “change is continual and change is unpredictable.” Species have distributed and redistributed themselves across the landscape in response to influences from various disturbances (Mehringer 1995). The ebb and flow of glacial activity, repeated large-scale catastrophic floods, volcanic activity, and smaller-scale disturbances have created the ever-changing vegetative composition and structure within the planning area. The geologic history that influences these interactions is described in the Physical Environment section earlier in this chapter, and in more detail in the *Landscape Dynamics* (Hann et al. 1996) chapter of the AEC.

Just as climate and drought cycles affect what types of vegetation will grow well in a particular area today, vegetation also responded to small- and large-scale climatic fluctuations in the past. Fossil records show that forestlands and rangelands advanced and retreated in response

to the advance and retreat of glaciers. The edge between forestlands and rangelands has shown the most significant movement in recent geologic history, changing in elevation as climates changed (Mehringer 1995).

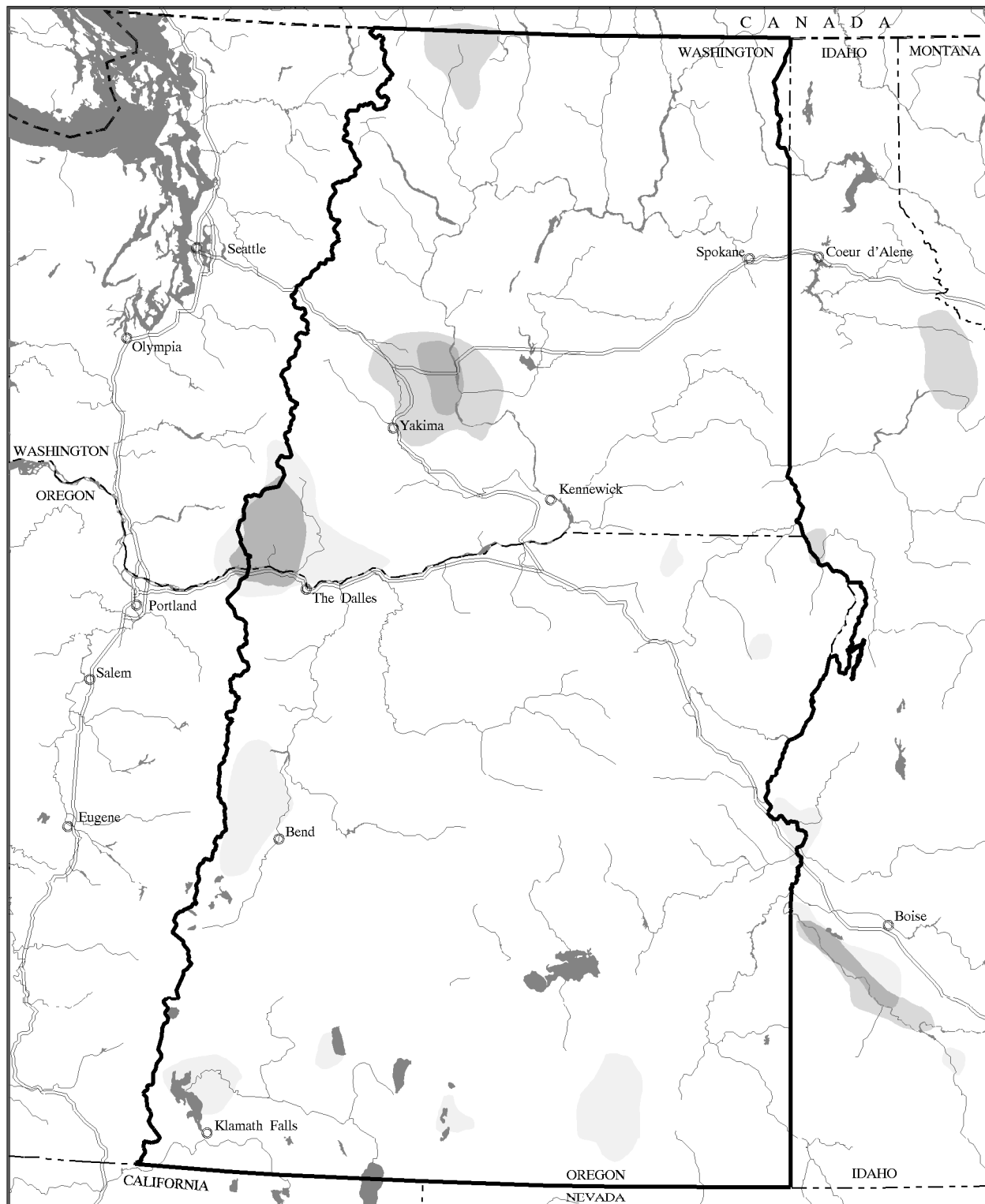
Volcanic activity, some on a much larger scale than the 1980 eruption of Mt. St. Helens (which destroyed most of the forest cover on the north side of the mountain and deposited ash and debris as far east as western Montana), removed or buried vegetation under layers of ash. In areas where vegetation was completely removed by lava or covered by ash, forestlands and rangelands slowly recolonized the bare soil. As the present day landscape was being molded, changes occurred over and over, at various degrees, and in different places. As vegetation patterns changed and adjusted to the different environment, the landscape gained a new look and different plant and animal relationships developed. The numbers of animal species that could be supported by the landscape changed; through time, some species gained habitat, while others lost habitat.

Change continues today. Changes to existing landscapes can be a result of people’s interaction with their environment. From burning fields to enhance the production of food resources, to the logging of forests to produce timber products, people have had effects on vegetation, animals, and on people themselves.



Disturbances

Examples of disturbances include fire, insects, diseases, harvest storms, drought, floods, volcanoes, etc.

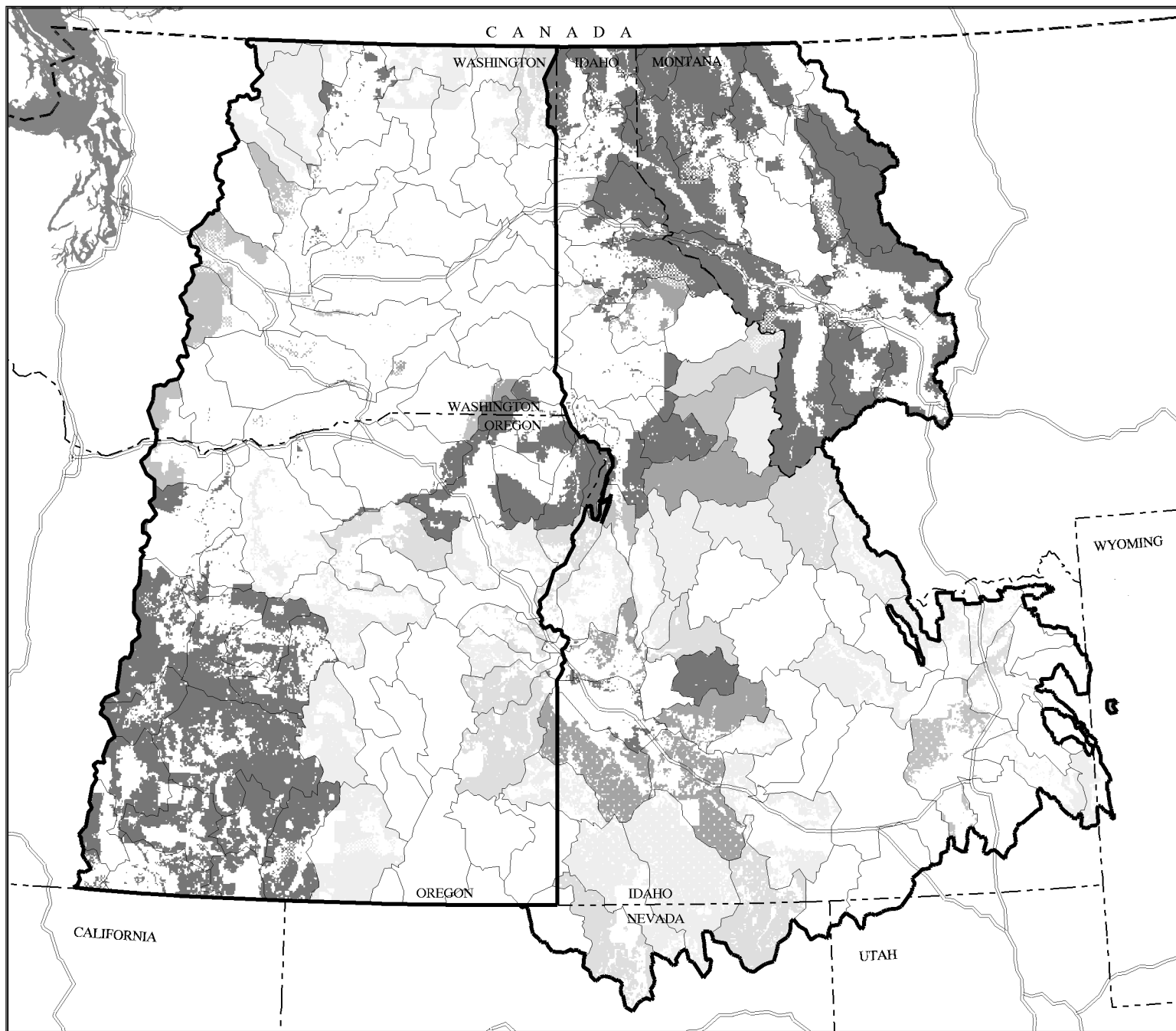


**Map 2-6.
Rarity/Endemism and
Biodiversity Hotspots**

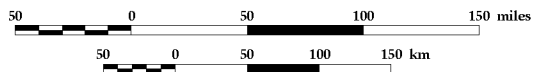
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Draft EASTSIDE EIS
1996

- | | |
|---|-----------------|
| Overlap of Endemism/Rarity and Biodiversity | Water |
| Biodiversity Hotspots | Major Rivers |
| Rarity/Endemism Hotspots | Major Roads |
| | EIS Area Border |



Map 2-7.
Disjunct Vertebrate Species

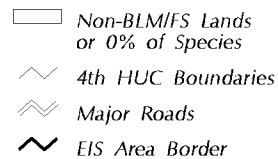
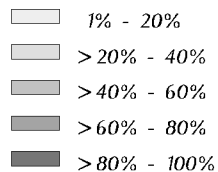


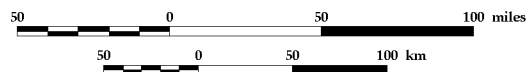
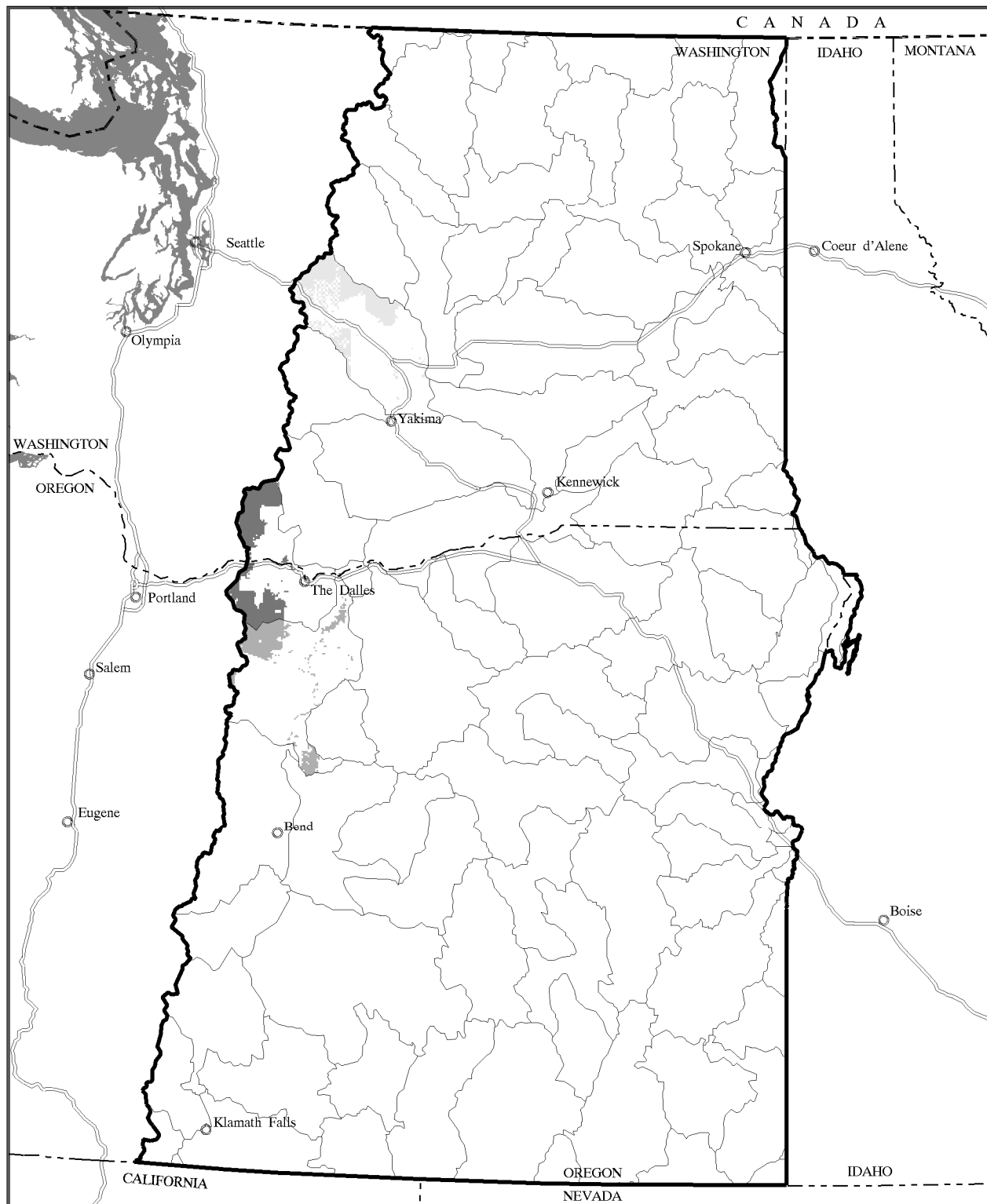
*BLM and Forest Service
Administered Lands Only*

INTERIOR COLUMBIA
BASIN ECOSYSTEM
MANAGEMENT PROJECT

Project Area
1996

% of Total Number
of Disjunct
Species Present:





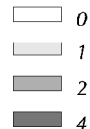
Map 2-8. Amphibians of the Columbia Gorge

*BLM and Forest Service
Administered Lands Only*

INTERIOR COLUMBIA
BASIN ECOSYSTEM
MANAGEMENT PROJECT

Draft EASTSIDE EIS
1996

Number of
Species:



4th HUC Boundaries
Major Roads
EIS Area Border
Cities and Towns

Vegetation and Wildlife Classifications

Vegetation

The existing vegetative cover within an area, generally classified as a grass/forb, shrub, or tree species, can vary based on past disturbances. The term potential vegetation group (PVG) is used to represent all of the plant species that could grow on a specific site in the absence of disturbance, or vegetation that would grow on a site in the presence of frequent disturbance, which is an integral part of that ecosystem and its evolution. Potential vegetation groups are comprised of several potential vegetation types (see Table 2-11 in the Forestland Section and Table 2-13 in the Rangeland Section). For example, the “Dry Douglas-fir with Ponderosa Pine” potential vegetation type in the dry forest potential vegetation group consists of Douglas-fir, ponderosa pine, and fescue bunch grass which grows on these sites when disturbance is not present. If disturbance kept the site from producing this mix of species, the site might instead be occupied by grass and shrubs, ponderosa pine, and other seral species unique to this type.

For the Interior Columbia Basin Ecosystem Management Project, vegetation was grouped into 14 potential vegetation groups ~ dry forest, moist forest, cold forest, dry shrub, cool shrub, dry grass, riparian shrub, riparian herb, woodland alpine, agricultural, urban, water, and rock. These groupings were based on similar general moisture or temperature environments, and potential vegetation types.

In this chapter, vegetation and habitats in terrestrial ecosystems are discussed by potential vegetation group. Dry forest, moist forest, and cold forest potential vegetation groups are described in the Forestlands section of this chapter, while dry shrub, cool shrub, and dry grass potential vegetation groups are discussed in the Rangelands section. Riparian shrub and riparian herb potential vegetation groups are addressed in the Riparian Areas subsection of the Aquatic Ecosystems section. The woodland potential vegetation group is scattered throughout the project area, and is therefore not described separately, but is referred to in various places.

The alpine potential vegetation group has not been significantly altered from its historic condition and makes up only a small portion of the project area; therefore, it is not discussed in detail in this EIS. Agricultural, urban, water, and rock potential vegetation groups are not discussed in detail in this EIS because their geographic extent is relatively minimally influenced by agency management decisions. In addition, the greatest portion of agricultural and urban potential vegetation groups are located on private lands within the project area, which are beyond the scope of this EIS.

Table 2-6 lists approximate acreage for the three forestland and three rangeland potential vegetation groups on Forest Service- and BLM-administered lands in the project area.

Plants and Allies: Fungi, Lichens, Bryophytes, and Vascular Plants

Most of the vegetation descriptions in this chapter focus on more common plant communities that comprise forestland and rangeland ecosystems in the project area. However, rare or sensitive plant species, and smaller and lesser known (but often critical) plants, form the base of each community in the ecosystem.

The *Terrestrial Ecology* (Marcot et al. 1996) chapter of the AEC considered more than 12,000 plant species in the project area, including 4,000 non-vascular plants and plant allies (fungi and lichens). Among their findings: two were endangered species; two were threatened species; four were candidate species; and 385 were classified as sensitive. This richness in plant diversity is a reflection of the variety of habitats found in the project area, ranging from alpine to desert conditions with different bedrock, soils, and temperature and moisture regimes. Plants are primary producers that convert energy from the sun into food and nutrients for all living organisms; they are the most critical component for ecosystem maintenance. In addition to ecosystem function, plant communities provide the foundation for the economic life of the project area. Commercial resources critical to the region's economy are provided by plants, including timber, forage, and other special plant products.

Many groups of plants and plant allies play multiple, but often poorly-understood roles in

Table 2-6. Total Forest Service/BLM Acres by PVG within each ERU, in the Eastside EIS Planning Area.

Ecological Reporting Unit	Dry Forest	Moist Forest	Cold Forest	Dry Grass	Dry Shrub	Cool Shrub	Total
<i>in thousands of acres</i>							
Northern Cascades (ERU 1)	343	1,566	1,345	60	22	24	3,360
Southern Cascades (ERU 2)	607	824	338	16	25	98	1,908
Upper Klamath (ERU 3)	1,338	193	94	38	43	68	1,774
Northern Great Basin (ERU 4)	743	96	43	43	6,072	298	7,295
Columbia Plateau (ERU 5)	627	230	45	99	731	808	2,540
Blue Mountains (ERU 6)	3,772	491	457	523	441	441	6,125
Northern Glaciated Mountains (ERU 7)	213	1,148	86	9	3	< .5	1,459
Owyhee Uplands (ERU 10)	20	1	< .5	< .5	3,410	484	3,915
Total	7,663	4,549	2,408	788	10,747	2,221	28,376

Abbreviations used in this table:

BLM = Bureau of Land Management

PVG = potential vegetation group

ERU = ecological reporting unit

EIS = environmental impact statement

Source: ICBEMP GIS data (converted to 1 km² raster data) and Hann et al. (1996).

functional and sustainable ecosystems. Different levels of information are available for each plant, fungi, lichen, or bryophyte (mosses and liverworts) group. The vast majority of plant data is available for those vascular plant species that are currently listed as sensitive, threatened, or endangered. There is considerably less site-specific data available for the fungi, lichens and bryophytes.

Fungi

Fungi are the least understood group of plant-related organisms in the project area. One key role of fungi in ecosystems is that of a decomposer; recycling nutrients within an ecosystem to make them available for use by other living organisms. Many species of fungi

(mycorrhizae) also play a role in assisting moisture and nutrient absorption by plants through beneficial relationships with plant roots. Other species of fungi in the project area have commercial value and economic importance. Due to the limited knowledge of this group of organisms, effects of management activities on fungi are difficult to determine. Therefore, this group of plants is not discussed further in this EIS.

Lichens

Lichens, which are organisms made up of algae and fungi, are represented by at least 736 species in the project area. Lichens function in a wide variety of ecosystems as food sources for animals, such as deer, elk, caribou, flying

squirrels, red-backed voles, and woodrats; and they contribute living matter to forestland and rangeland soils. Birds and small mammals use lichens to build nests. When attached to tree branches, lichens also absorb moisture. Microbiotic crusts consist of both lichens and bryophytes, and cover and protect what would otherwise be bare soil between grass clumps and/or shrubs. Lichens also play a role in the initial establishment of plant communities on surfaces such as bare rock, through the breaking down of rock into soil that is more conducive to plant growth. Some lichens are used as food by American Indians, and others are used as bio-indicators for air quality, or as environmental purifiers where heavy metals accumulate. Other species of lichens may prove to have medicinal values.

Lichens are affected when their substrate (dead plant matter, tree bark, tree trunks without bark, rock, and soil) is modified through timber harvest, mining, livestock grazing, fire, or invasion of exotic annual grasses. Lichens also appear to be sensitive to the planting of uncharacteristically high numbers of trees; artificially dense forest stands create unsuitable habitat for most lichens. One lichen is currently listed as a candidate species (Howell's spectacular thelypody). Basic knowledge about these species and their interactions is limited, and therefore is not discussed further in this EIS.

Bryophytes

Non-vascular plants include mosses, liverworts, and hornworts (bryophytes). Like other plant allies, bryophytes are poorly understood, and even the most basic information is lacking for some. Approximately 800 species of bryophytes are known to occur in the project area, four of which are endemic, meaning they grow nowhere else. They are found on substrates, such as wet soil, alkali soil, calcareous rock, peatlands, geothermal areas, and decaying wood. Since bryophytes produce chlorophyll (a green pigment which absorbs light and is converted into food and nutrients for other living organisms), they function in ecosystems as a food source. Bryophytes, much like lichens, also play a role in the initial establishment of plant communities on surfaces such as bare rock, through the breaking down of rock into soil that is more conducive to plant growth.

Of bryophytes known in the project area, 360 appear to be rare. As a group, they are affected by the same activities as lichens. For species found on wet rocks, or for aquatic submerged species, changes in water quality may impact bryophyte composition and distribution. Like other plant allies, basic knowledge about these species and their interactions is limited. Therefore, they are not discussed further in this EIS.

Vascular Plants

Approximately 8,000 vascular plant species are found in the project area. Vascular plants are "ordinary" plants which have roots, stems, leaves, and reproductive structures. Included in the vascular plant group are ferns and fern allies, cone-bearing plants such as conifers, and flowering plants. Vascular plants in the project area are remarkably diverse with species found in a wide spectrum of habitats.

Vascular plants function as the basis of the food webs that sustain life on earth. Vascular plant species protect exposed soil from the erosive forces of wind and water through the binding action of their roots. They also serve to regulate stream temperatures by providing shade to streams, and enhancing habitat for aquatic and riparian area-dependent species.

Among the species known in the project area, 154 are regionally endemic and 87 are of concern to American Indian tribes. Approximately 526 of the species are sensitive, or of special management concern to the Forest Service or BLM. Of particular concern are plant communities affected by grazing, introduced exotic species, and timber harvest. One of the findings of the *Scientific Assessment* was that plant species or groups in native bunch grass types and low elevation cedar/hemlock forests currently have the lowest amount of habitat area, and also showed the greatest negative change (loss) over time (*Terrestrial Ecology* [Marcot et al. 1996] chapter of the AEC). Species that are federally listed as threatened or endangered and that occur in the project area include: Water howellia (threatened), Applegate's milk-vetch (endangered), MacFarlane's four-o'clock (threatened), and Malheur wire-lettuce (threatened). All of these species occur in the Eastside planning area.

Noxious Weeds

There are 862 exotic (non-native) plant species that have been documented in the project area, of which 113 are considered noxious weeds (*Terrestrial Ecology* [Marcot et al. 1996] chapter of the AEC). “Noxious” is a legal classification rather than an ecological term. Plants that can exert substantial negative environmental or economic impact can be designated as noxious by various government agencies. Federal and state laws require certain actions be directed at the management of noxious weeds.

Vegetation in both forestlands and rangelands is being invaded by noxious weeds at an accelerating rate, jeopardizing public expectations, consumptive and non-consumptive uses, including livestock grazing, timber production, and wildlife and scenery viewing. Noxious weeds reduce these uses by displacing native plant species and lessening natural biological diversity; degrading soil integrity, nutrient cycling, and energy flow; and interfering with site-recovery mechanisms, such as seed banks, that allow a site to recover following disturbance.

Wildlife

Two hierarchical classifications for wildlife species were used in the *Terrestrial Ecology* (Marcot et al. 1996) chapter of the AEC: one for “Key Ecological Functions” and one for “Key Environmental Correlates.” Key Ecological Functions comprise a wide range of roles that species play in the ecosystem, such as predation, herbivory, nutrient cycling, and biomass (total quantity of living organisms of one or more species). Key Environmental Correlates consist of environmental factors either associated with or required by a given species, such as forest canopies, downed wood, snags, or piles of bark. Both Key Ecological Functions and Key Environmental Correlates were used when discussing terrestrial species and their habitats. This subsection provides examples of wildlife species, key ecological functions, and species that depend on certain key environmental correlates.

The seven important key ecological functions are:

- ◆ major biomass accumulations in an ecosystem;
- ◆ herbivory;
- ◆ nutrient cycling;

- ◆ interspecies relations (species that depend on each other);
- ◆ soils relations (species that interact with the soil, such as moles and voles);
- ◆ wood relations (decomposers); and
- ◆ water relations (amphibians and reptiles).

The ten important key environmental correlates upon which species depend are:

- ◆ forest canopy;
- ◆ mistletoe brooms;
- ◆ dead parts of live trees;
- ◆ exfoliating bark;
- ◆ snags;
- ◆ downed wood;
- ◆ bark piles at the base of trees;
- ◆ litter and duff;
- ◆ fire processes and insect outbreaks; and
- ◆ recreation activity, roads, and trails.

Changes in vegetation composition, distribution, and structure; climate; water availability and quality; soil characteristics; and human disturbance may all affect terrestrial species habitats. The degree to which any species is affected depends on (1) the magnitude of change, (2) the ability of a species to move to other blocks of the same habitat or other habitat types, (3) the distribution and interconnections of species populations, (4) the sensitivity of these species or their habitat to human activity, and (5) many other factors that are not always well understood. Species populations can increase or decrease because of habitat changes that affect their distribution, density, access to habitat, or a combination of all three. Thus, what may be harmful to one species may benefit or have no effect on another, or may affect the ways that terrestrial species interact with and affect other species (*Terrestrial Ecology* [Marcot et al. 1996] chapter of the AEC).

Habitat trends are not meant to be interpreted only as trends in population size for individual species. In part, this is because the abundance of animals (or lack thereof) can be affected by factors other than habitat quality, quantity, or distribution. For example, even if habitat remains constant, climatic conditions

during breeding or wintering may cause changes in species population size and density. However, local habitat changes could have affected certain species or groups of species. Specific changes in wildlife habitat related to vegetation are discussed in the Rangelands and Forestlands sections.

Not all information is known about all species, their habitat requirements, and current conditions in the project area. It would be undesirable and unrealistic to apply species habitat relationship requirements project area-wide because of the great variation and complexity of habitats within an area this large. For example, while some species occur throughout the project area, it would be unwise to use habitat relationships in moist forests for the same species that also occur in dry or cold forests. Some of their requirements will be the same and some will not, depending on the individual species. Local habitat conditions which most species have adapted to need to be evaluated for applicability.

Plant communities and their successional stages, as well as many other environmental factors, provide unique environmental conditions that are ecologically important as niches for wildlife species (Thomas et al. 1979). Many terrestrial wildlife species can be found in more than one forestland or rangeland potential vegetation group. In part, this is because sometimes an important habitat characteristic for one particular wildlife species may be a certain vegetative structure that can be found in more than one vegetation type. For example, while some wildlife species need large diameter trees, the particular *type* of tree may be unimportant to some species yet important to others. However, some of the information from the *Terrestrial Ecology* (Marcot et al. 1996) chapter of the AEC databases enabled the Science Integration Team to discuss wildlife species or groups separately within particular forestland or rangeland potential vegetation groups that were identified in the *Landscape Dynamics* (Hann et al. 1996) chapter of the AEC. Therefore, this EIS follows the same convention and displays wildlife information by potential vegetation group where possible, for ease of tracking changes in vegetation on the landscape and the broad-scale effects of changes in terrestrial wildlife species.

Natural Areas

Natural areas are defined as areas managed by various landowners for a variety of purposes, but which are maintained in a relatively natural state, with minimal human disturbance. Natural areas are designated for purposes of recreation, research, monitoring, habitat protection, education, and scenic quality. They include designated wildernesses, wilderness study areas, research natural areas, areas of critical environmental concern, botanical areas, and similar areas. They can occur in all categories of land allocations, and can vary in management objectives and allowed uses. Natural Areas are intended to represent the spectrum of vegetation, habitats, physical settings, and land types within a region.

Natural areas are distributed throughout the project area. Within the project area approximately 28 percent of the Forest Service- and BLM-administered land is within some type of natural area designation or category. Natural areas in the project area tend to be in the upper elevation, forested portions of the landscape. Cold forests represent approximately 35 percent of the area that is within natural areas (mainly wildernesses or wilderness study areas) because of their scenic beauty, recreation demand, and lack of roads and development. Nine percent of moist and mid-elevation forests are within natural areas, although some of these forests are also represented in some unroaded areas. Forested habitats in lower elevations are the least represented within natural areas.

Of the rangeland areas included within Congressionally or administratively designated natural areas, five percent of cool shrub, three percent of dry grass and dry shrub, seven percent of riparian shrub, and seven percent of woodland are represented. This compares to 59 percent of alpine areas, 35 percent of cold forest, and 55 percent of rock areas represented within natural area designations (includes all ownerships within the project area).

In summary, relatively few rangeland types are being specifically managed under low human disturbance regimes for the general goals of established natural areas, for example, recreation, research, monitoring, habitat protection, education, and scenic quality.

The Assessment of Ecosystem Components analyzed the size-class distribution of natural areas and vertebrate home ranges to determine the value of natural areas in maintaining vertebrate communities. All natural areas and species were pooled without regard for habitat composition and use differences. For this broad treatment, the simplified assumption was made that natural areas were isolated from adjacent habitat that might have increased the effectiveness of the natural area for species conservation and management. In reality, this may not always be the case, and much of the land surrounding some natural areas also contributes suitable habitat for vertebrate species.

Even small natural areas (less than 125 acres) would be expected to contain at least one individual, and perhaps small populations, of 70 percent of vertebrate species. Natural areas larger than 1,600 acres would be expected to contain 90 percent of the vertebrate species typical of the habitat for natural areas in general. Natural areas would have to be at least 24,700 acres before 99 percent of the vertebrate species would be expected to occur. Of existing natural areas in the project area, 16 percent are larger than 24,700 acres. Expectations of species occurrence based on home range size does not necessarily mean that a particular sized natural area would contain viable populations of all associated species. Natural areas would have to be several times larger than the area of an individual home range for most species to support enough individuals for a viable population. Many factors relative to species would need to be considered to ensure natural areas fully address viability concerns.

Forestlands

Key Terms Used in This Section

Biophysical template~ The successional and disturbance processes, as well as landform, soil, water, and climate conditions that form the native system through which species of plants and animals evolve.

Disturbance~ Refers to events that alter the structure, composition, or function of terrestrial or aquatic habitats. Natural disturbances include, among others, drought, floods, wind, fires, wildlife grazing, and insects and pathogens. Human-caused disturbances include actions such as timber harvest, livestock grazing, roads, and the introduction of exotic species.

Ecotone~ A transition area of vegetation between two plant communities, having characteristics of both kinds of neighboring vegetation as well as characteristics of its own. Varies in width depending on site and climatic factors.

Landscape composition~ The types of stands or patches (see definition below) present across a given area of land.

Landscape structure~ The mix and distribution of stands or patch (see definition below) sizes across a given area of land. Patch sizes, shapes, and distributions are a reflection of the major disturbance regimes operating on the landscape.

Old forest ~ (a) Old single-story forest refers to mature forest characterized by a single canopy layer consisting of large or old trees. Understory trees are often absent, or present in randomly spaced patches. It generally consists of widely spaced, shade-intolerant species, such as ponderosa pine and western larch, adapted to a non-lethal, high frequency fire regime. (b) Old multi-story forest refers to mature forest characterized by two or more canopy layers with generally large or old trees in the upper canopy. Understory trees are also usually present, as a result of a lack of frequent disturbance to the understory. It can include both shade-tolerant and shade-intolerant species, and is generally adapted to a mixed fire regime of both lethal and non-lethal fires.

Patch (stand)~ An area of uniform vegetation that differs from what surrounds it in structure and composition. Examples might include a patch of forest surrounded by a cut-over area or a patch of dense young forest surrounded by a patch of open old forest.

Regeneration~ The process of establishing a new crop of trees on previously harvested land; also refers to the new crop of trees that have become established.

Seral~ Refers to the sequence of transitional plant communities during succession. Early-seral or young-seral refers to plants that are present soon after a disturbance or at the beginning of a new successional process (such as seedling or sapling growth stages in a forest); mid-seral in a forest would refer to pole or medium sawtimber growth stages; late- or old-seral refers to plants present during a later stage of plant community succession (such as mature and old forest stages).

Species composition~ The mix of different types of vegetation in an ecosystem. For example, in a forest, species composition refers to the mix of different types of trees

Stand (patch) density~ The number of trees growing in a given area; in forests, usually expressed in terms of trees per acre.

Stand (patch) structure~ The mix and distribution of tree sizes, layers, and ages in a forest. Some stands are all one size (single-story), some are two-story, and some are a mix of trees of different ages and sizes (multi-story). (See Table 2-8 for structural stages used in this EIS to describe stand structure.)

Summary of Conditions and Trends

The following trends have been noted in forestlands of the project area due to departures from native disturbance and successional processes since historical times. These broad-scale changes in forest health conditions have influenced the susceptibility of forests to uncharacteristic wildfires and large-scale insect and disease events, and have affected habitat for many wildlife species.

- ◆ Interior ponderosa pine has decreased across its range with a significant decrease in old single-story structure. The primary transitions were to interior Douglas-fir and grand fir/white fir.
- ◆ There has been a loss of the large tree component (live and dead) within roaded and harvested areas. This decrease affects terrestrial wildlife species that are closely associated with these old forest structures.
- ◆ Western larch has decreased across its range. The primary transitions were to interior Douglas-fir, lodgepole pine, or grand fir/white fir.
- ◆ Western white pine has decreased by 95 percent across its range. The primary transitions were to grand fir/white fir, western larch, and shrub/herb/tree regeneration.
- ◆ The whitebark pine/alpine larch potential vegetation type has decreased by 95 percent across its range, primarily through a transition into the whitebark pine cover type. Overall, however, the whitebark pine cover stand has also decreased, with compensating increases in Engelmann spruce/subalpine fir.
- ◆ Generally, mid-seral forest structures have increased in dry and moist forest potential vegetation groups (PVG), with a loss of large, scattered, and residual shade-intolerant tree components, and an increase in the density of smaller shade-tolerant diameter trees.
- ◆ There has been an increase in fragmentation and a loss of connectivity within and between blocks of late-seral, old forests, especially in lower elevation forests and riparian areas. This has isolated some animal habitats and populations and reduced the ability of populations to move across the landscape,

resulting in a long-term loss of genetic interchange.

- ◆ There has been an increase in access for humans which has decreased the availability of areas with low human activities. These areas are important to large forest carnivores and omnivores (meat and plant eating).

Introduction

“Forest health” is defined as the condition in which forest ecosystems sustain their complexity, diversity, resiliency, and productivity while providing for human needs and values. It is a useful way to communicate about the current condition of the forest, especially with regard to resiliency, a part of forest health which describes the ability of an ecosystem to respond to disturbances. Resiliency is one of the properties that enables a system to persist through many different states or successional stages. Forest health and resiliency can be described, in part, by species composition, distribution, density, and structure; and landscape composition and structure.

To understand forest health, it is important to recognize that forests are constantly changing through a combination of disturbances such as fire, climate, insects, disease, timber harvest, and grazing. Change determines the plant and animal species that will exist in forested areas, and governs future products, recreational opportunities, habitats, and other resources provided by forests.

Unless otherwise noted, material for this section was derived from the *Landscape Dynamics* (Hann et al. 1996) and *Terrestrial Ecology* (Marcot et al. 1996) chapters of *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins* (AEC; Quigley and Arbelbide 1996b).

Forested Potential Vegetation Groups

As mentioned previously, forestlands in the project area are divided into and described by three groups: dry, moist, and cold forest potential vegetation groups (see Figure 2-5). Potential vegetation groups are comprised of several potential vegetation types. Table 2-7 shows these classifications.

Data on these groups were analyzed for the entire project area, not by EIS planning area; therefore, the following discussions generally describe the project area.

The forestland potential vegetation groups are described in this section by distribution, composition, structure; and historical and current conditions, disturbance patterns, and disturbance processes. Historical and current distribution of the forestland groups are shown on Maps 2-9 and 2-10. Terrestrial (land-based) wildlife species, their habitats, and associated changes are also discussed.

Succession and Disturbance

Plants respond to influences and disturbances from animals, people, and even other plant species by growing in patterns of succession. "Disturbance" refers to events that alter the structure, composition, and/or function of terrestrial or aquatic habitats. Historically,

disturbances in the project area generally followed cycles of infrequent, high intensity events (such as drought, floods, or crown fires) interspersed with frequent, low intensity events (such as non-lethal underburns, annual wildlife grazing cycles, or scattered tree mortality from bark beetles). Figure 2-6 shows the different fire types and Table 2-8 defines commonly used fire terms.

"Succession" refers to a predictable process of changes in structure and composition of plant and animal communities over time. Successional (or seral) stages are often described in terms of early-seral, mid-seral, or late-seral to reflect the species and/or condition of vegetation and animal communities generally characteristic of different periods of succession (see Figure 2-7 and Table 2-9).

Successional growth and the development of vegetation, combined with disturbance, result in vegetation changes across the forested landscape. For example, shade-intolerant trees, those that

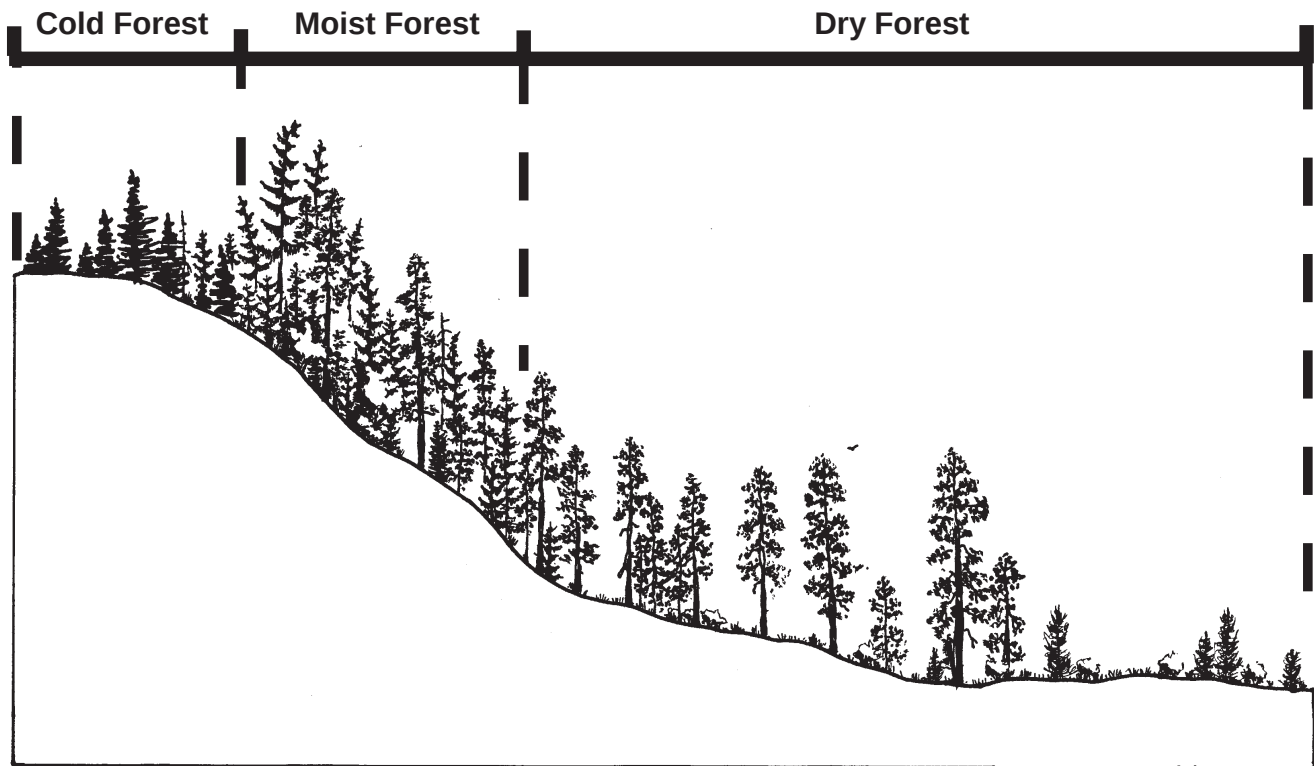


Figure 2-5. Forested Potential Vegetation Groups ~ These groups are classified by climate, species, and disturbance patterns.

Table 2-7. Forestland Vegetation Classifications.

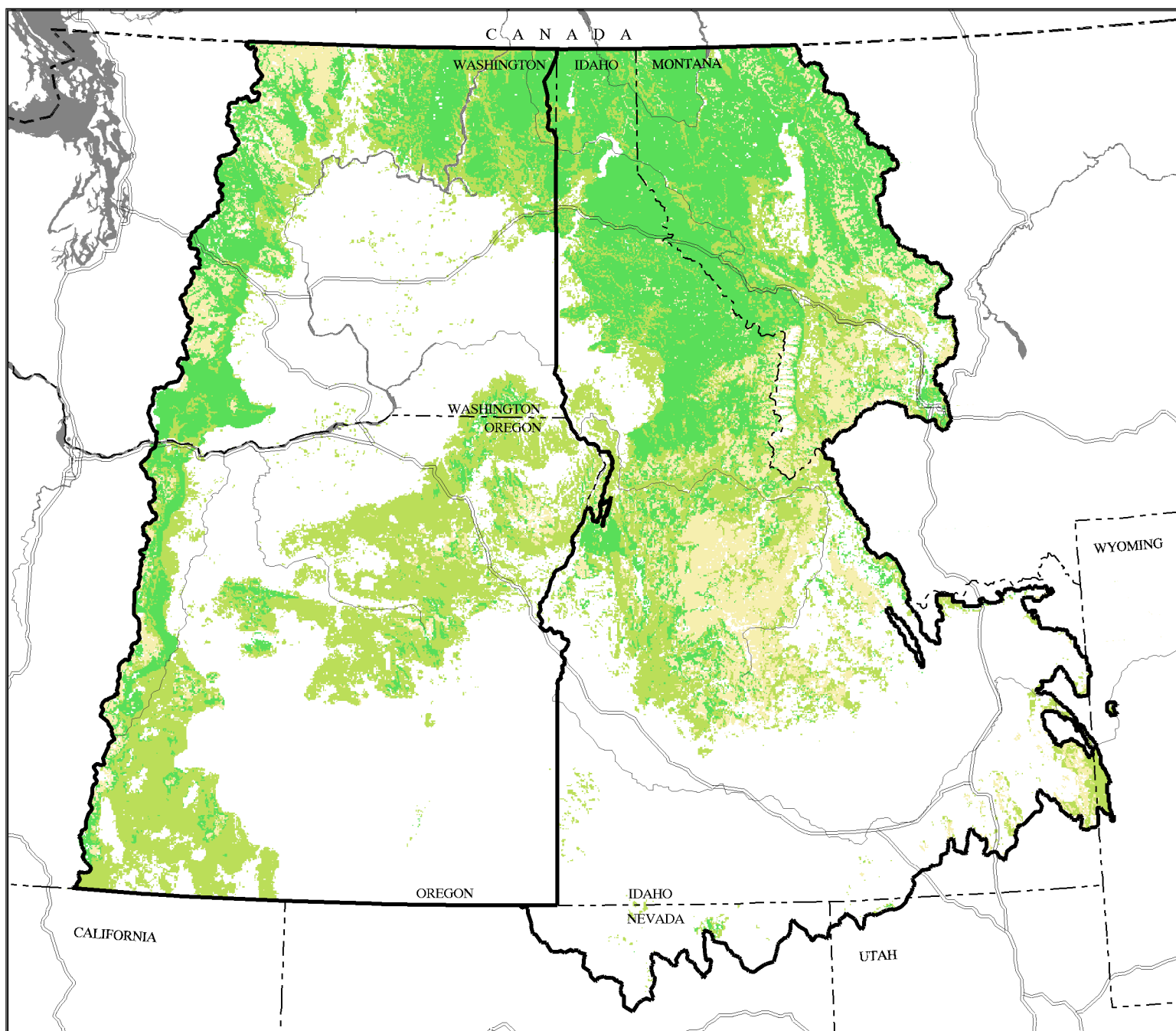
Potential Vegetation Group	Potential Vegetation Types
Dry Forest	Dry Douglas-Fir with Ponderosa Pine Dry Douglas-Fir without Ponderosa Pine Dry Grand Fir/White Fir Interior Ponderosa Pine Lodgepole Pine - Oregon Lodgepole Pine - Yellowstone Pacific Ponderosa Pine/Sierra Mixed Conifer
Moist Forest	Cedar/Hemlock - East Cascades Cedar/Hemlock - Inland Grand Fir/White Fir - East Cascades Grand Fir/White Fir - Inland Moist Douglas-Fir Pacific Silver Fir Spruce-Fir Wet
Cold Forest	Mountain Hemlock - East Cascades Mountain Hemlock - Inland Mountain Hemlock/Shasta Red Fir Spruce-Fir Dry with Aspen Spruce-Fir Dry without Aspen Spruce-Fir (more lodgepole pine than white bark pine) Spruce-Fir (more white bark pine than lodgepole pine) White Bark Pine/Alpine Larch - North White Bark Pine/Alpine Larch - South

Source: Hann et al (1996).

grow better in open sunlight, may dominate newly opened forested areas. They may continue to dominate if disturbance events remove enough of the existing trees to allow a new generation to reproduce and grow in the sunny, open areas. If such a disturbance does not open up the forest to sunlight, shade-intolerant trees mature and create shade on the forest floor, which does not allow their own seedlings to become established, but does allow other more shade-tolerant species to take root. These new trees will continue to grow in the shade of the overstory, and will eventually dominate the forest unless they are removed by fire, wind, harvest, or another disturbance, returning sunlight to the forest floor and allowing shade-intolerant species to once

again become established in open areas. A partial list of common shade-tolerant and intolerant species can be found in Table 2-10.

The interaction of successional and disturbance processes, constrained by the dynamics of landform, soil, water, and climate, creates the basic “native biophysical template” in which native species have evolved. Insect, disease, and fire disturbance events react differently, and affect forested stands differently, depending on species composition, density, and structure. Regional-scale changes in landscape patterns over time can be described as changes in vegetation structure (heights, sizes, and ages of vegetation) and



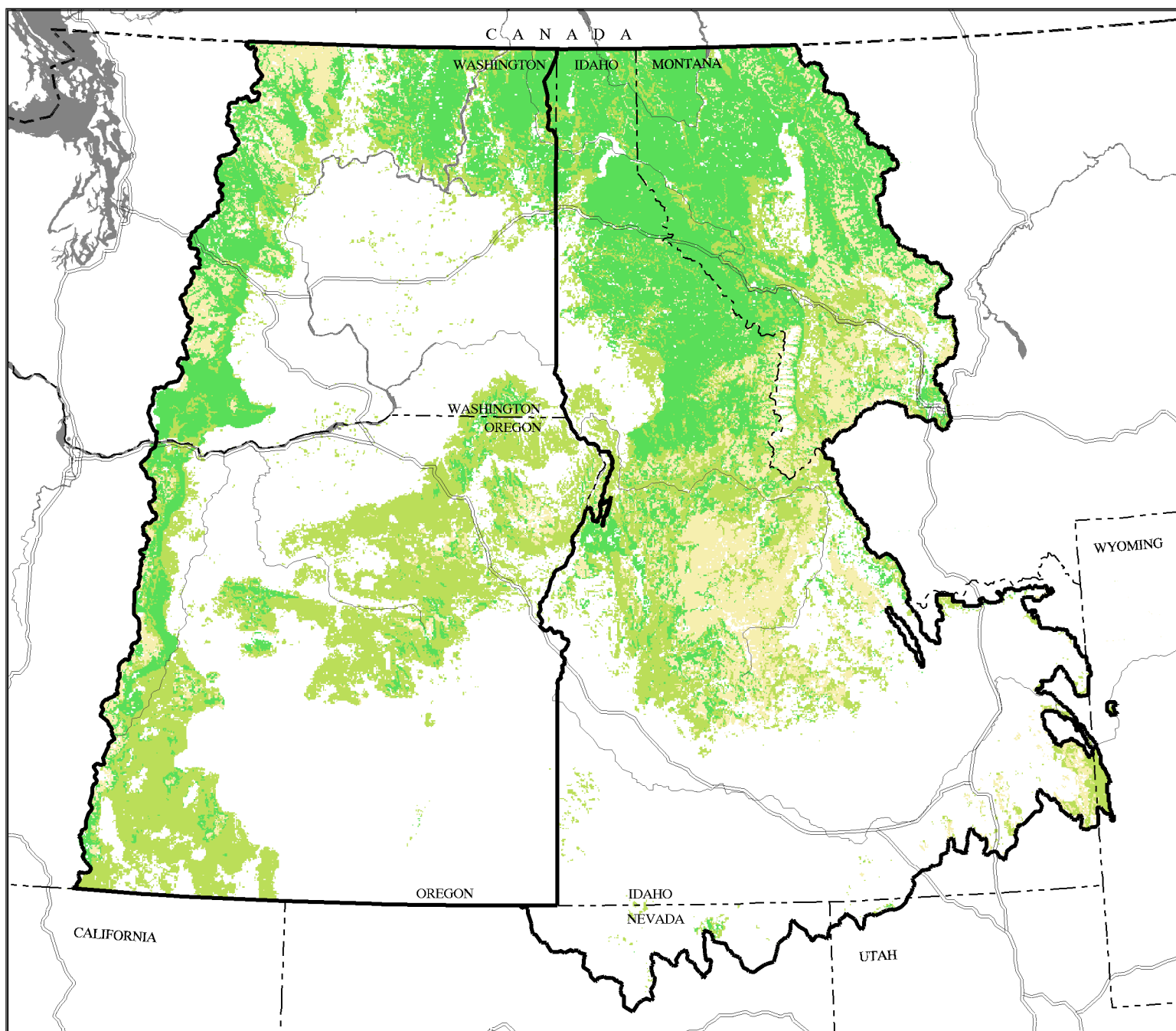
Map 2-9.
Forest Potential Vegetation Groups
Historical

INTERIOR COLUMBIA
 BASIN ECOSYSTEM
 MANAGEMENT PROJECT

Project Area
 1996



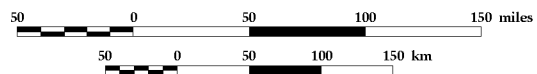
- | | |
|--------------|-----------------|
| Cold Forest | Major Rivers |
| Dry Forest | Major Roads |
| Moist Forest | EIS Area Border |



Map 2-10.
Forest Potential Vegetation Groups
Current

INTERIOR COLUMBIA
 BASIN ECOSYSTEM
 MANAGEMENT PROJECT

Project Area
 1996



- | | |
|--|---|
|  Cold Forest |  Major Rivers |
|  Dry Forest |  Major Roads |
|  Moist Forest |  EIS Area Border |

composition (percent of each species occurring on a site). These characterize changes that have occurred in successional and disturbance processes, which may indicate changes in ecological function and overall forest health.

Definition:
Historical Conditions

Historical conditions – The vegetation types, structural stages, dynamics, and other conditions and processes that are likely to have occurred prior to European settlement, approximately the mid-1800s. This time period is used only as a reference point to understand ecological processes and functions. In many cases it is neither desired, nor possible, to return to actual historical conditions.

Successional and disturbance processes have changed considerably since settlement of the

project area. New disturbances, such as timber harvest and the introduction of exotic species, as well as changes in the frequency or intensity of disturbance resulting from fire suppression or exclusion, have created conditions and disturbance regimes different from those which native plant and animal species adapted to. Table 2-11 shows the changes in fire regime in dry, moist, and cold forest potential vegetation groups from historic to current. Figures 2-8 and 2-9 summarize changes in structural stages and shade tolerance, by potential vegetation group, that have occurred on lands administered by the Forest Service or BLM in the project area.

Some terrestrial wildlife species are found in all potential vegetation groups in the project area. Similarly, shrub and grasslands occur in all potential vegetation groups, including forested areas. These areas, called transitory range, provide forage for wildlife and livestock. Terrestrial species that are common to all forested potential vegetation

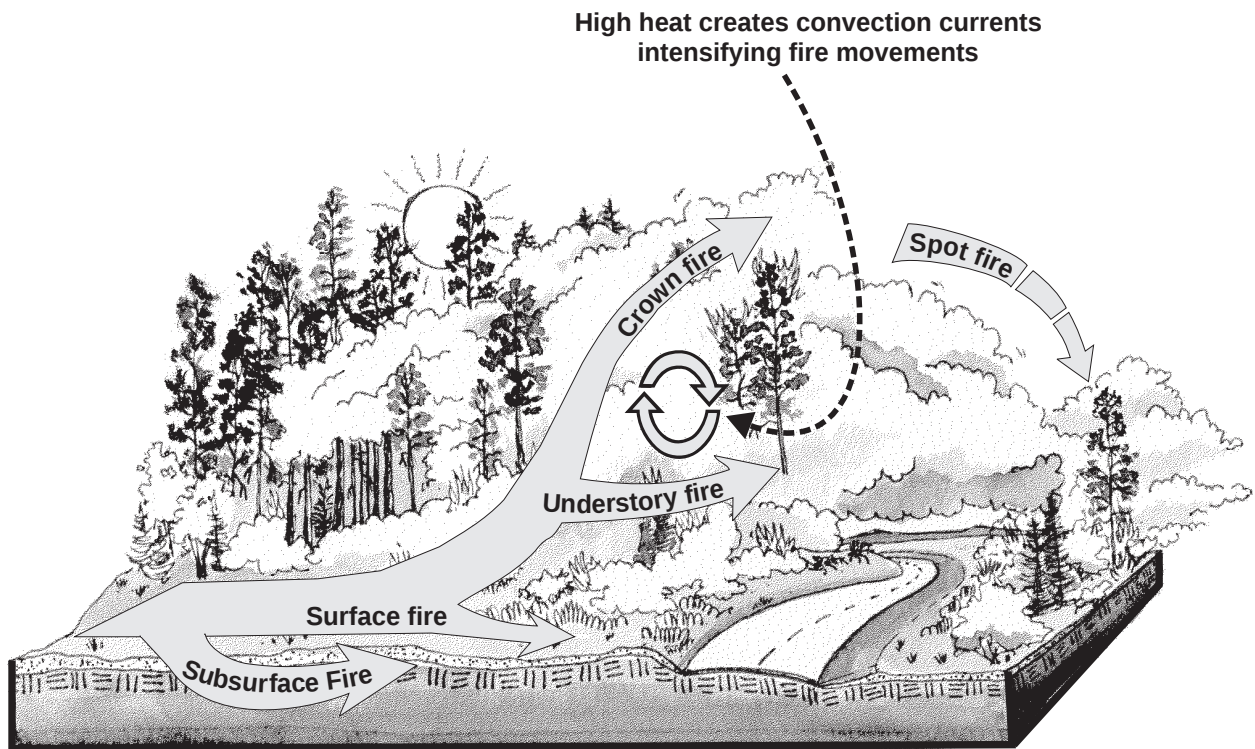


Figure 2-6. Fire Types ~ Fires are often referred to by which layer of available fuel is sustaining the spread of the fire. See Table 2-8 for fire terms and definitions.

Table 2-8. Fire Terms and Definitions (Forestlands/Rangelands).

Fire Term	Definition
Crown fire	A fire burning into the crowns of the vegetation, generally associated with an intense overstory fire.
Fire cycle	The average time between fires in a given area.
Fire regime	The characteristic frequency, predictability, intensity, seasonality, and extent of fires in an ecosystem.
Fire severity	The effect of fire on plant communities. For trees, it is often measured as the percentage of basal area killed by fire.
Fireline intensity	The rate of heat release along a unit length of fireline, measured in BTUs per foot per second often equated to flame lengths.
Fuel	Dry, dead vegetation which can readily burn.
Fuel ladder	Vegetative structures or conditions such as low-growing tree branches, shrubs, or smaller trees that allow fire to move vertically from a surface fire to a crown fire.
Fuel load	The dry weight of combustible materials per unit area; usually expressed as tons per acre.
Ground fire	A fire that burns along the forest floor, and does not affect trees with thick bark or high crown bases.
Lethal fire	A wildland fire that kills the overstory vegetation on a site. For example, a lethal fire in a forest would generally kill the overstory trees, either by crown scorch or by basal injury. A lethal fire in a grass/shrub community would kill the overstory of shrubs. Both fires are lethal, but there can be great differences in the actual fire intensity.
Non-lethal fire	Rangeland fires in which vegetation structure and composition, three years following the fire, are similar to pre-burn conditions.
Mixed fire	Fires possessing a mosaic of fire intensities which result in intermediate effects that vary across the landscape.
Prescribed fire	Intentional use of fire to achieve specific forest and soil management objectives; under controlled conditions, the area burned, smoke emitted, and fire intensity can be controlled.
Prescribed natural fire	A fire ignited by natural processes (usually lightning) and allowed to burn within specified parameters of fuels, weather, and topography to achieve specified resource management objectives.
Surface fire	A fire burning along the surface without significant movement into the understory or overstory, usually below one meter (three feet) flame length.
Underburn	Burn by a surface fire.
Understory fire	A fire that burns in the understory, more intense than a surface fire with flame lengths of one to three meters (three to nine feet).
Wildfire	A human or naturally caused fire that does not meet resource management objectives.

Abbreviations used in this table:

BTUs = British Thermal Units

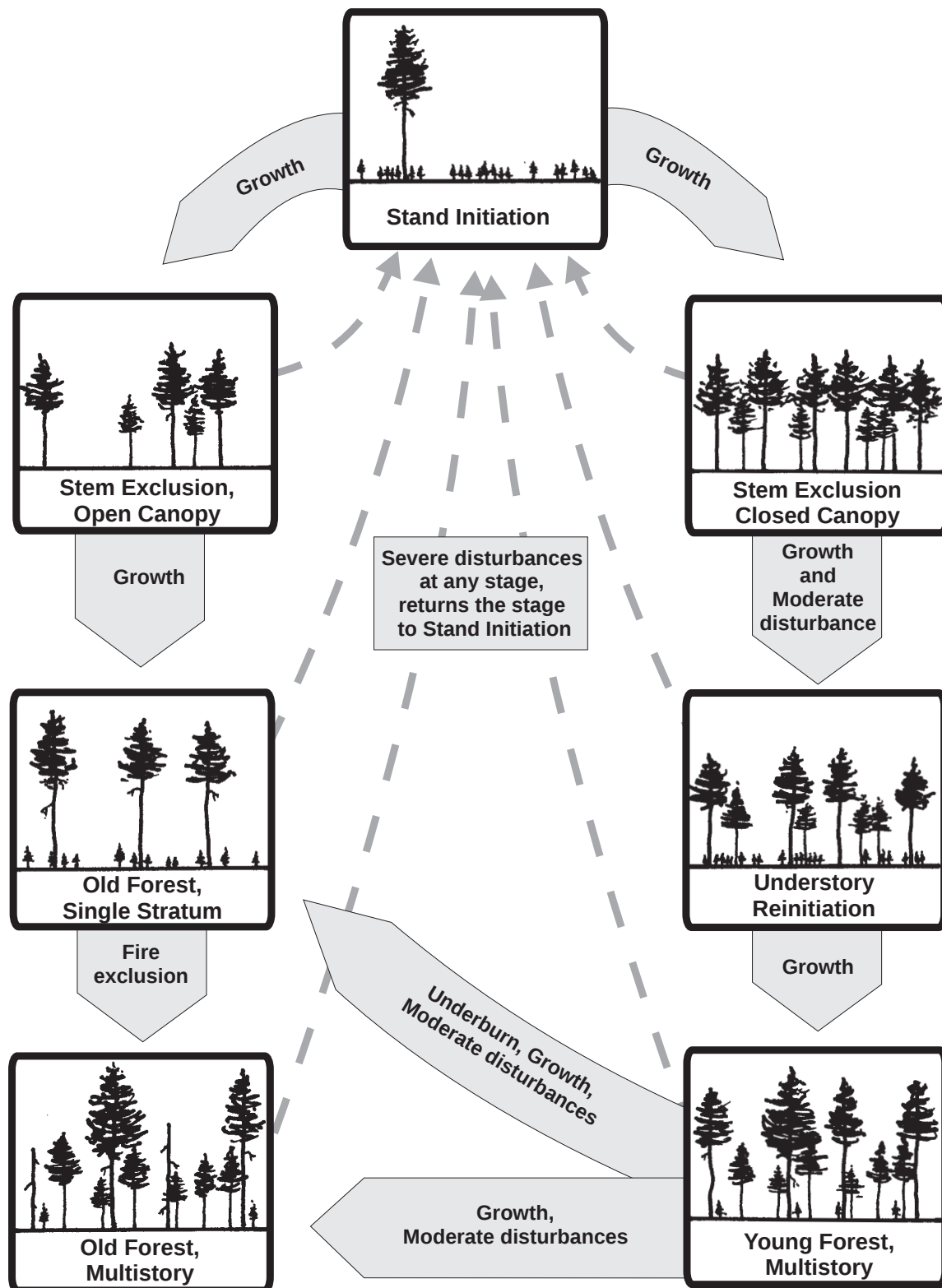


Figure 2-7. Forest Successional Stages ~ Potential forest succession stages are predictable changes in vegetation that can be described by stand structure, growth patterns, and disturbance patterns. Conditions of one successional stage create conditions that are favorable for the establishment of the next stage.

Table 2-9. Structural Stages Often Used to Describe Changes in Forest Vegetation Structure Over Time.

Structural Stage	Definition	Also Referred to As
Stand Initiation	When land is reoccupied by trees following a stand-replacing disturbance.	Early-successional Early-seral Regeneration
Stem exclusion-open canopy	Forested areas where the occurrence of new trees is predominantly limited by moisture.	Mid-successional Mid-seral Young forest
Stem exclusion-closed canopy	Forested areas where the occurrence of new trees is predominantly limited by light.	Mid-successional Mid-seral Young forest
Understory reinitiation	When a second generation of trees is established under an older, typically seral, overstory.	Mid-successional Mid-seral Young forest
Young forest multi-story	Stand development resulting from frequent harvest or lethal disturbance to the overstory.	Mid-successional Mid-seral Young forest
Old multi-story	Forested areas lacking frequent disturbance to understory vegetation.	Late-successional multi-story Late-seral multi-story Old forest multi-story
Old single-story	Forested areas resulting from frequent non-lethal prescribed or natural underburning, or other management.	Late-successional single-story Late-seral single-story Old forest single-story

Table 2-10. Common Shade-Tolerant/Intolerant Tree Species in the Planning Area.

Shade-tolerant Tree Species	Shade-intolerant Tree Species
Grand fir	Pacific ponderosa pine
White fir	Interior ponderosa pine
Douglas-fir (sometimes)	Lodgepole pine
	Douglas-fir (sometimes)
	Western larch (sometimes)

groups, and to transitory range, are discussed next. Wildlife species that occur predominantly in one or two potential vegetation groups are discussed in those sections.

Terrestrial Wildlife Species and Habitats

This section describes the wildlife species common to all forested vegetation groups in the project area, their status if federally listed as a threatened, endangered, or candidate species, list, and their habitat requirements.

Large Carnivores and Omnivores

Carnivores are those species that eat only meat, while omnivores eat a combination of meat and vegetation. The project area includes six species of large carnivores and omnivores including grizzly and black bears, gray wolves, mountain lions, lynx, and wolverine. The grizzly bear (threatened) and gray wolf (endangered) are federally listed under the Endangered Species Act of 1973, as amended; two carnivores (the lynx and fisher) have recently undergone a status review by the U.S. Fish and Wildlife Service to determine whether they should be listed. Two other carnivore species are considered species of concern (see Glossary) by the U.S. Fish and Wildlife Service: the Pacific fisher and American marten. These species are at the top of the food

chain (see Figure 2-10) and are indicators of total biodiversity and ecosystem health. As such, they are susceptible to changes in habitat, especially changes associated with human activities, such as road building, traffic, recreation, logging, mining, and grazing, all of which occur in forested ecosystems. Unroaded areas and wildernesses that exceed various species' home ranges, are essential for their continued existence, especially those whose ranges that extend into Canada. These areas provide for emigration to help re-establish forest carnivores and omnivores.

The Canada lynx, which evolved in areas with patches of regeneration and old forest, now have to travel greater distances to find food and denning sites (Martin et al. 1995). Areas with moist forests, such as the Northern Cascades (ERU 1), have become more isolated as cover needed for travel between patches is removed by highways, cities, rural housing, and reservoirs, causing barriers to migration. These changes have negative effects on grizzly bears, wolves, wolverine, and fisher, which have lost much of their historical range (Martin et al. 1995, and Marcot et al. in Everett et al. 1994).

Some carnivores and omnivores in northern portions of the project area, such as the grizzly bear, gray wolf, Canada lynx, wolverine, Pacific fisher, and American marten, interact with populations in British Columbia and Alberta Canada. The Northern Glaciated Mountains (ERU 7) contain large blocks of wilderness and unroaded lands in both the moist forest and subalpine cover types. These areas interconnect with habitat blocks in Canada and have the greatest species richness of forest carnivores in the project area. These large, mobile species have large home ranges and often run into conflicts with humans and livestock when wildlife habitat is reduced.

Map 2-11 shows some of the key linkage areas for terrestrial species in the project area.

Federally Listed Threatened, Endangered, and Candidate Species

As of May 1996, the bald eagle, grizzly bear, northern spotted owl, marbled murrelet, water howellia, and MacFarlane's four-o'clock were federally listed as threatened terrestrial species; the peregrine falcon, woodland caribou, gray wolf, Malheur wire-lettuce, and Applegate's milkvetch were endangered species; and the



Seral Stages

Seral stages are identified vegetation groups, based on plant species, disturbance patterns, and growth patterns. Stages transition until they reach a climax stage.

Table 2-11. Changes in Fire Regime in Forest Potential Vegetation Groups for FS- and BLM-administered Lands.

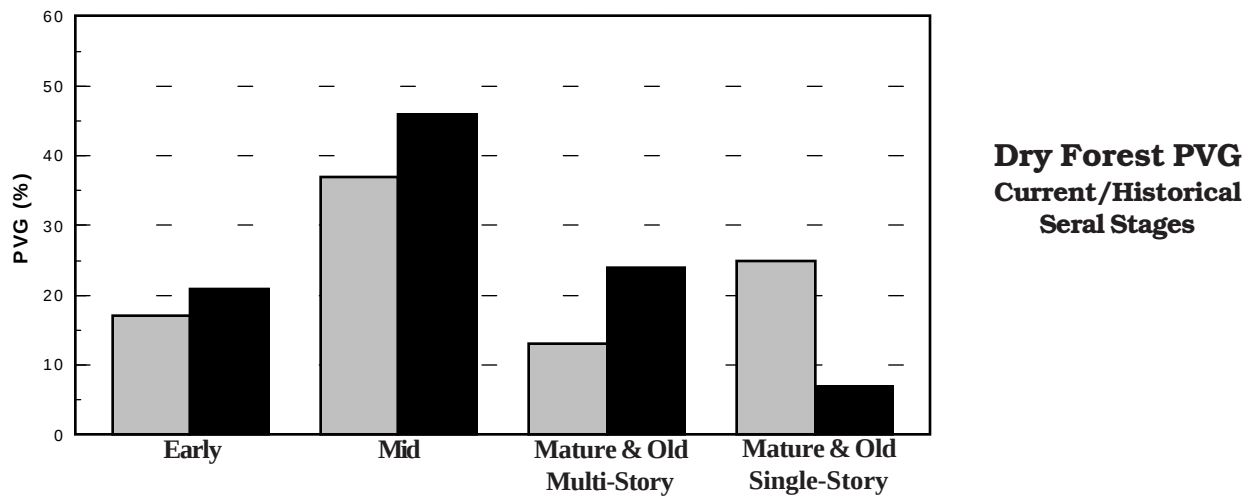
Fire Regime Class	Cold Forest Historic	Cold Forest Current	Moist Forest Historic	Moist Forest Current	Dry Forest Historic	Dry Forest Current
	<i>percent</i>					
Rarely Burns or No Data	2	2	2	2	0.2	0.2
Nonlethal, very frequent (<25 years)	0	0	30	0	71	0.2
Nonlethal, frequent (26 - 75 years)	12	0	4	0	7	0.1
Nonlethal, infrequent (76 - 150 years)	2	0	7	17	5	45
Total Nonlethal	14	0	41	17	83	45
Mixed, very frequent (<25 years)	0	0	0.8	0	0	0
Mixed, frequent (26 - 75 years)	5	0	20	3	0.1	3
Mixed, infrequent (76 - 150 years)	62	55	16	23	6	35
Mixed, very infrequent (151 - 300 years)	4	0	4	0	0	0
Total Mixed	71	55	40	26	6	38
Stand-replacing, very frequent (<25 years)	0	0	0	0	0	0
Stand-replacing, frequent (26 - 75 years)	2	0	3	1	9	0
Stand-replacing, infrequent (76 - 150 years)	0	6	4	31	2	17
Stand-replacing, very infrequent (151 - 300 years)	11	38	9	23	0	0.2
Stand-replacing, extremely infrequent (>300 years)	0	0	0	0	0	0
Total Stand-replacing	13	44	16	55	11	17

Abbreviations used in this table:

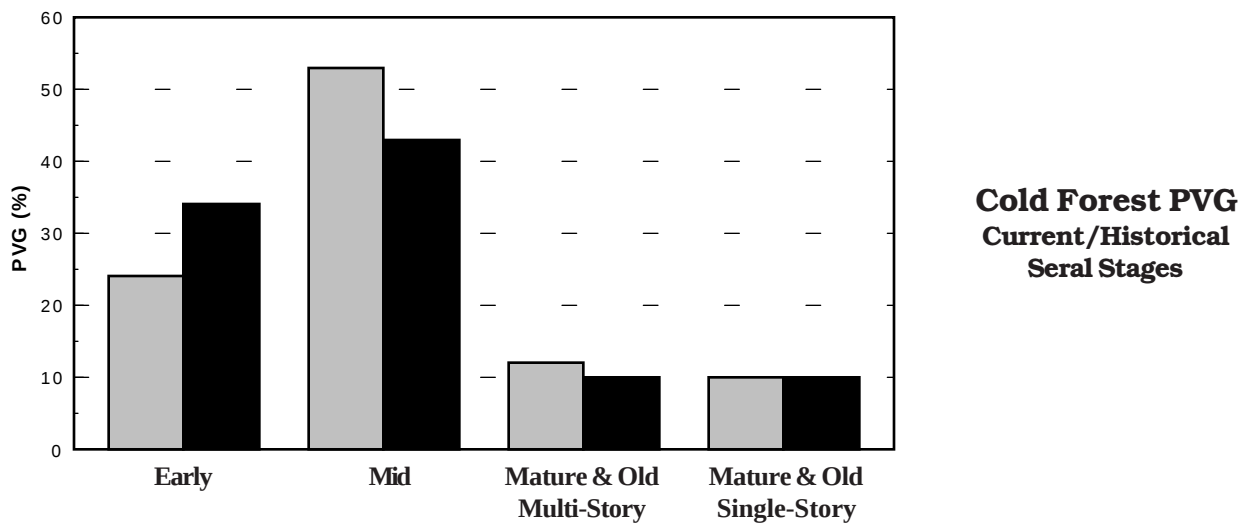
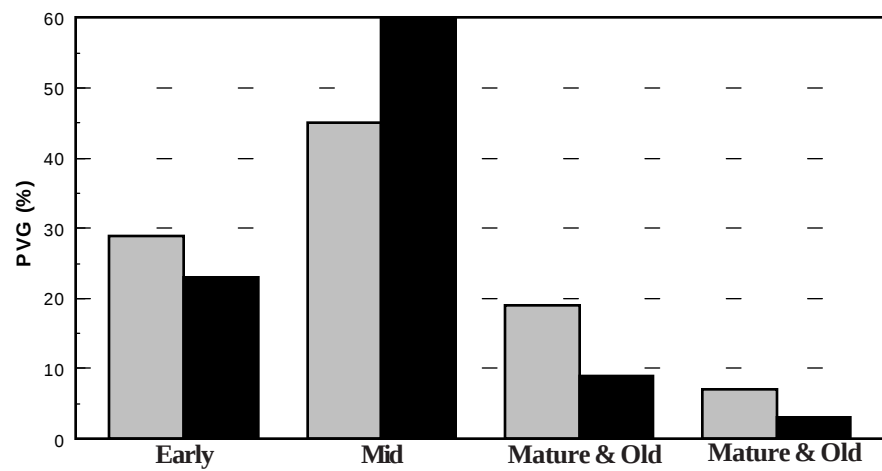
FS = Forest Service

BLM = Bureau of Land Management

Source: ICBEMP GIS data (1 km² raster data).

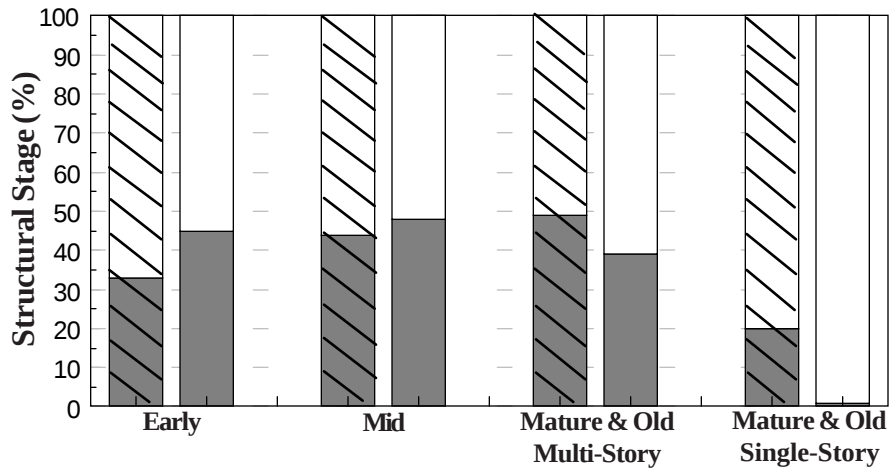
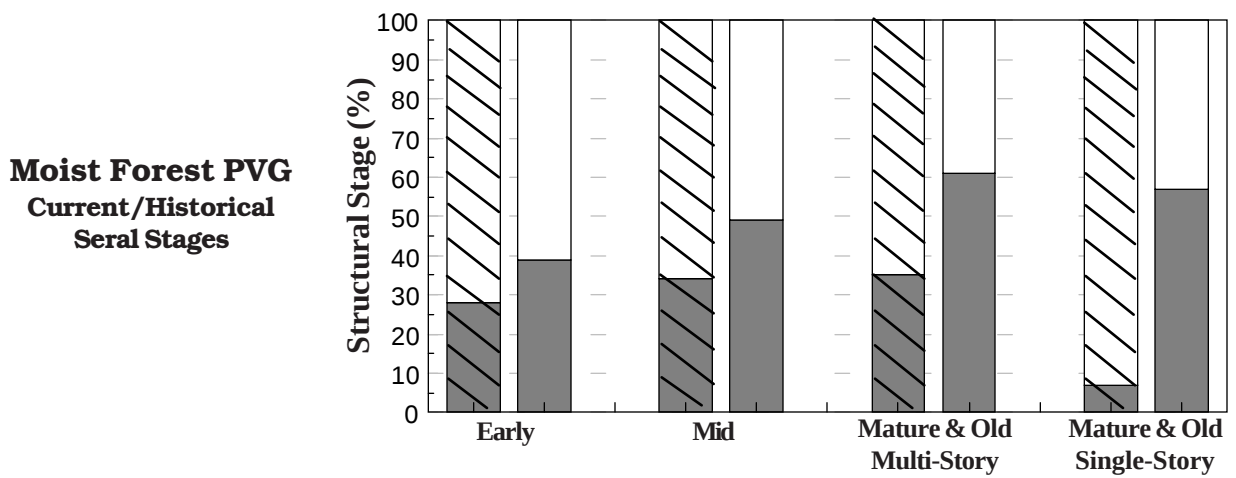
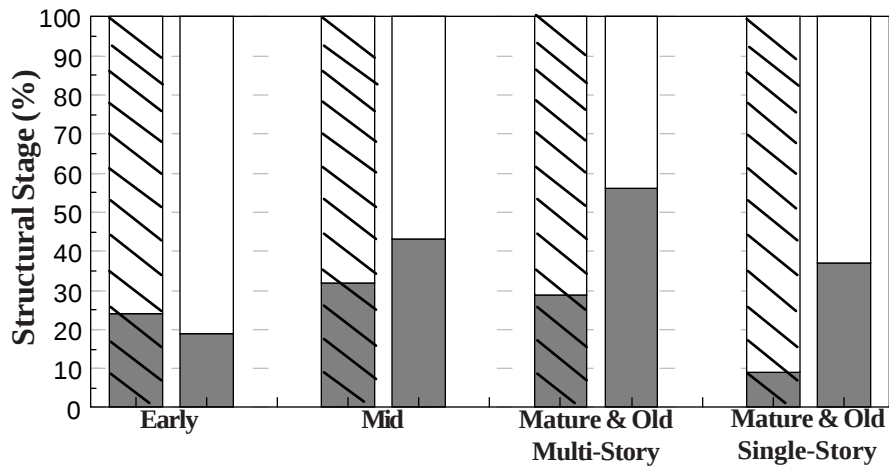


Moist Forest PVG
Current/Historical
Seral Stages



■ Historical ■ Current

Figure 2-8. Current/Historical Seral Stages - Dry, Moist, and Cold expressed as a percentage of the Potential Vegetation Group (PVG), in the Project Area.



Historic (T)
 Historic (I)
 Current (T)
 Current (I)

Figure 2-9. Shade Tolerance (T) vs. Intolerance (I) - for forested lands administered by the Forest Service or BLM, in the Project Area.

Energy Flow ~ Wildlife in the Food Web

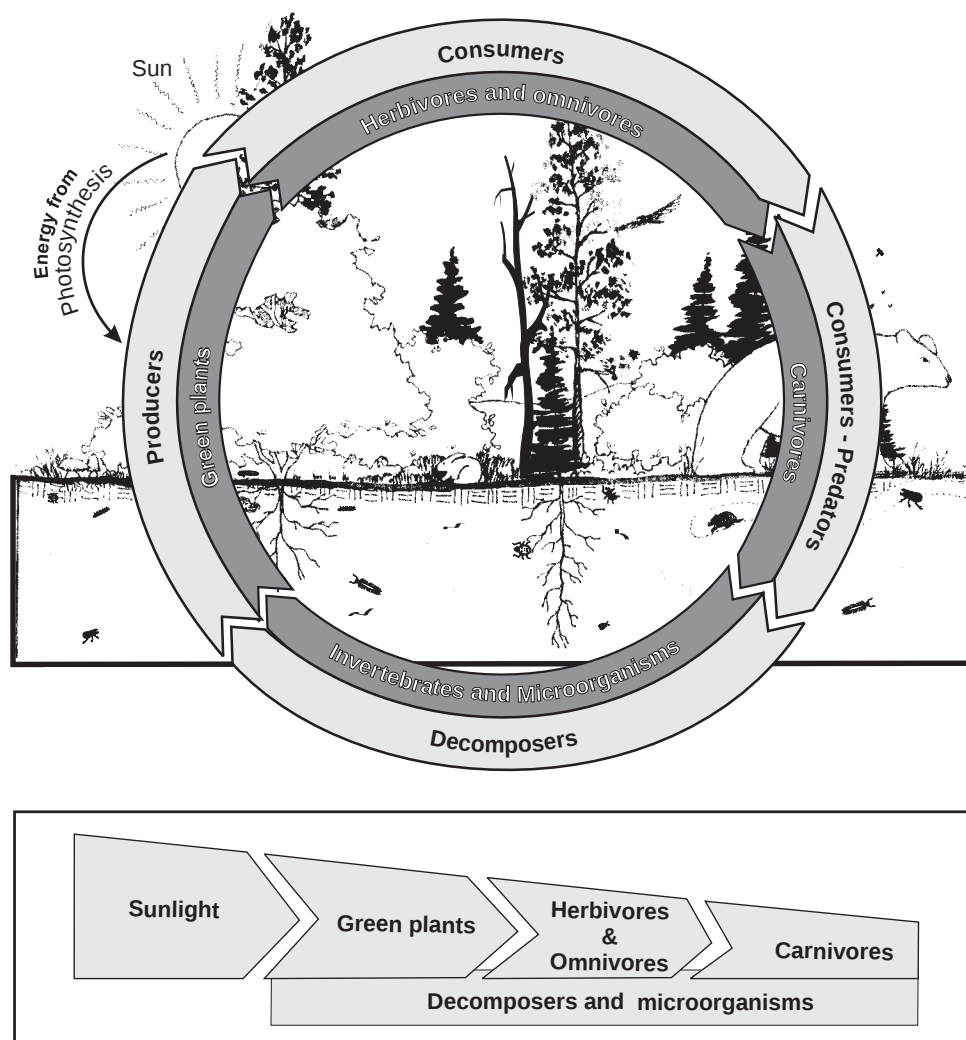
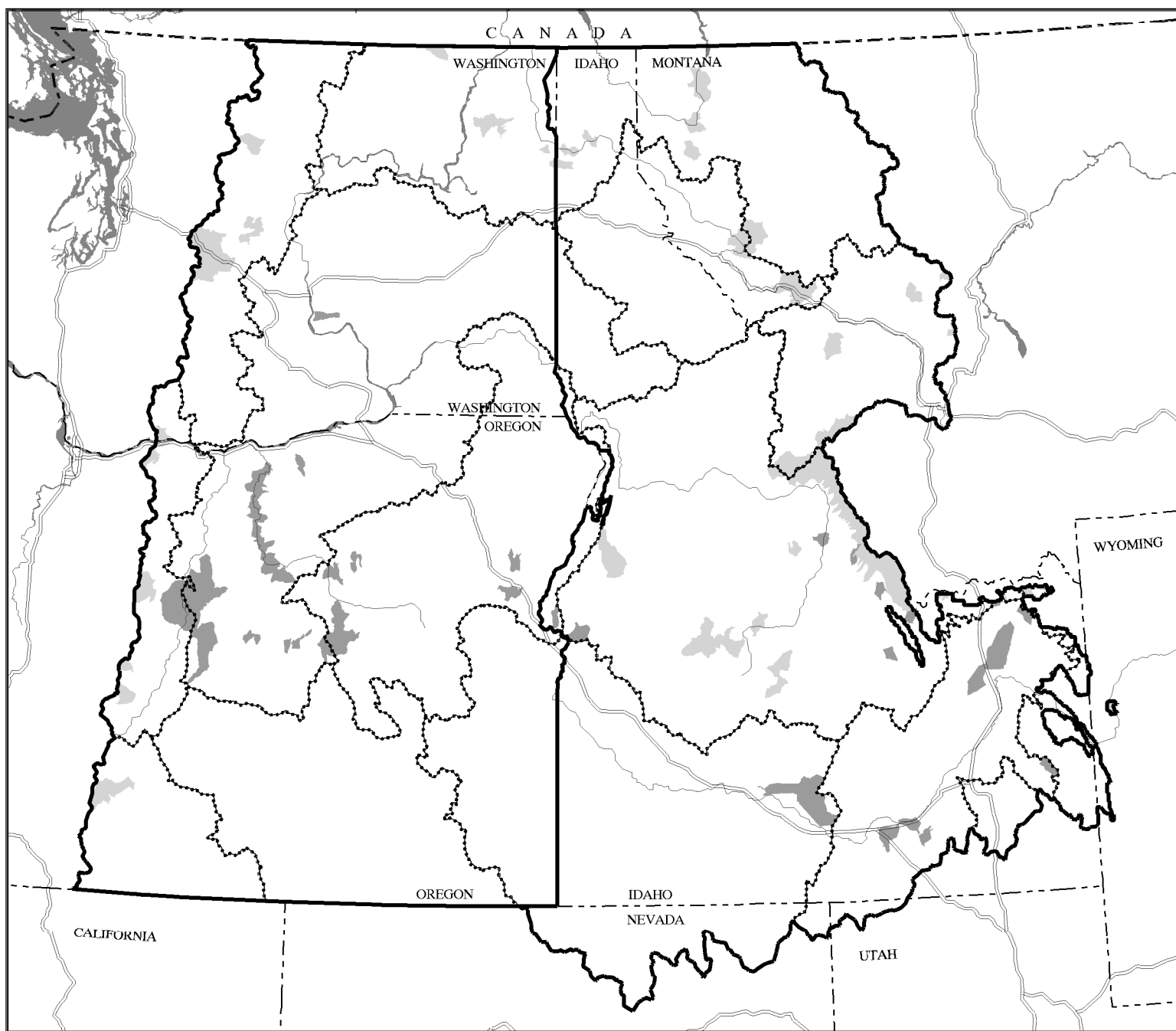


Figure 2-10. Energy Flow - Terrestrial Food Chain

Life on earth depends upon energy, which is supplied by the sun. On land, this energy then flows through organisms in a predictable way, call a terrestrial food chain.

Energy from the sun is trapped by plants (for example, trees, shrubs, and grasses) in a process called photosynthesis. This energy then is transferred to animals (for example a herbivore, like a cow, or an omnivore, like a bear) that eat plants. Predators are the next step of the food chain, for they often eat animals that eat plants. Eventually, organisms die and the energy that is stored in their bodies is taken up by decomposers. In each step of the terrestrial food chain, from the sun to plants, from plants to herbivores, from herbivores to predators, and from these organisms to decomposers, some energy is lost as heat. Thus, the amount of useful energy, which is the energy available to produce body tissue, decreases. This is why, if we compare the weight, or mass, of plants on the earth, it far exceeds the mass of predators. If humans wish to continue to observe grizzly bears in the wild, or graze cattle on rangeland, for example, we need to recognize that energy flow through a food chain is necessary for these animals to exist and for us to make a living from them, if we desire. How we manage the plants for example, has a bearing on how many cattle we can produce and how many grizzly bears we can observe in the wild.



Map 2-11.
Key Linkages in
Terrestrial Habitats

INTERIOR COLUMBIA
BASIN ECOSYSTEM
MANAGEMENT PROJECT

Project Area
1996



- | | |
|-----------------------|-----------------------------------|
| Upper Montane Linkage | Major Rivers |
| Shrub Steppe Linkage | Major Roads |
| | EIS Area Border |
| | Ecological Reporting Unit Border* |

*Ecological reporting unit names and numbers are found on Map 1-1.

spotted frog, Howell's spectacular thelypody, basalt daisy, and Oregon checkermallow were candidate species. Threatened, endangered, and candidate fish species are listed in the Aquatics section. Table 2-12 provides the number of terrestrial species that are known or estimated to exist in the project area; the number of federally listed threatened, endangered, candidates and proposed species; and BLM- or Forest Service-designated sensitive species. All of the listed threatened or endangered species, except the gray wolf, have recovery plans or strategies approved by the U.S. Fish and Wildlife Service. Although a recovery plan has not been approved for wolves, there is an EIS for reintroduction into Yellowstone Park. No reintroduction areas for wolves are identified in Washington or Oregon. To date there is no confirmed evidence of year-round occupancy by grizzly bears in the Northern Cascades (ERU 1). See maps in Appendix 2-1 for wolf, grizzly bear, and caribou recovery areas.

Populations of bald eagles and peregrine falcons have increased to the point that bald eagles were recently reclassified from federally endangered to threatened in the lower 48 states, and there is a proposal to remove peregrine falcons from the list of endangered species (U.S. Fish & Wildlife Service Notices 1995). In both cases, the primary reason for recovery is restriction of pesticides that caused eggshell thinning and reproductive failures, but habitat improvement and road management has also contributed to their increase.

There are two candidate animal species in the planning area ~ the spotted frog and the bull trout. The spotted frog is known to exist in just two areas in southern Oregon in ERU 3 (Upper Klamath). Not all federal candidate species or agency sensitive species are necessarily in decline; some species are little-known or naturally rare because of habitat rarity. It is suspected that no vertebrate species have gone extinct throughout their range in the project area in recent decades, although it is possible that undescribed, locally endemic species or subspecies might have vanished before they could be studied.

Habitat Needs for Threatened and Endangered Species in the Project Area

The Northwest Forest Plan set the stage for recovery of both the marbled murrelet and the northern spotted owl. The marbled murrelet, a federally threatened species, is a small seabird that nests in old forests within approximately 55 miles of the ocean. The distance from the ocean for Zone One and Zone Two habitat for the marbled murrelet varies by state (California, Oregon, and Washington). The planning area contains only Zone Two habitat for the marbled murrelet. In Washington state, Zone Two habitat is within 30 to 55 miles from the ocean, and in the Northern Cascades (ERU 1; see Map 2-12). Retention of blocks of multi-story, mature, or old forests with large trees is important to the survival of this species.

Table 2-12. Numbers and Status of Terrestrial Wildlife Species in the Project Area¹.

Type	Total # of Species		Threatened	Endangered	Proposed	Candidate	FS/BLM Sensitive
	Known	Estimated					
Invertebrate	3,780	24,270	1	5	0	0	23
Amphibian	26	26	0	0	0	1	11
Reptile	27	27	0	0	0	0	9
Bird	283	283	3	2	0	1	85
Mammal	132	132	1	2	0	1	30

Abbreviations used in this table:

FS = Forest Service

BLM = Bureau of Land Management

¹ Federally listed, proposed, or candidate species are as of July 1996. Does not include fish.

Source: Marcot et al. (1996); Sensitive List, see Appendix 2-1.

The northern spotted owl nests in moist forest stands of mature and old forest just east of the Cascade Crest. Unlike spotted owls west of the crest, owls on the eastside also use multi-story, old and younger second growth stands created through timber harvest. These stands have a greater dominance of fire-intolerant species, such as grand fir, Douglas-fir, and hemlock (Proposed Rules, U.S. Fish & Wildlife Service 1995). Habitat for the northern spotted owl in the planning area occurs from the Canadian border to the California border along the eastside of the Cascade Range. This area is generally shown in Map 1-3, which shows the overlap of the Northwest Forest Plan with the Eastside EIS. Fire suppression and timber harvest have created these stand conditions, but there is concern that they may not be sustainable with the predicted fire, insect, and disease regimes of eastside forests (Northwest Forest Plan 1993).

Woodland caribou only inhabit the planning area in the extreme northeast corner of Washington where two small populations exist (U.S. Fish & Wildlife Service Status Report 1995). Woodland caribou interact with populations in British Columbia and Alberta in Canada. Caribou inhabit Engelmann spruce/subalpine fir and western red cedar/western hemlock, mature or old forest stands. Although woodland caribou populations have been stable, there is concern that low reproductive success, increasing predation by mountain lions, poaching, and harassment from snowmobiles and other vehicles could drive caribou to extinction (U.S. Fish & Wildlife Service Status Report 1995).

Although not required to the same degree by all of these species, late and old forest structure and old forests are important habitats, especially for the bald eagle, northern spotted owl, marbled murrelet, and woodland caribou. Detailed discussions of ecological niches and roles and habitat requirements for listed species can be found in the appropriate recovery plan or reintroduction EIS.

Peregrine falcons require high cliffs for nesting (at least 30 feet in height) where they are secure from predators. It is important for peregrines to have adequate bird prey populations in areas surrounding the cliffs.

Eastern Oregon and Washington are important wintering areas for bald eagles. Wintering eagles require large hardwood or conifer trees (over 16

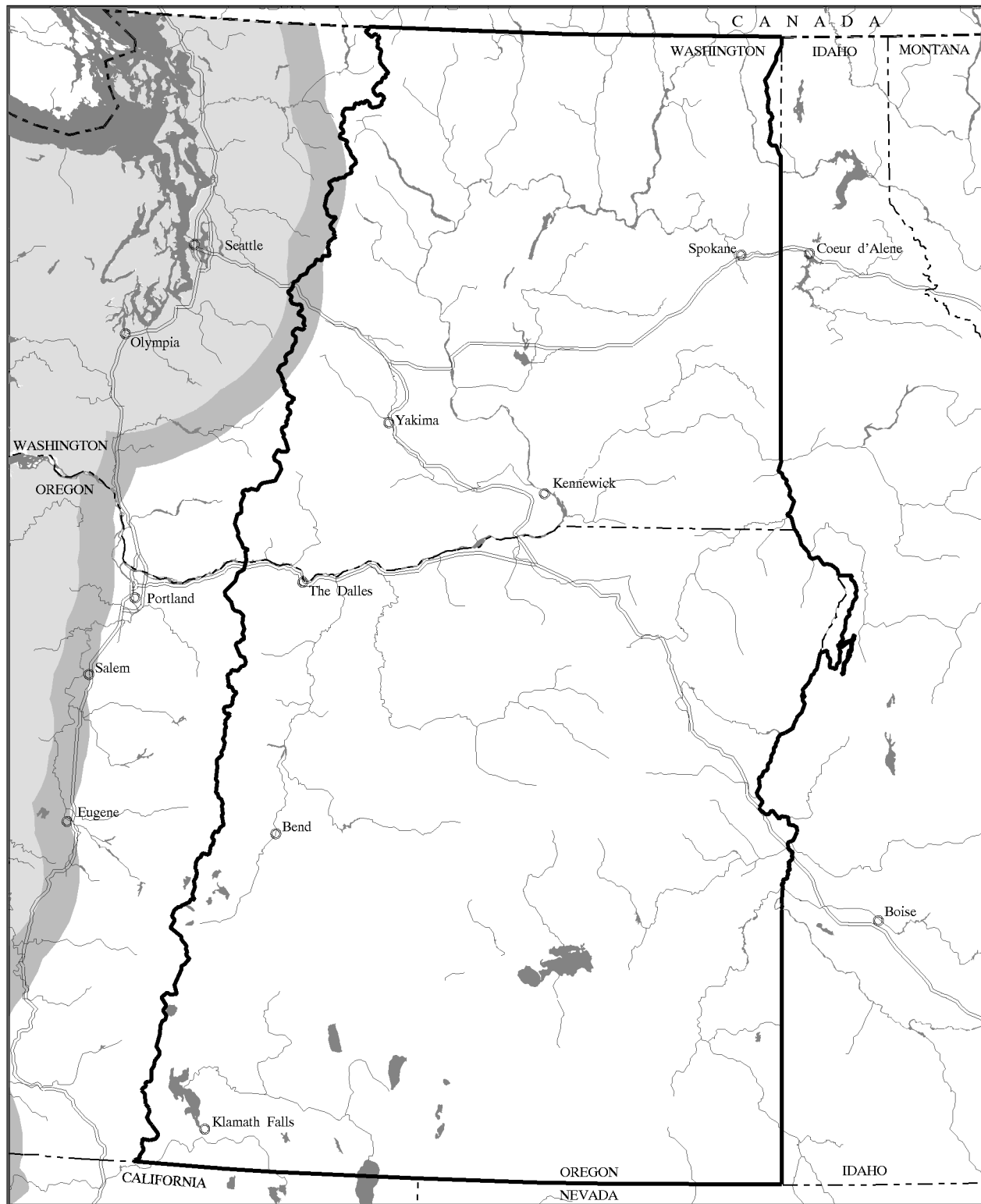
inches in diameter) near ice-free bodies of water that contain fish. Nesting eagles need large trees in late successional forests with low levels of human disturbance. Nest habitat usually exists within one mile of water that supports fish and waterfowl. Large, dead trees are used by a variety of predatory birds for roosting (U.S. Fish & Wildlife Service 1995).

Rangelands in Forested Areas (Transitory Rangelands)

Rangelands in forested areas are called transitory rangelands. These lands are suitable for grazing; however, because transitory rangeland changes over time, its availability also changes. These rangelands are generally associated with timber harvest activities which open up the tree canopy. Transitory rangeland can also be created by major fires or insect and disease events. Understory plant species suitable for grazing grow well in these newly opened areas because there is less competition for sunlight and moisture. Transitory rangeland is found in dry, moist, and cold forest potential vegetation groups.

A significant portion of annual forage production for livestock can come from transitory rangeland, particularly in heavily forested areas. Although disturbance events that help create transitory rangeland allow forage values to increase, these values will decrease over time as trees increase and the stand reverts to pre-disturbance levels. Transitory rangeland areas typically remain important foraging areas for approximately 20 years.

Timber practices that maintain open canopy conditions will prolong forage production on transitory rangelands. Available forage increases are directly related to the amounts and types of timber harvest activities. Plant palatability, forage quantity, and nutrient content all increase as plants are exposed to more moisture and sunlight after removal of the forest canopy. Usable forage within timber harvest areas can decrease in the first few years after harvest because of downed trees, debris left following harvest, and disturbance to the site from harvest and debris removal. Shrubs, forbs, and grasses may require a few years to grow to a point where they can be grazed successfully. Livestock may be discouraged on some sites until tree regeneration is adequate and established.



Map 2-12.
Marbled Murrelet Zones

INTERIOR COLUMBIA
BASIN ECOSYSTEM
MANAGEMENT PROJECT

Draft EASTSIDE EIS
1996

- | | | | |
|---|--------|---|------------------|
|  | Zone 1 |  | Major Rivers |
|  | Zone 2 |  | Major Roads |
|  | Water |  | EIS Area Border |
| | |  | Cities and Towns |

Dry Forest Potential Vegetation Group

Table 2-11 lists the various potential vegetation types in the dry forest group.

Current Distribution

Sixty-nine percent of the dry forest potential vegetation group is found above 4,000 feet in elevation, and currently makes up 18 percent of the project area. Of that percentage, the Forest Service and BLM administer 56 percent. Forest stands in dry forests are generally limited by low moisture, and are often subject to drought. Dry forest areas can also be stressed by limited nutrients if surface soils are eroded or displaced, or if tree density is high.

Composition and Structure

Tree species that make up dry forests are those capable of surviving in dry environments, and with disturbance processes typical of these environments. The historical distribution of dominant shade-tolerant and shade-intolerant tree species in the dry forest potential vegetation group is shown on Map 2-13; current distribution is shown on Map 2-14.

Rates of growth are faster for trees that are grown out in the open with good root systems,

but are generally slow for the regeneration and old tree stages in dense forest communities. The length of time in herb, shrub, and regeneration forest stages is generally relatively long, often of almost equal length to the young forest stage. Shrubs and grasses are usually fairly productive in open communities, but relatively unproductive in closed communities.

Ponderosa pine is widely distributed throughout dry forests in eastern Oregon and Washington. Of the tree-dominated vegetation east of the Cascades, only western juniper woodlands occur on sites that are warmer and drier than those for ponderosa pine communities. Other trees associated with ponderosa pine forests are western juniper, quaking aspen, lodgepole pine, and Oregon white oak (Johnson, Clausnitzer, Mehringer, and Oliver 1994).

As dry forests transition toward moist forests, tree species such as Douglas-fir, grand fir, and white fir may become the dominant species. If forests have frequent low intensity fires burning close to the ground (underburning), fire will thin tree stands, and will favor ponderosa pine and western larch that are relatively resistant to fire damage and grow best in open, well-spaced stands (see Figure 2-11). The rapid growth of pine and larch allow them to become large enough between disturbances to resist low intensity fires. Shade-tolerant species are more susceptible to damage by fire until they become

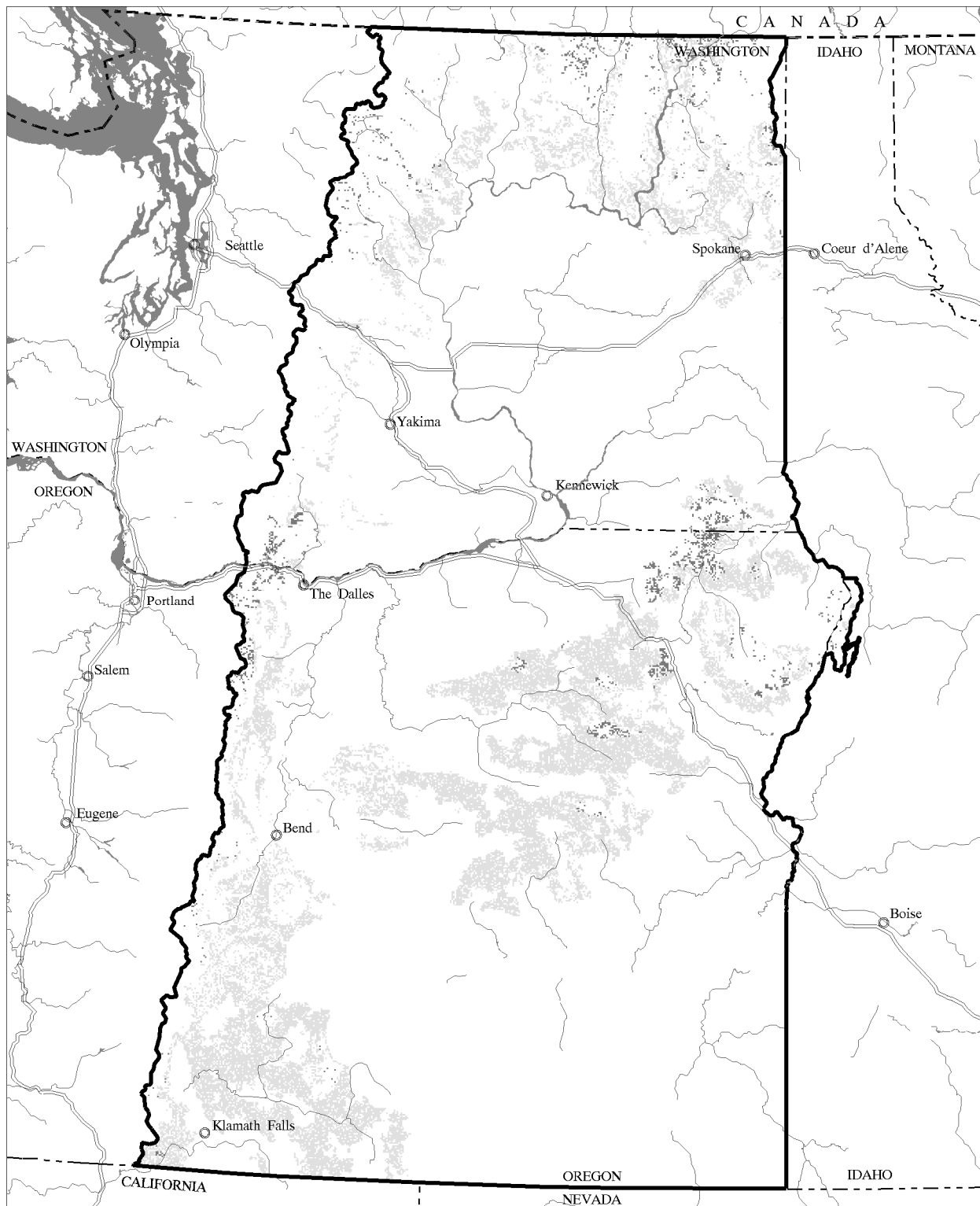
Special Status Species

Special status species include federally listed threatened or endangered species; federal candidate species; species recognized as requiring special protection by state agencies and species managed as sensitive species by the Forest Service and/or BLM.

The Endangered Species Act of 1973, as amended, provides a program for the conservation and recovery of threatened or endangered species, as well as a means to protect the ecosystems such species depend upon. According to the U.S. Fish and Wildlife Service, an **endangered species** is any species in danger of extinction throughout all or a significant portion of its range. A **threatened species** is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Candidate species are those that may be proposed (as threatened or endangered) and listed in the future. The U.S. Fish and Wildlife Service recently revised its list of candidate species (February 28, 1996 Federal Register). Under their new system, only those species for which they have enough information to support a listing proposal will be called candidates.

Other management agencies use additional terminology to identify rare species. The Forest Service and the BLM maintain regional lists of **sensitive** species and species of concern for which there are significant current or predicted downward trends in population numbers, density, or habitat capability. Some species are listed due to natural conditions which limit numbers and distribution.

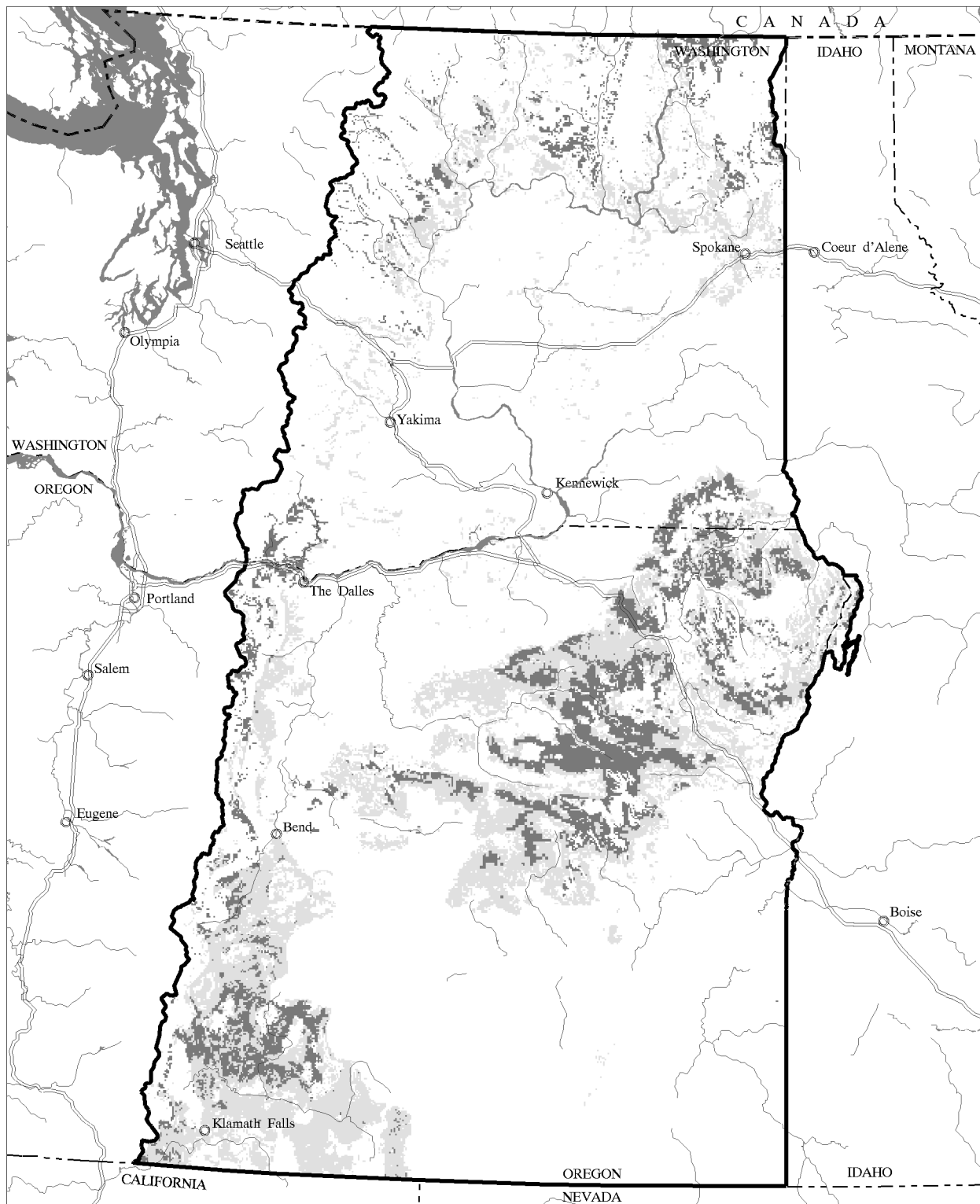


Map 2-13.
Dry Forest Distribution
Historical

INTERIOR COLUMBIA
BASIN ECOSYSTEM
MANAGEMENT PROJECT

Draft EASTSIDE EIS
1996

- | | | | |
|---|--------------------------------------|---|-------------------------|
|  | <i>Shade-tolerant Tree Species</i> |  | <i>Major Rivers</i> |
|  | <i>Shade-intolerant Tree Species</i> |  | <i>Major Roads</i> |
| | |  | <i>EIS Area Border</i> |
| | |  | <i>Cities and Towns</i> |



Map 2-14.
Dry Forest Distribution
Current

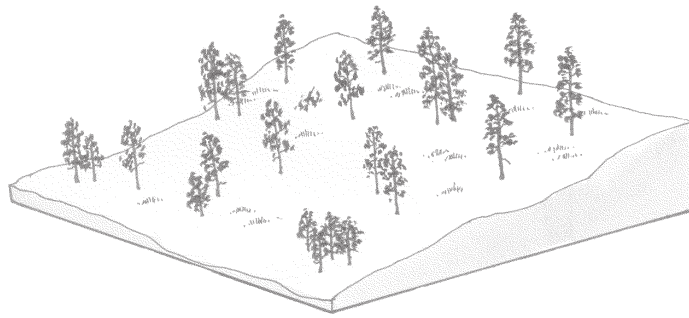
INTERIOR COLUMBIA
 BASIN ECOSYSTEM
 MANAGEMENT PROJECT

Draft EASTSIDE EIS
 1996

- | | | | |
|---|--------------------------------------|---|-------------------------|
|  | <i>Shade-tolerant Tree Species</i> |  | <i>Major Rivers</i> |
|  | <i>Shade-intolerant Tree Species</i> |  | <i>Major Roads</i> |
| | |  | <i>EIS Area Border</i> |
| | |  | <i>Cities and Towns</i> |

large and mature. Therefore, frequent fires reduce their presence in forests. In areas with longer fire-free intervals, some Douglas-fir, grand fir, or white fir grow large enough to resist destruction by fire (Keene et al. 1990). The amount of Douglas-fir, grand fir, or white fir present in stands is generally determined by the amount and type of fire that the stand experienced throughout its history (Agee 1994).

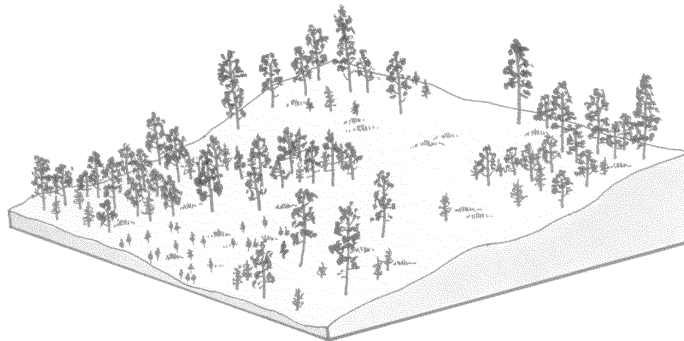
Quaking aspen is one of the non-coniferous trees associated with the dry forest potential vegetation group. Aspen is a deciduous tree species which occurs in relatively moist habitats within natural openings of forest stands. Non-tree vegetation in dry forests is remarkably diverse. Shrub and herb species have evolved under natural fire regimes, and moderate grazing pressure and soil disturbance. Shrubs are



A. Non lethal Fire Regime

Open stand pattern.

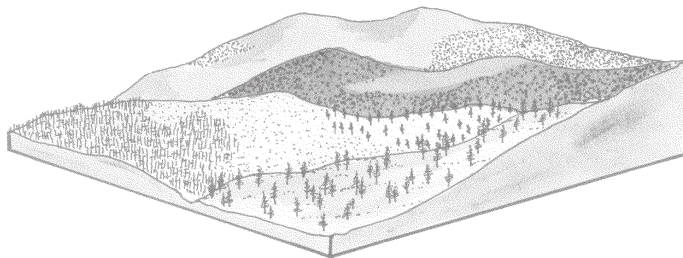
Frequent low-severity fires.



B. Mixed Fire Regime

Patches of clumps/gaps.

Generally a greater time span between fires than the non-lethal fire regime.



C. Lethal Fire Regime

Large patches of stand-removing fire. Generally a longer time span between fires than the non-lethal fire regime.

Figure 2-11. Fire Regimes/Patterns ~ Three general fire regimes create definite landscape vegetation patterns.

generally widely spaced in the understory beneath tree cover, and are fire-tolerant and shade-intolerant. Spaces between shrubs is generally occupied by fire-tolerant and shade-intolerant grasses and forbs.

The dry forest potential vegetation group frequently shares lower elevation edges with grasslands, which form alternating vegetative patterns interspersed with tree-dominated stands. Between grassland and tree-dominated patches, shrubs may be dense. Shrub species in this ecotone (transitional zone between adjacent plant communities) include: snowbrush, mallow ninebark, common snowberry, antelope bitterbrush, and kinnikinnik. Herbaceous species throughout dry forests include: elk sedge, Wheeler's bluegrass, cat's ear, mariposa lily, harsh paintbrush, silky lupine, and few-flowered pea.

Historical Conditions

When European settlement of the area began, ponderosa pine forests could be characterized as unbroken parklands of widely spaced tree clumps with a continuous understory of grasses and flowering plants. Ponderosa pine forests were fairly stable, maintained by frequent, low intensity fires. Regeneration of young trees in areas created where trees were attacked by bark beetles or where fire climbed into the crowns of trees infected by dwarf mistletoe, was usually in small groups of the same age. The resulting small stands were thinned by frequent fires (Agee 1994).

In dry forests, mortality of small trees from fire, insects, disease, and competition among trees was common prior to widespread fire suppression. Old forests of large trees with one canopy layer were typically found in more gentle terrain or rocky areas. Young forest patches, resulting from crown fires, were typically found in steep areas where topographical effects on fire behavior increased fire intensities. Poor site productivity also prevented trees from reaching a survivable height between fire intervals. Fire intervals in dry forests prior to suppression typically ranged from 5 to 50 years (Agee 1993). In general, these fires typically consisted of 80 percent non-lethal surface fires, 5 percent mixed fires, and 15 percent lethal crown fires.

The fire season for dry forests is relatively long, generally from June through September.

Historically, fires were usually geographically large because of the availability of long-needled pine litter and dried grasses on the forest floor, which created a continuous source of fuel on the soil surface (Agee 1994). The actual extent of these fires is hard to determine because the thick bark of ponderosa pine and larch do not always show fire scars that document historical fires (Bork 1985).

The understory of stands prior to fire suppression was dominated by grasses and flowering plants, which would generally recover quickly after low-intensity fires. Many shrubs in dry forests were adapted to frequent fire by either sprouting after burning, or regenerating from fire-stimulated seed (Kauffman and Martin 1984, 1985, and 1991 in Agee 1994).

Lodgepole pine forests developed in areas where local climatic and physical situations limited the ability of other tree species to either regenerate successfully, or obtain a competitive advantage over lodgepole pine. Disturbance was fairly constant in lodgepole pine forests. Some stands were burned in crown fire events, but such fires appear to have been limited in extent. Fires that maintained a patchy structure due to the uneven distribution of fuels were most common. The landscape pattern was probably stable over time; however, occasional (50 to 100 years) region-wide decreases in lodgepole pine forests occurred as a result of widespread mountain pine beetle attacks (Agee 1994).

Interactions between fire and other disturbances were common historically. Insect outbreaks were common after a fire if the severity resulted in substantial scorch of the tree's crown or tree trunk (Agee 1994). Increased fuel loadings in lodgepole pine stands following mountain pine beetle epidemics would result in increased fire intensities and severities. Although little decay is generally associated with fire scars in ponderosa pine, insects and diseases often enter through fire scars and cause severe impacts to fir species. Fire historically reduced dwarf mistletoe infection by pruning dead branches and consuming individual tree crowns that had low-hanging bushy limbs created by the infection (Harrington and Hawksworth 1990; Koonce and Roth 1980; Agee 1994).

Current Conditions and Trends: Departures in Composition, Structure, and Disturbance Processes and Patterns

There has only been a one percent loss of the dry forest potential vegetation group in the project area from historical to current times, mostly because of a shift to agricultural and urban uses on lands not administered by the Forest Service or BLM (*Landscape Dynamics* [Hann et al. 1996] chapter of the *Assessment of Ecosystem Components*). However, the composition, structure, and disturbance patterns in dry forests have changed significantly. Human intervention has brought about these changes through a combination of timber harvesting, fire suppression, and/or livestock grazing. Human-caused disturbances have been more pronounced in the dry forest potential vegetation group than in moist or cold forests. This is partly because dry forests are more accessible to housing developments, logging, and livestock grazing. Dry forests also contain tree species historically favored by the timber market (Everett et al. 1994).

Fire Regimes

Historically, dry forests had shorter intervals between fires so the disruption of natural fires through fire suppression has changed dry forest structure and composition more than that of moist or cold forests. Since the application of fire suppression, a lack of thinning fires has contributed to the higher density of small diameter Douglas-fir, grand fir, and white fir that exists currently. Effects from fire suppression have been greatest in the most heavily roaded areas where it has been most successful.

Lack of frequent, non-lethal underburns has resulted in an increase in fuel loading, duff depth, stand density, and a fuel ladder that can carry fire from the surface into the tree crowns. Stands that are more densely stocked with trees provide increased shade, and reduce wind speeds within stands. Levels of carbon and nutrients tied up in woody material (see Figure 2-4) are higher than they were historically. Fuel moisture is greater in dense stands, particularly in small diameter fuels, because increased shading and reduced wind speed decrease the drying rate of forest fuels. Total available fuel has generally increased everywhere in dry forests because of the absence of frequent fires.

However, within dense stands, the rate of fuel increase is greater because more dead woody material is available.

As a stand transitions from an open park-like, single-canopied structure to a dense, multi-storied structure, expected fire behavior also changes. Generally, a fire occurring in a dense stand will not spread (move across the landscape) as fast as in an open stand because fuels are more moist and wind speeds are reduced. However, when weather conditions become hot and dry, dense forest stands will burn at greater intensities than open stands. So the non-lethal, frequent fire regime of open, single-canopied stands is converted to a fire regime with moderate to high severity and low frequency in dense, multi-storied stands (Agee 1994; see Table 2-11). Map 2-15 shows the historical fire regime and Map 2-16 shows the current fire regime on Forest Service- and BLM-administered lands in the project area.

The increase in fire intervals, without equivalent fuel reductions, has resulted in much higher fuel loads, fireline intensities, and fuel consumption when fires do occur. This causes much higher mortality of the dominant overstory, as well as higher potential for soil heating and death of tree roots and other understory plants. Development of residential areas and other cultural facilities in forests of the project area has been most common in this potential vegetation group, which, coupled with the changed fire regime, has caused a greatly increased risk to life and property.

Human Disturbance

In general, all forests which show the most change from their historical condition are those that have been roaded and harvested. Large trees of high-value species, such as ponderosa pine, were selectively logged. True firs, Douglas-fir, and lodgepole pine were left in stands because either these species were not desirable on the timber market, or they were smaller trees and could not be processed efficiently. The remaining trees, which were not always the best genetic stock, provided seeds for the next generation of forest. Suppression of fires and availability of seeds allowed shade-tolerant trees to replace open, park-like stands with dense stands of trees (overstocking). These dense stands did not receive the thinning treatment that frequent fires produce, resulting in competition for sunlight and nutrients; this is now reflected in changes in forest health.

Changes include a loss of growth potential due to overstocking, greater risk of severe insect and disease problems, greater risk of high severity fires, and a loss of habitat diversity when compared to historical conditions. Currently, 30 percent of stands within dry forests are dominated by shade-tolerant species, or more than twice the amount that existed in the early 1800s.

Livestock grazing in some cases has reduced the amount of grass and other vegetation that provide continuous fuel for the spread of surface fires. Therefore, fires that would have thinned young trees and favored shade-intolerant species were reduced to much smaller fires. As a result, forest understories became more densely stocked with a higher proportion of shade-tolerant species.

There are currently as many young tree stands as there were historically. However, these types of stands are most often created by harvesting, and are missing the scattered large live and dead trees that would have been present if a fire had initiated the stand. Ponderosa pine has been replaced by grand fir and white fir on 19 percent of its range, and by interior Douglas-fir on another 20 percent of its range. Western larch stands have been replaced by Douglas-fir (16 percent), lodgepole pine (12 percent), and grand fir or white fir (10 percent).

In the past 100 years, fires have become less frequent and more intense (Agee 1993, Gast et al. 1991 in Lehmkuhl et al. 1994). The clumpy character of historical stands created by fire has changed. Timber harvest, especially clearcut logging, has created *larger* stands, with more uniformity within stands and more contrast between stands. Overall, stand structures changed from open park-like stands of large trees with clumps of small trees, to dense overstocked young stands with several canopy layers (Caraher et al. 1992, Gast et al. 1991 in Lehmkuhl et al. 1994).

The dry forest potential vegetation group is particularly vulnerable to the introduction of exotic species and noxious weeds. Noxious weeds, such as knapweed, may rapidly displace native species.

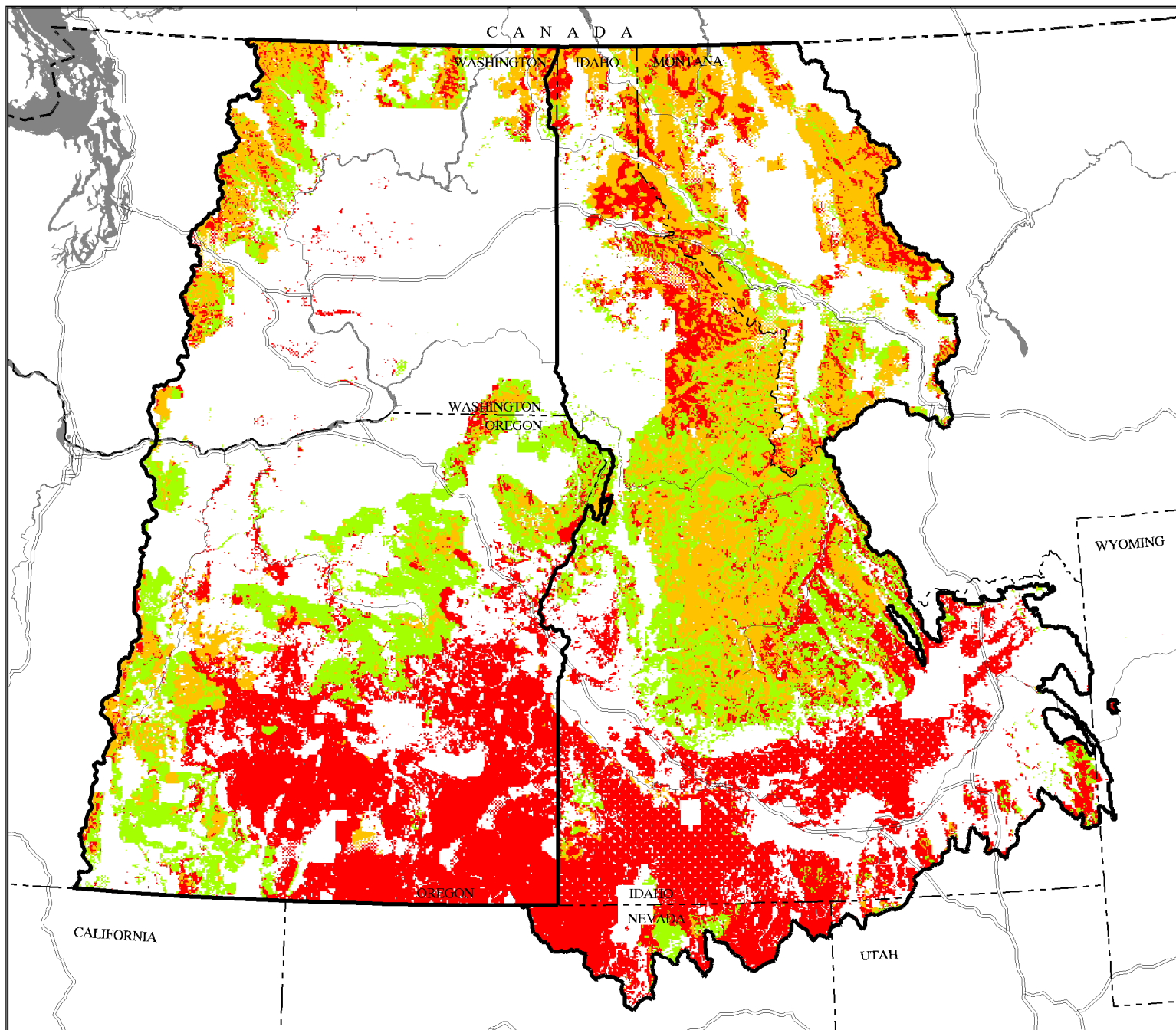
Insects and Disease

The insect and disease relationship as it relates to forest health in dry forests has changed as forest structure has changed. Insects and

diseases always existed in forests, but the size and intensity of their attacks has increased in recent years (Caraher et al. 1992, Gast et al. 1991 in Lehmkuhl et al. 1994). With the exclusion of fire, stand densities are often much greater, and species composition has changed to dominance by trees such as Douglas-fir, grand fir, and white fir. The younger forest structure or multi-storied structure comprised of a high proportion of shade-intolerant species is highly susceptible to large-scale infestations of needle-eating insects, such as the western spruce budworm or Douglas-fir tussock moth. These insects have been active in all ecological reporting units in the project area, especially in the Southern Cascades and Columbia Plateau (ERUs 2 and 5). Overstocked stands result in moisture stress in the normal summer drought period, and make stands highly susceptible to bark beetles. Currently bark beetles often replace fire by eliminating trees growing in excess of site potential.

Susceptibility to the Douglas-fir beetle has increased significantly in the Blue Mountains (ERU 6), and declined in the Southern Cascades (ERU 2) compared to historical conditions. This was attributed to increased (1) spread of shade-tolerant Douglas-fir, (2) abundance of host trees of adequate size for successful bark beetle breeding, (3) patch densities and layering of canopies, and (4) area susceptible to the Douglas-fir beetle. In the Southern Cascades (ERU 2), lodgepole pine forests were recently hosts to mountain pine beetle attacks. Areas susceptible to spruce beetle declined significantly in the Blue Mountains (ERU 6). This is especially noteworthy because beetle outbreaks during the last decade reduced spruce stands in valley bottoms and on benches that were once common in the Blue Mountains (ERU 6). Spruce beetle activity appears to be correlated with the drought of the last eight to nine years.

Areas susceptible to Douglas-fir dwarf mistletoe increased significantly in the Blue Mountains (ERU 6), and declined in the Southern Cascades (ERU 2). Increasing susceptibility was associated with increased abundance of Douglas-fir, increased canopy layering, and Douglas-fir encroachment on dry and relatively moist sites that historically had frequent understory fires. Areas susceptible to ponderosa pine dwarf mistletoe decreased with declining area in the ponderosa pine cover type in the Blue Mountains (ERU 6), Northern Cascades (ERU 1), and Northern



Map 2-15.
Fire Regime Severity
Historical

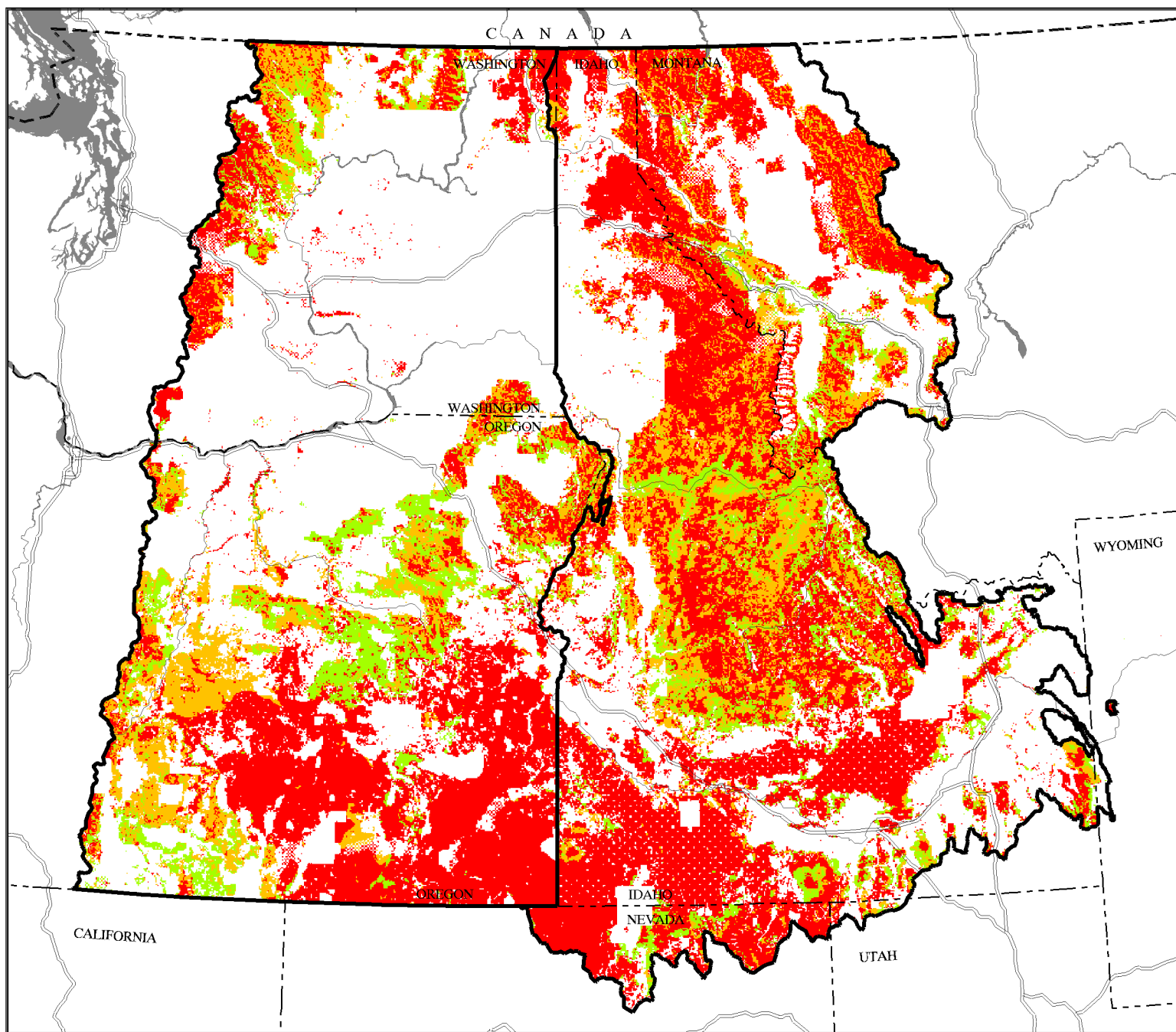
BLM and Forest Service
Administered Lands Only

INTERIOR COLUMBIA
BASIN ECOSYSTEM
MANAGEMENT PROJECT

Project Area
1996



- | | |
|---|---|
| Nonlethal | Major Rivers |
| Mixed | Major Roads |
| Lethal | EIS Area Border |

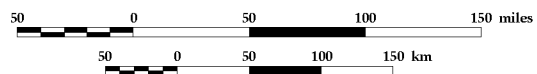


Map 2-16.
Fire Regime Severity
Current

*BLM and Forest Service
Administered Lands Only*

INTERIOR COLUMBIA
BASIN ECOSYSTEM
MANAGEMENT PROJECT

Project Area
1996



- | | |
|---|--|
| Nonlethal | Major Rivers |
| Mixed | Major Roads |
| Lethal | EIS Area Border |

Glaciated Mountains (ERU 7). Areas susceptible to western larch dwarf mistletoe decreased because the western larch cover type in the Northern Glaciated Mountains (ERU 7) also decreased.

An additional forest health concern is that, with few exceptions, areas susceptible to *Armillaria* root disease, laminated root rot, and S-group annosum root disease increased across the project area. Areas susceptible to *Armillaria* root disease increased significantly in the Columbia Plateau (ERU 5), Northern Glaciated Mountains (ERU 7), and Southern Cascades (ERU 2). Areas susceptible to S-group annosum root disease increased in the Columbia Plateau (ERU 5), Northern Cascades (ERU 1), and Northern Glaciated Mountains (ERU 7). Increases in susceptibility to root diseases are associated with effective fire suppression, the selective harvest of shade-intolerant species, and the spread of Douglas-fir and true firs in dense, multi-story arrangements. Historically, fires not only favored the regeneration and release of shade-intolerant species by providing large openings and bare mineral soil, but they minimized fuel loads and effectively thinned from below, favoring lower tree densities and drought and disease tolerance.

The increasing number of dead trees due to attacks by insects and diseases makes forests even more susceptible to large, high-intensity fires. The stands that are most susceptible to moisture stress, insects, and disease tend to be those at the lowest elevations, which typically border private, state, tribal, or other land ownerships. Homes; private, tribal, and state forest resources; wildlife winter ranges; and other important resources are increasingly at risk from fire and insect and disease attack from lands administered by the BLM or Forest Service (Everett et al. 1994).

Terrestrial Species and Habitats in Dry Forests

Unless otherwise noted, information in this section was derived from the *Terrestrial Ecology* (Marcot et al. 1996) chapter of the *Assessment of Ecosystem Components*.

Animals that evolved in dry forest environments adapted to changes brought on by frequent natural disturbances. They did so by shifting within the environment, using the mosaic of habitats and microsites (small habitat areas) created by fires and other events (Collopy and Smith 1995).

Invertebrates

The variety of tree species in dry forests has been relatively low and patch sizes were historically large, allowing invertebrates to distribute across a broad area. Insects, in concert with drought and fire, sometimes play an important role in shaping stand structure. Invertebrates use a variety of habitat patches and microsites in forests that appear uniform. Tree canopies, downed wood material, snags, flowers, forest floor litter, and soils are important habitats for invertebrates. These varied physical factors are considered key environmental correlates in the *Assessment*. Even after fires, islands of unburned trees and litter, and large trees with thick bark provide places for insects and other invertebrates to survive and recolonize the area. Invertebrates perform vital functions in the forest by decomposing wood and litter that return nutrients to the energy cycle, and by serving as food for all other groups of animals. These considerations are classified as key ecological functions in the *Assessment*. Other important key ecological functions of invertebrates include turning over soil and increasing its productivity, pollinating flowers, and dispersing seeds.

Amphibians

Many salamanders and frogs use downed wood, talus, and trees, but riparian area and wetland habitats within dry forests are key environmental correlates for amphibians. Although the Species Environmental Relationship Model (SER Model) for eastern Oregon and Washington contains seven frog, two toad, one newt, and five salamander species known to inhabit the dry forest potential vegetation group, many of these are local endemics (unique to a given area), and are more common west of the Cascade Range. Key ecological functions of amphibians include helping control insects, turning over soils, creating burrows for other species, and as indicators of water quality and quantity.

Reptiles

Reptile distribution is influenced more by climate and terrain than by vegetation type or structure. There are two turtles, four lizards, one skink, and ten snakes recorded in the planning area, none of which are unique to eastern Oregon and Washington (endemic). Most reptiles are restricted to open areas and lowlands because colder temperatures, and shading, limit their ability to

regulate body temperature. The mountain kingsnake is more common in California, but also occurs in dry forests in the Upper Klamath Basin (ERU 3), with sporadic distribution (Collopy and Smith 1995). Key ecological functions of reptiles include helping control rodents and insects, providing food for birds and mammals, and providing burrows for other animals.

Birds

Birds use all the structural stages of dry forests, from young stands and brushy openings to old forests and dead trees and downed logs. The presence of riparian vegetation within the forest brings in additional bird species, such as ducks and shore birds, including some that stop only during migration (Collopy and Smith 1995). The SER Model lists 118 bird species that use at least some aspects of dry forests. Federally listed species that use dry forests in the planning area include the threatened northern spotted owl, marbled murrelet, and bald eagle, all of which need large trees and old forests. The endangered peregrine falcon uses cliff habitat to nest while it preys on birds in open stands in dry forests.

At least nine species of woodpeckers rely on dead trees to excavate nesting holes. A key ecological function of woodpeckers is excavating holes for many other birds and mammals that need holes to nest, but cannot excavate their own. Different species of woodpeckers select different habitats, some using trees over 16 inches in diameter, some using smaller trees, and others needing clumps of dead trees or trees of different heights. Woodpeckers, and other birds and bats that use woodpecker holes, control insect outbreaks and watch for birds.

Birds with large wingspans, such as some hawks, eagles, and owls, hunt for food in openings or in open stands of trees. The tight spacing of trees in dense stands makes it difficult for them to fly between trees, limiting their ability to central populations of some prey species. Goshawks require large trees in older stands of mixed conifers, pine, or Douglas-fir to nest, and also need mixed old and young forest structures, and water in areas surrounding the nest for feeding and fledging of young birds (Thomas 1979, Schommer and Silivsky 1994).

Mammals

The SER Model lists 70 species of mammals known to inhabit dry forests of the project area. Mammals use a wide variety of habitats, including burrows; litter; downed logs; rock outcrops; forest openings; young forests with or without shrubs; and middle, late, and old forests. Many squirrels, mice, woodrats, and other species rely on seeds from trees, especially large ponderosa pine seeds. Mule deer and elk forage, rest, and hide in tree or brush stands, but dense stands of trees often have too much shade to provide shrubs, grass, and forbs for food (Lyon et al. 1995). Desert and mountain bighorn sheep avoid dense stands of trees or shrubs where food (grass and forbs) is limited, sight distances are short, and they are more vulnerable to predators. Some chipmunks and other small mammals use young and dense stands because they prefer the jumble of small logs and canopy cover that protects them from predators.

Twelve species of bats in the project area use thick barked trees, especially large ponderosa pine or western larch, for roosting. Old buildings, bridges, caves, mines, tree cavities, and other small openings are also used by bats. Bats prey on a variety of insects and help control insect outbreaks in dry forests.

Effects of Vegetation Changes on Terrestrial Species, Habitats, and Functions

Unless otherwise noted, information in this section was derived from the *Terrestrial Ecology* [Marcot et al. 1996] chapter of the AEC.

Over time, species associated with the dry forest potential vegetation group have undergone the greatest change in habitat conditions. Habitat that was once large areas of pine and larch forests are now much smaller, making it more difficult for animals to move to other patches of similar habitat (Collopy and Smith 1995, Everett et al. 1994).

Fragmentation and loss of connection to similar habitat means that some animals have to travel farther to find suitable habitat. Some animals are limited in how far they can travel, and those that travel are more vulnerable to predators, traffic, and other hazards. Fragmentation has increased isolation of different species

populations and limited genetic interchange among populations. Many areas were identified in the *Terrestrial Ecology* (Marcot et al. 1996) chapter of the AEC as maintaining several species with very limited distribution (narrow endemics). These species are especially vulnerable to local disturbance events that can endanger an entire population or species. The Columbia River Gorge is one example of an area with many rare, endemic species, some of which rely on dry forest habitat (see Map 2-8). The Gorge also provides barriers to colonization, repopulation, and emigration in the form of divided highways (east to west) and two railroad lines on both sides of the river, and a major waterway transportation system.

Factors most affecting wildlife have been the reduction in ponderosa pine and western larch; reduction of mature and old forest stages, especially open, single-storied stands; and loss of large trees. There has also been a decline in large snags and downed logs, especially where firewood gathering and salvage logging has occurred. The diversity of habitat created by mosaic fire patterns is rarely present in more uniform logging units of unburned stands. Increased density of dry forest stands in all structural stages has limited the light, moisture, and nutrients available to understory plants and animals. Dense stands slow forests' ability to produce large trees and snags for future habitat (*Landscape Dynamics*[Hann et al. 1996] chapter of the AEC, Collopy and Smith 1995, Henjum 1994).

General

Animals most vulnerable to changes in habitat are those that depend on a narrow range of habitats, and those that are not very mobile. Mobile species that use a variety of habitats, can move into other habitat types or patches when disturbance occurs. Coyotes, deer mice, robins, big brown bats, black widow spiders, and house wrens have all adapted to unique habitats created in people's backyards where dry forests often once stood. Changes in disturbance patterns and newly-created habitats have allowed exotic species, such as spotted knapweed, musk thistle, starlings, and bull frogs to invade dry forests and compete with native species. Logging, road construction, seeding of exotic grasses and forbs, and other disturbances often create opportunities for domestic livestock to graze in forested habitats, which may further spread exotic species and compete with native wildlife for forage.

Birds

The decline in open, single-storied mature pine and larch stands has reduced habitat for the olive-sided flycatcher and Lewis's woodpecker, both of which have shown significant declines in the past 25 years (Saab 1995). The Townsend's big-eared bat, California myotis bat, and fringed myotis have been impacted by the loss of large trees for roosting. These species help control insect populations which in turn influence tree survival. The *Terrestrial Ecology* (Marcot et al. 1996) chapter of the AEC concluded that 1 tree bole feeder, 5 bark beetles, and 22 defoliating insects can alter plant succession, and create new vegetation patterns. The decline in insect-eating birds and bats due to the change in forest structure can affect structure, energy flow, nutrient cycling, and soil productivity of future forests. Therefore, the key environmental correlates and key ecological functions (listed under the Terrestrial Wildlife Species section earlier in this chapter) and Habitats for these species are directly affected.

The decline in large trees impacts the nesting and roosting habitat for birds. Bird surveys indicate a decline in nesting sites and foraging areas for goshawks, Vaux's swift, pileated woodpecker, white headed woodpecker, red-tailed hawk, and flammulated owls (Collopy and Smith 1995). Several species, such as the northern flicker, tree swallow, violet-green swallow, house wren, and mountain bluebird, that use medium to small dead trees, show increasing population trends. This correlates with the recent increase in insect and disease outbreaks and fires in densely-stocked stands (Collopy and Smith 1995).

Invertebrates

Dense stocking of stands has reduced the amount of light reaching the forest floor, thus reducing understory vegetation, temperature, and the decomposition rate and nature of woody debris for invertebrates. Within burned areas, mosaic patterns of habitat and unburned islands of vegetation have decreased. This limits the distribution of less mobile species of invertebrates, such as snails, and may limit recolonization of disturbed areas with invertebrate species.

Increased compaction and soil displacement during logging, grazing, and other activities have reduced habitat effectiveness for some soil

invertebrates, such as earthworms, nematodes, and bacteria, and may influence long-term site productivity. Many unique, and some rare or endemic species (species with very limited distribution) of invertebrates depend upon talus, caves, bogs, springs, gravel, and other forest habitat features that fall within the key environmental correlates.

Amphibians

Many salamander and frog populations are vulnerable to changes or reductions in available riparian habitats brought on by logging and grazing, predation by exotic fish and exotic bullfrogs, changes in invertebrate populations, and potential climate changes. The tiger salamander, which only lives east of the Cascades, is used as live bait and has shown an increase in distribution, probably due to release during fishing. The western toad is declining in some parts of its range as a result of dam and spring developments in streams and seeps.

Reptiles

Reptiles are highly susceptible to changes in climate and microsites, especially in forested ecosystems, at the upper elevational end of their range. Downed logs, talus, and rocks are important habitat features that have been altered in some locations. Changes in populations of invertebrates and small mammals limits prey for reptiles. The increased stocking density of dry forest stands provides more shade, which may be reducing reptile habitat effectiveness. Reptiles help control rodent and insect populations, on and below the ground surface, and are indicators of climate and microsite changes.

Mammals

Some mammals, such as the pocket gopher, porcupine, and mountain beaver, have benefitted from clearcut logging and plantations. As these species increased, carnivores that help control them, such as the fisher, marten, mink, and goshawk, decreased due to trapping, predator control, and habitat changes. As a consequence, animal-related tree damage in tree plantations has increased. Conversion of open stands of pines and larch to densely stocked, mixed species forests has benefitted some squirrels, but the loss of understory vegetation and habitat mosaics may be adversely affecting other species, such as the mountain cottontail, pygmy shrew, and Belding's ground squirrel. Forest

fragmentation and degradation of oak woodlands has reduced continuity of the tree canopy and is causing a decline in western gray squirrels (Collopy and Smith 1995). These small forest mammals provide important food for hawks, owls, eagles, and other carnivores, and help transport and plant seeds.

Historical accounts are not conclusive, but it appears that elk and white-tailed deer populations in the dry forest potential vegetation group are higher now than they were before European settlement. Elk and white-tailed deer have expanded their ranges in recent times, causing animal damage problems in rural and agricultural areas on private lands. In some forest settings, elk and deer are using dense stands of shade-tolerant understory trees for cover, which they would not have used as extensively under natural fire regimes. This cover, plus added forage available from clearcutting, may not be sustainable. The density of open, useable roads is high in the dry forest potential vegetation group, due to the gentler terrain, emphasis on timber harvest, and proximity to human habitation. People using roads are the single biggest threat to big game populations, making them vulnerable to poaching, stress, hunting, accidents, and displacement (Christensen 1993). The potential decline in created habitat for deer and elk, combined with high road densities, may mean fewer animals available in the near future for social and economic benefits.

Bighorn sheep are also popular for hunting and viewing. While some populations are maintaining current numbers, other populations are generally declining due to widespread habitat changes, such as replacement of grass, forbs, and low shrubs with tall shrubs and trees, which bighorns avoid. Fire suppression and livestock grazing contribute importantly to these changes (Lyon et al. 1995).

Moist Forest Potential Vegetation Group

Current Distribution

The moist forest potential vegetation group includes transitional areas between drier, lower elevation forests or woodland types in dry forests, and higher elevation subalpine forest types in cold forests (Agee 1994). The majority of moist forests in the planning area occur in the

Northern Cascades (ERU 1), Southern Cascades (ERU 2), and Northern Glaciated Mountains (ERU 7). Approximately 40 percent of the moist forest potential vegetation group in the project area occurs at elevations less than 4,000 feet, and the remainder occurs above that. Moist forests cover approximately 18 percent of the project area; 64 percent of that is administered by either the Forest Service or BLM.

Moist forests typically have relatively high soil moisture in the spring and early summer, followed by drought stress in the late summer and early fall. In addition to drought stress, available nutrients in the soil can limit productivity, especially if the decomposition of dead wood and litter is slow. Tree growth rates are generally rapid, and young forests develop relatively quickly into mid-seral structures.

Composition and Structure

Shade-intolerant species, which dominate 70 to 80 percent of moist forest stands, include western white pine, western larch, lodgepole pine, interior ponderosa pine, and sometimes interior Douglas-fir. The dominant shade-tolerant species include Engelmann spruce, subalpine fir, grand fir, white fir, interior Douglas-fir, mountain hemlock, and Pacific silver fir. See Maps 2-17 and 2-18 for a representation of both historical and current shade-tolerant and shade-intolerant tree species distribution.

Typically in both young and old, healthy moist forests, single-layer forests are dominated by shade-intolerant species. Occasionally, there are long periods (50 to 150 years) between fires where shade-intolerant species shift to shade-tolerant species, because young trees growing in the shade of mature trees are not thinned by fire. Old multi-story stands often have a mix of shade-tolerant and shade-intolerant species, depending on the fire history of the stand.

The adequate moisture levels, moderate climate, and presence of soils derived from volcanic ash often make moist forests ideal for tree growth and productivity. Stands within the moist forest potential vegetation group that do not have intense fires are composed of four dominant tree species: Douglas-fir, grand fir, western hemlock, and white fir. Grand fir is the most common species. These stands typically have more variety in tree species than the dry forest potential vegetation group. Stands that undergo intense fires, or other disturbances that open up

the stand to sunlight, are dominated by lodgepole pine, western larch, Douglas-fir, and ponderosa pine (Johnson et al. 1994).

As in dry forests, quaking aspen can be found in the moist forest potential vegetation group. Other vegetation in moist forests is highly diverse. Shrub and herbaceous understories have evolved under more limited light and lower fire frequencies than in dry forests. Shrub species in moist forests include: Oregon boxwood, big huckleberry, oceanspray, baldhip rose, streambank gooseberry, prince's pine, and American twinflower. Herbaceous species are characterized by shade-tolerant species, including: queencup beadlily, mountain lady's slipper orchid, heart-leaved arnica, wild ginger, sword fern, white trillium, and pioneer violet. Grasses include: pinegrass, Columbia brome, and tufted hairgrass. One sedge species, Ross' sedge, appears to be widely distributed in moist forests across the project area.

Historical Conditions

Historically, native fire patterns and intensities within the moist forest potential vegetation group were variable. Low intensity fires on the forest floor occurred at relatively frequent intervals (15 to 25 years) on benches and ridges. These fires typically did not kill mature trees (non-lethal fires), but did thin out young trees, especially the more susceptible shade-tolerant species and small trees. Fires that burned with enough intensity to kill overstory trees (lethal fires), varied from every 20 to 150 years, generally in upland slope environments. In this situation, some stands were unlikely to mature beyond a young forest stage between fires. The mixed fire regime, with a combination of low and high intensity fires at different levels in the canopy, occurred at highly variable intervals, but averaged between 20 to 300 years. The fire season generally started in July and lasted into September. Fires were usually very small, but some became quite large. Non-lethal fires occurred in approximately 25 percent of moist forests, lethal fires in 25 percent, and mixed fires in 40 to 45 percent.

Grand fir forests in the Blue Mountains (ERU 6) had a wider range of historical fire types than Douglas-fir forests. Ponderosa pine and western larch, and to some extent Douglas-fir, were historically more dominant than grand fir on drier sites. No information is available on landscape fire patterns in these forest types, but in other

mixed-conifer locations, clumping of single species, such as one group of ponderosa pine and another of fir, tended to occur (Agee 1994).

In the cooler grand fir forests, intervals between fires were longer, and natural fires were of moderate severity. Fires that killed most trees and initiated growth of a new stand were more common than on drier sites. When fire created an opening in the forest canopy, the ground received more sunshine, and shade-intolerant species were favored in the young stands. Lodgepole pine and western larch became dominant following a fire as they out-competed Douglas-fir and grand fir (Agee 1994).

Douglas-fir is dominant on sites that are wetter than ponderosa pine sites, yet drier than grand fir or subalpine fir sites. Tree species that may precede Douglas-fir on a site are ponderosa pine, western larch, and lodgepole pine (Johnson et al. 1994). When the interval between fires was short (less than 20 years), Douglas-fir was essentially absent from the landscape because small Douglas-fir trees were easily killed by fire. With longer intervals between fires, Douglas-fir became co-dominant with ponderosa pine and larch (Agee 1994). In historical eastside white fir forests, white fir was at most co-dominant because frequent fires selectively removed young fir trees.

Forests dominated by western hemlock are rare in eastern Oregon and Washington. Older forests are most prevalent, indicating long intervals between fires. Western hemlock tends to grow on moist benches, ravines, and river valleys that are more resistant to fire, and intermingled with patches of drier forest that burned (Agee 1994).

Insects and Disease

Historical insect and disease disturbances were similar to those discussed in the dry forest potential vegetation group, with the addition of white pine blister rust. White pine blister rust is an introduced disease that was not present in the past.

Historically, moist forest structure was fairly dynamic. Early-seral forest structure comprised 20 to 30 percent of moist forests in the project area. Young (mid-seral) forests generally made up from 40 to 50 percent of the moist forest potential vegetation group, and were typically cycled back to early-seral structural stages by lethal fire events (see Figure 2-7). Old forest made up between 20 and 30 percent of moist

forests in the project area. In many cases, low intensity ground fires, or mixes of low and high intensity fires, maintained the young forest stage or moved it toward single-story, mature, or old forests. Creeping, low intensity fires maintained multi-storied, old forests in cool, moist bottoms where fires created small openings that filled with young trees.

Current Conditions and Trends: Departures in Composition, Structure, and Disturbance Processes and Patterns

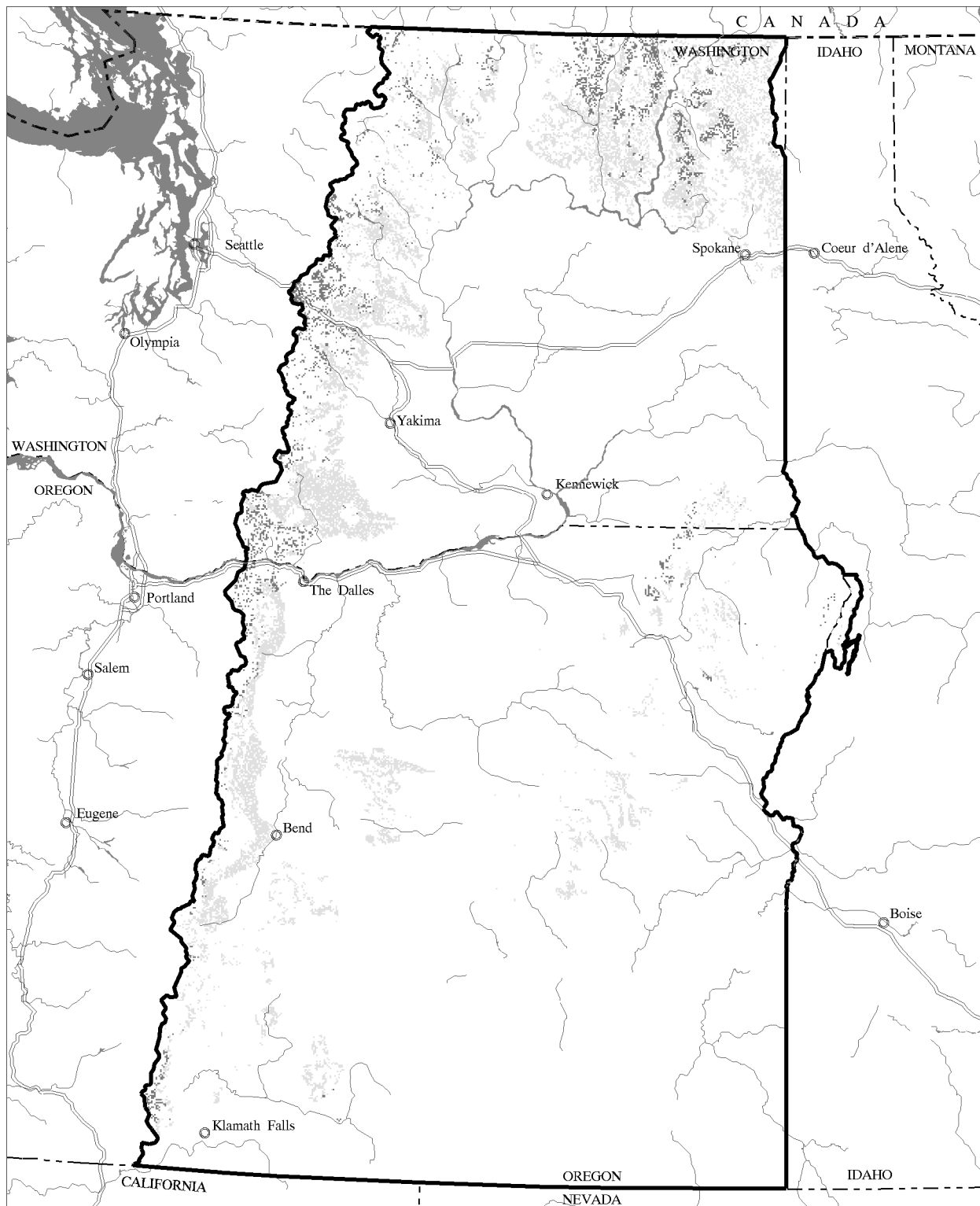
Fire Regimes

There has been a 0.5 percent change in the distribution of moist forests from historical to current times. The interval between intense fires was longer in moist forests (100+ years) than dry forests, so the effects of fire suppression on forest structure and composition are not as obvious in moist forests. However, the effective exclusion of almost all non-lethal underburns and a reduction of mixed severity fires has resulted in the development of dense, multi-layered stands with a high potential for stand-replacing fires. These highly productive forests have increased amounts of carbon and nutrients stored in woody material, resulting in fires that are of higher intensity and severity. Even where fires do not crown, dominant trees can be killed by the consumption of large diameter surface fuels and duff layers. The potential for significant amounts of soil heating and the death of tree roots and other understory plants is much higher than it was historically. (See Table 2-10.)

Major changes to the moist forest potential vegetation group include the network of roads and timber harvest units across the landscape, increased stand density, increased dominance by shade-tolerant species, rapid decline in western white pine due to introduced blister rust, reductions in early-seral and old forest stands, and increases in young, mid-seral stands.

Human Disturbance

In general, moist forests identified with forest health problems are in areas already roaded and harvested. Clearcuts or partial cuts where western larch, western white pine, and ponderosa pine were harvested have had changes in stand structure and composition. The resulting stands have few of the large dead or

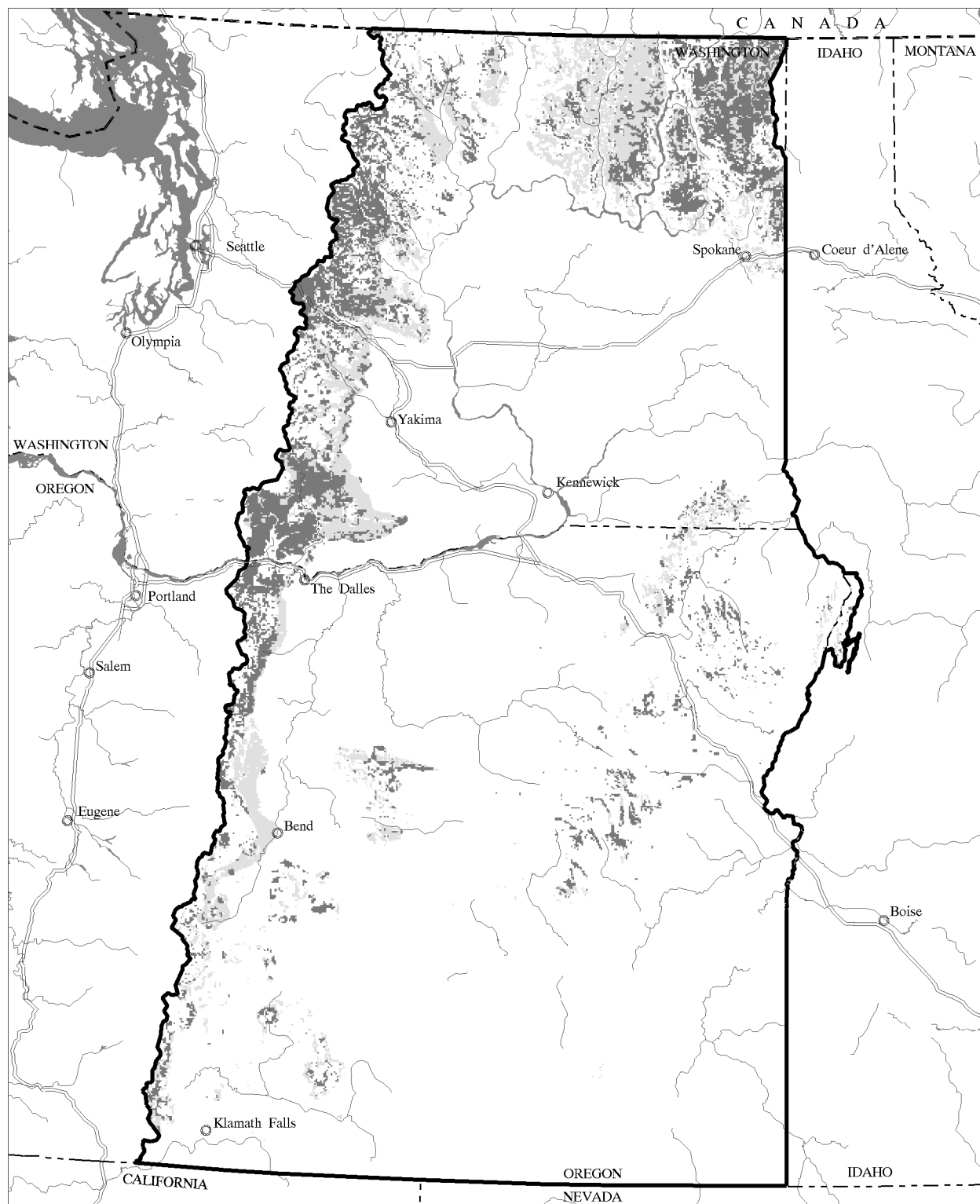


Map 2-17.
Moist Forest Distribution
Historical

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- | | | | |
|---|--------------------------------------|---|-------------------------|
|  | <i>Shade-tolerant Tree Species</i> |  | <i>Major Rivers</i> |
|  | <i>Shade-intolerant Tree Species</i> |  | <i>Major Roads</i> |
| | |  | <i>EIS Area Border</i> |
| | |  | <i>Cities and Towns</i> |



Map 2-18.
Moist Forest Distribution
Current

INTERIOR COLUMBIA
 BASIN ECOSYSTEM
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Draft EASTSIDE EIS
 1996

- | | | | |
|---|--------------------------------------|---|-------------------------|
|  | <i>Shade-tolerant Tree Species</i> |  | <i>Major Rivers</i> |
|  | <i>Shade-intolerant Tree Species</i> |  | <i>Major Roads</i> |
| | |  | <i>EIS Area Border</i> |
| | |  | <i>Cities and Towns</i> |

live trees that historically could have remained on most sites, even after intense fire events. With the selective removal of shade-intolerant species, seed to grow new trees came mainly from shade-tolerant trees or trees with poor form or growth. Moist forests evolved with shade-intolerant species that dominated 70 to 80 percent of landscapes. Current landscapes are mixed in dominance or are dominated by shade-tolerant species. Young stands of trees are dominated by even-aged grand fir, Douglas-fir, or white fir species; fire suppression reduced the thinning effect that favored shade-intolerant trees in the stands. Seed from poorly formed or undesired trees may pass on characteristics that will not provide the wood quality or other tree values desired in the future.

Tree harvest and fire suppression compound forest health concerns with the extensive loss of western white pine and sugar pine to blister rust, and unsuccessful regeneration. Western white pine has been replaced by grand fir and white fir (now representing 28 percent of moist forests in the project area), western larch (24 percent), and shrub/herb/tree regeneration (17 percent). Aspen and Sierra mixed conifer forest types have also declined significantly. Causes for decline in aspen include fire suppression and livestock grazing in regenerating aspen stands, and infestations of large aspen tortrix and satin moth in some aging aspen stands. However, without fire or other disturbance, often required for successful regeneration, aspen stands may die out in some areas. Habitat diversity for wildlife provided by these forest types has also decreased, as have scenic qualities, recreation values, and wood products provided by those tree species which are now declining.

As in dry forests, large trees, early-seral stands, and old, single-storied stands have decreased. Young and multi-storied, old stands have increased.

Nutrient cycles can be limiting in moist forests. Soil fertility of some sites has been depleted through timber harvest practices or from multiple fires, which displace or erode surface soil, or remove much of the large woody material, litter, or duff. Concern for the health of the forest is escalated by lower productivity, higher probability of insect and disease infestation, greater probability of high intensity fires, and changes in habitat conditions.

Insects and Disease

Similar to changes discussed for dry forests, the susceptibility to large-scale damage by insect infestations and diseases has increased in many moist forests. Tree density has significantly increased and vigor has decreased in moist Douglas-fir and grand fir forests, making them more vulnerable to insect and disease damage. Moist forests provide productive environments where insects and disease are very active, given the right hosts. Timber harvest and mortality from fir engraver beetles have contributed to the sharp decline in productive grand and white fir patches in the Blue Mountains (ERU 6). The susceptibility of moist forests to Armillaria root disease, laminated root rot, and S-group annosum root disease is similar to that described in the dry forest potential vegetation group.

Terrestrial Species and Habitats in Moist Forests

Unless otherwise noted, information in this section was derived from the *Terrestrial Ecology* [Marcot et al. 1996] chapter of the AEC.

Moist forests support a high level of terrestrial diversity, and have more tree species and more variety in stand structure than dry forests. This variety provides more habitat types, and therefore more available niches. The wetter climate promotes more flowering plants to provide food for a variety of species. The key environmental correlates such as downed logs and litter, provide habitat for species including carpenter ants, fungi, mosses, lichens, checkered beetles, Larch Mountain salamanders (an endemic species), northwestern salamanders, rubber boas, and sharp-tailed snakes. These and other species contribute to the breakdown of logs, returning nutrients to the soil, a key ecological function. They also provide food for bears, snakes, lizards, pileated woodpeckers, and other species.

Invertebrates

Invertebrates live in the soil, litter, leaves, needles, bark, wood, understory plants, and special habitats, such as rock, talus, and caves. These varied environmental factors, key environmental correlates, are more abundant in moist forests. Moisture keeps these habitats from drying out as easily as in dry forests, thus creating a more favorable environment for many

invertebrates, especially snails, slugs, litter, soil organisms, and wood decomposers.

Amphibians

Moist forests have a rich diversity of amphibians due to the damp climate and high presence of aquatic habitats. Moist forests in eastern Oregon and Washington provide habitat for ten types of salamanders, one species of newt, one toad, and ten frog species (*Species Environmental Relationship Model* [SER Model]). These species use downed logs and burrows, but must be near water to reproduce.

Reptiles

Habitat selection for snakes and lizards is driven more by the need for warm climates, rocks, talus, and soils suitable for burrows, than by specific vegetation needs. Reptile habitat exists in moist forests, especially in openings, south-facing slopes, and rock outcrops. Two turtles, four lizards, and ten snake species use moist forests in eastern Oregon and Washington (SER Model).

Birds

Moist forests typically have multiple layers of trees which provide a wider variety of bird habitat than dry forests. Many birds nest at specific heights off the ground, or in trees of a certain diameter range. The SER Model lists 127 species of birds that use moist forests in the project area, which increases to 150 if riparian habitats are present. Birds nest and feed in the canopies of trees, in cavities they excavate, in cavities excavated by other species, on the trunks or branches of trees, on the ground, or near water (Thomas 1979). Species in moist forests include the goshawk, pileated woodpecker, Lewis' woodpecker, northern three-toed woodpecker, boreal owl, and great gray owl.

Aspen stands tend to be small and scattered in moist forests, but are important for nesting and feeding habitat for many birds, including red-breasted and red-naped sapsuckers, western tanager, violet-green swallow, and Swainson's thrush (Thomas 1979). In general, aspen stands, which are in decline, fill a vital role in providing key environmental correlates required for bird survival.

Mammals

The diversity of small mammal species is highest in the Northern Cascades (ERU 1) where the variety in forested habitat and proximity to westside habitats provides a mix of Cascades and Rocky Mountain species. The richness of the species in the Blue Mountains (ERU 6) is limited by their isolation from other forested habitats, especially for the less mobile species (Collopy and Smith 1995). In total, 89 species of mammals use different structural stages of moist forests in the project area (SER Model).

Moist forests are used by many species of big game that are socially and economically important for hunting and viewing. They are used for food and other cultural and spiritual values by local tribes. Big game species are food for bears, mountain lions, wolves, and other large carnivores. Elk, moose, and mule deer use moist forests, especially meadows, shrublands, and early-seral forests for summer range. Bighorn sheep use cliffs and rock walls within moist forests, and feed in and move through grass and low shrub habitat, but avoid stands of trees or tall shrubs (Lyon et al. 1995). Aspen sprouts and buds within moist forests provide important winter and early spring nutrition for elk, deer, black bear, grouse, and hares.

Moist forests in the Northern and Southern Cascades, and the Columbia River Gorge have been identified in the *Terrestrial Ecology* (Marcot et al. 1996) chapter of the *Assessment of Ecological Components* as important to several rare or endemic species. Refer to the Dry Forest Potential Vegetation Group section earlier in this chapter for supplemental information on the importance of these areas.

Effects of Vegetation Changes on Terrestrial Species, Habitats, and Functions

Invertebrates

Dense stocking of stands reduces light to the forest floor, which reduces understory vegetation, temperature, and the decomposition rate and nature of woody debris. These changes affect nutrient cycling and energy flows, which in turn reduce soil productivity, plant growth, and habitat for animals (refer to the Key Ecological Functions listed under the Terrestrial Wildlife Species and Habitats section earlier in this

chapter. In moist forests, the mosaic of habitat conditions and islands of unburned habitat created by fire have been reduced. Current stands are more uniform, which limits the distribution of less mobile species of invertebrates, such as snails, and may limit the reintroduction of insect and soil organisms into disturbed areas. Regenerated forests have also increased in moist forests.

Amphibians

Many amphibians east of the Cascades are on the edge of larger populations that live west of the Cascades. These peripheral populations are vulnerable because of changes in riparian habitats, predation by exotic fish and exotic bullfrogs, changes in invertebrate populations, and potential climate changes. The tiger salamander, which only occurs east of the Cascades, is used as live bait and has shown an increase in distribution, probably due to release during fishing. Larch Mountain salamander habitat extends just over the eastern crest of the Cascades, in the moist talus slopes of late-seral forests. Mining of talus for road construction, rock, and other uses is impacting this amphibian. Since amphibians have permeable skins, they are good indicators of changes in water quality, climate, and microsites. Amphibians also help control insects; serve as food to fish, small birds, and mammals; provide burrows for other animals; and turn over soil. Each of these factors represents a key ecological function necessary to amphibian survival.

Birds

Based on surveys of banded birds, twice as many bird species increased populations in moist forests than decreased. Major declines occurred for species that use old forests and large trees (northern goshawk, Vaux's swift, pileated woodpecker, Hammond's flycatcher, pygmy nuthatch, and Swainson's thrush), and species that use riparian and montane meadow habitats (red-eyed vireo, gray catbird, cedar waxwing, MacGillivray's warbler, Wilson's warbler, Brewer's blackbird, and song sparrow), especially in the Blue Mountains and Northern Glaciated Mountains (ERUs 6 and 7). Brown-headed cowbirds, which are nest parasites on other birds, have increased due to the reduction of forested cover in riparian areas. Species that use shrubby riparian areas and young forests

(western wood-peewee, dusky flycatcher, northern oriole, lazuli bunting, and warbling vireo) have increased compared to historic times (Collopy and Smith 1995).

Mammals

Mountain bighorn sheep populations have declined in most areas due to the spread of disease from and competition with domestic sheep, conifer encroachment, and increased habitat isolation. Some bighorn sheep populations, such as the Snake River Canyon herd, are increasing due to habitat improvements and control of direct contact with domestic sheep, which limits the spread of disease. Moose are gradually increasing, especially in areas near Canadian moose populations.

The red-backed vole, northern flying squirrels, pygmy shrew, redbellied chipmunk, and other moist forest mammals may be declining due to the decrease in mature moist forests. These small mammal species are important food for owls, hawks, martens, and other carnivores, as well as to distribute and plant seeds throughout the forest (Collopy and Smith 1995).

Cold Forest Potential Vegetation Group

Current Distribution

The cold forest potential vegetation group is a significant component of vegetation at higher elevations; however, it only occurs on approximately ten percent of the project area. The Forest Service and BLM administer 87 percent of cold forests in the project area.

Subalpine sites that support cold forests are marginal for tree establishment and growth; they define the upper limits of tree survival on mountains. Cold forests are generally limited by a short growing season, and on some sites also by low available moisture. Rates of tree growth are generally slow in comparison to moist forests. Nutrients are often limited and loss of volcanic ash soil, litter, surface soil, or tree foliage from the site can greatly reduce productivity. Maintenance of dead and downed wood on these sites is important for nutrient cycling (refer to the Key Ecological Functions listed under the Terrestrial Wildlife Species and Habitats section earlier in this chapter).

Tree regeneration in the cold forest group is generally slow; mortality from stress, insects, and disease thins stands and accelerates growth of the surviving trees. Cold forests extend into moist forests along stream courses, in areas with cold air pockets, or on other cold sites (*Landscape Dynamics* [Hann et al. 1996] chapter of the AEC).

Composition and Structure

Dominant shade-intolerant tree species in cold forests are western larch, lodgepole pine, western white pine, white bark pine, and alpine larch. Dominant shade-tolerant species in cold forests are aspen, Engelmann spruce, subalpine fir, grand fir, white fir, interior Douglas-fir, mountain hemlock, and red fir. Mountain hemlock occurs in only a few scattered areas immediately east of the Cascade Crest, and in the northern Blue Mountains (ERU 6) in eastern Oregon and northeastern Washington (Agee 1994). Mountain hemlock communities are limited to northerly aspects below ridgetops where deep snowpack and cold temperatures persist throughout the year (Johnson et al. 1994). See Maps 2-19 and 2-20 for the distribution of historical and current cold forests.

With an absence of disturbance, cold forests are dominated by subalpine fir or Engelmann spruce. Spruce tends to be present on moist sites and in areas with cold air pockets. Subalpine fir dominates when sites are too cold for other shade-tolerant species. When fire is present as a disturbance, lodgepole pine is the dominant species after intense fires kill most trees. Douglas-fir and western larch are the major species on warmer, drier, disturbed sites, especially on southerly slopes at higher elevations or lower slope elevations adjacent to grand fir forests (Johnson et al. 1994).

Whitebark pine may be co-dominant with subalpine fir in stands at the upper limits of tree growth (timberline). Whitebark pine forests exist in harsh areas with high winds, and can withstand severe ice and snow damage which create open or clumped stands (Johnson et al. 1994).

Non-tree vegetation in the cold forest potential vegetation group includes shrubs and grasses which have evolved under natural cycles of fire and ice. Characteristic shrubs of the cold forest potential vegetation group include fool's huckleberry, grouse huckleberry, Cascades

azalea, laborador tea, and thimbleberry. Herbaceous species include white-coiled beak, white hawkweed, alpine hawkweed, pink elephant heads, and explorer's gentian. Grasses include green fescue, western needlegrass, Idaho fescue, and bluebunch wheatgrass. Many of these species are perennial, surviving years in which flowering and fruiting cycles are disrupted by the early arrival of killing frosts. The transition zone between lower elevations of cold forests, and upper elevations of moist forests is characterized by relatively moist openings that can support meadow vegetation.

Historical Conditions

Historically, fire intervals in the cold forest potential vegetation group were highly variable and correlated with landform. The interval between fires varied from 25 to 300 years in cold forests. The historical distribution of fire regimes within this group were 10 percent non-lethal fires, 25 to 30 percent lethal fires, and 60 percent mixed fire regimes. The fire regime was often intermixed with the other regimes in one fire event or through a series of fire events. The fire season for this group is short, generally during August. Fires that burned hot enough to kill trees changed stand composition from shade-tolerant species to shade-intolerant species, such as lodgepole pine and western larch (Lehmkuhl et al. 1994). Depending on the extent of the fire and the weather that followed, substantial burned areas have remained treeless for decades unless a seed source of lodgepole pine was present at the time of the burn. Where lodgepole pine is present, tree cover is usually rapidly re-established (Agee 1994). These intense fires also changed old multi-story stands that developed with low intensity fire events to single-layer stands. Large fires maintained large patches of similar forest conditions within river drainages, compared with dry and moist forests which tended to have small patches created by fire events (Agee 1994).

Cold forests on steep slopes with moist to wet conditions burned frequently with lethal crown fires. The interval between these lethal fires was often so short that stands did not reach the mature or old forest stage before the next fire. These fires varied in intensity, leaving scattered large residual trees, small patches of green trees in seep areas, and snags. Sometimes fires would reburn within a short time period and produce

open grass and shrublands that would last for relatively long periods before regenerating.

In general, a fairly high component of old multi-story forest was maintained. These old forests were typically found in cold, wet bottoms or basins where fires either did not burn or burned in a patchy manner. Old single-layer forests were generally maintained by frequent ground fires on benches and ridges dominated by whitebark and lodgepole pine.

Cold forests also experienced endemic insect and disease occurrences, which occasionally flared up into a localized epidemic.

Current Conditions and Trends: Departures in Composition and Structure and Disturbance Processes and Patterns

Cold forests have longer fire intervals and fewer human-caused disturbances than dry or moist forests. The effects of fire suppression, logging, road building, livestock grazing, and other modifications on forest structure and composition are not as noticeable as in dry or moist forests. However, some changes from historical conditions have occurred.

Primary changes in vegetation composition and structure have been in response to road and timber harvest, exotic blister rust disease on whitebark pine, and changes in fire type and frequency (see Table 2-11). The cold climate and short growing season in cold forests slow the natural rate of change in vegetation when compared to dry or moist forests.

Essentially, there has been no loss in distribution of this potential vegetation group from historical to current times. Some of the old multi-story forest has been harvested. Although the amount of old, single-layer forest has not changed significantly, its composition is deteriorating with the loss of whitebark pine to blister rust. Young forests have increased, generally as a result of harvesting old multi-story forests. These harvested areas generally do not have the number of snags that occurred historically, which limits habitat for birds, mammals, and insects that need dead trees. Additionally, cold forests have experienced more frequent lethal fires in the past ten years than they did under historical conditions, partly due to the spread of fires from other forest types.

Historically, shade-intolerant species dominated regeneration and young forest environments. This relationship has been altered, resulting in landscapes that now have mixed dominance or are dominated by shade-tolerant species. This is especially true where timber harvest has selectively removed high-value larch and pine, and fire suppression has favored the establishment of shade-tolerant species. As a result, much of the area where significant investments have been made (roads, harvest, planting, thinning, etc.) is highly susceptible to tree mortality from fire, insects, disease, and stress. Where whitebark pine and alpine larch have declined, they have been replaced by Engelmann spruce and subalpine fir. In particular, the loss of white bark pine and alpine larch habitat because of white pine blister rust, and overstocking caused by fire suppression, have become forest health concerns in the past ten years. Future forests will not provide as much habitat and tree species diversity from pine and larch as they have in the past.

Terrestrial Species and Habitats in Cold Forests

Unless otherwise noted, information in this section was derived from the *Terrestrial Ecology* [Marcot et al. 1996] chapter of the AEC.

Cold forests in the Northern Cascades (ERU 1) and Blue Mountains (ERU 6) support several rare wildlife species, or species with very limited distributions. These areas have unique habitats, such as springs, seeps, microsites for insects, and islands of alpine habitat that are isolated from other alpine habitat in Canada and Alaska. These subalpine and Arctic habitats were connected at various times in history when climates cooled and glaciers advanced.

In specific terms, the whitebark pine is an important source of seeds for grizzly bears, birds, and small mammals. Clark's nutcracker, a common bird in cold forests, is responsible for transporting whitebark pine seed for future seedlings. When it is available, squirrels and chipmunks cache white bark pine seed.

Invertebrates

The types of invertebrate species and their habitats found in the cold forests are similar in nature to those found in moist forests.

Amphibians and Reptiles

The Cascades frog lives in small pools adjacent to subalpine meadows. The introduction of predatory fish can threaten the breeding success of this species. This frog is sensitive to changes in ultraviolet radiation on its embryos, and may be a good early warning species for changes in the ozone layer. Cold forests and subalpine areas are generally too cold, with a short breeding season, to provide much habitat for reptiles and amphibians. Nine species of salamander, one newt, one toad, and nine frogs use cold forests in the project area (SER Model), but in small numbers. The Great Basin spadefoot toad, western toad, and Pacific treefrog, which use some cold forest areas, are sensitive to changes in wetlands, springs, and ponds.

There are no reptile species listed in the SER Model as cold forest inhabitants.

Birds

The SER Model lists 103 species of birds that use cold forest habitats in the project area. Although most species use both cold and moist forests, fewer birds use cold forests. This is due to lower diversity in tree species, fewer insects for food, and the shorter growing season in cold forests.

Boreal owls and great grey owls are starting to move into cold forests in northern Washington from Canada. These species are well known in cold forest habitats in the entire project area. Long-eared owls nest in subalpine fir forests. Red-tailed hawks and great horned owls feed on voles and squirrels that inhabit these forests. The increased occurrence of snags, especially large diameter snags, in cold forests are important for the survival of hairy woodpeckers, Williamson's sapsucker, black-backed three-toed woodpeckers, and northern three-toed woodpeckers. These species create cavities used by northern flying squirrels, mountain chickadees, and Vaux's swift, and help control insect outbreaks and distribute seeds.

Cold forests tend to have more downed logs and other woody material due to lower levels of logging, less road access, slower decomposition rate, and longer fire intervals. Moisture, insects, fungi, and wildlife in search of insects aid in the decomposition of logs. Franklin's, blue, and ruffed grouse, which are upland game birds, use logs in cold forests for cover and nesting areas. Logs are also used by vagrant shrews, Pacific

tree frogs, and many insects, fungi, and bacteria important to soil productivity and nutrient cycling. These are some of the key ecological functions that logs serve for birds.

Mammals

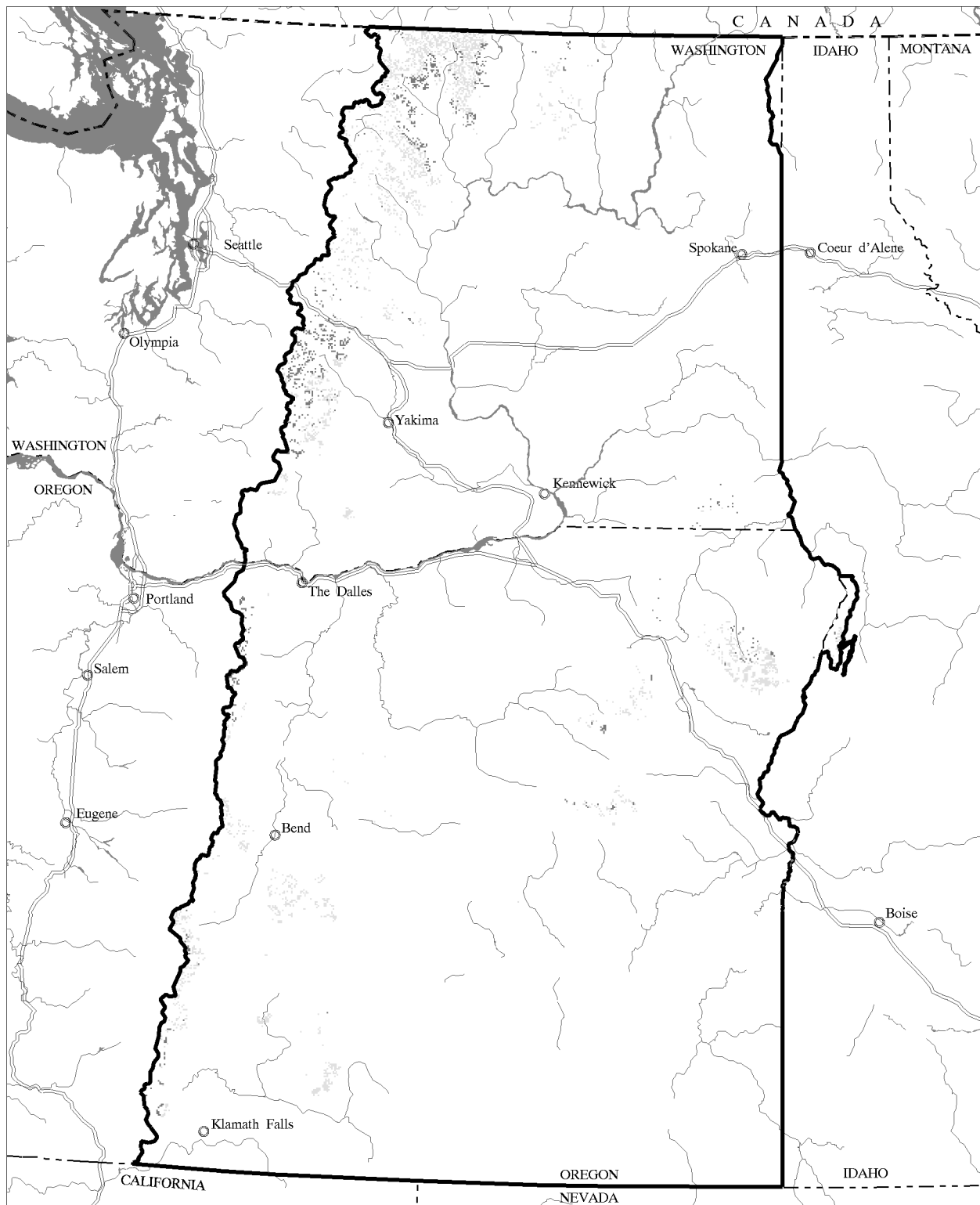
As with birds, most mammal species that use moist forests also use cold forests. The SER Model lists 73 mammals in cold forests of the project area. American pika, lynx, wolverine, bog lemming, snowshoe hare, and the northern flying squirrel are closely tied to cold forest habitats.

More than 35 percent of cold forests in the project area are included in wildernesses, wilderness study areas, or other natural areas. Significant portions of cold forests are also within other unroaded areas. Natural fires are more likely to be allowed in unroaded areas, which helps retain diversity in structural stages and create habitat mosaics in cold forests for the future. Lower road densities and steeper terrain make these important refuge areas for elk, bighorn sheep, mountain goats, wolverine, pikas, and other species that can use this habitat to escape human activity.

Effects of Vegetation Changes on Terrestrial Species, Habitats, and Functions

Cold forests have had less timber harvest, road construction, grazing, and associated impacts because of the steeper terrain, and a shorter growing season than dry or moist forests. Although lower road densities limit some human activities, snowmobiling, skiing, and dirt biking in cold forests can displace and stress wildlife from the noise and associated activities. Bighorn sheep, mountain goats, lynx, wolverine, bears, and marten are particularly sensitive to human activity and need areas of refuge from roads and activities. Although mountain goats have extended their range into areas where they have not historically been, some populations have declined for currently unknown reasons.

Declines have been documented in species that use old forests and large trees in cold forests, such as the northern goshawk, Vaux's swift, pileated woodpecker, Hammond's flycatcher, pygmy nuthatch, and Swainson's thrush; and species that use riparian and meadow habitats in cold forests, such as red-eyed vireo, gray catbird, cedar waxwing, MacGillivray's warbler,

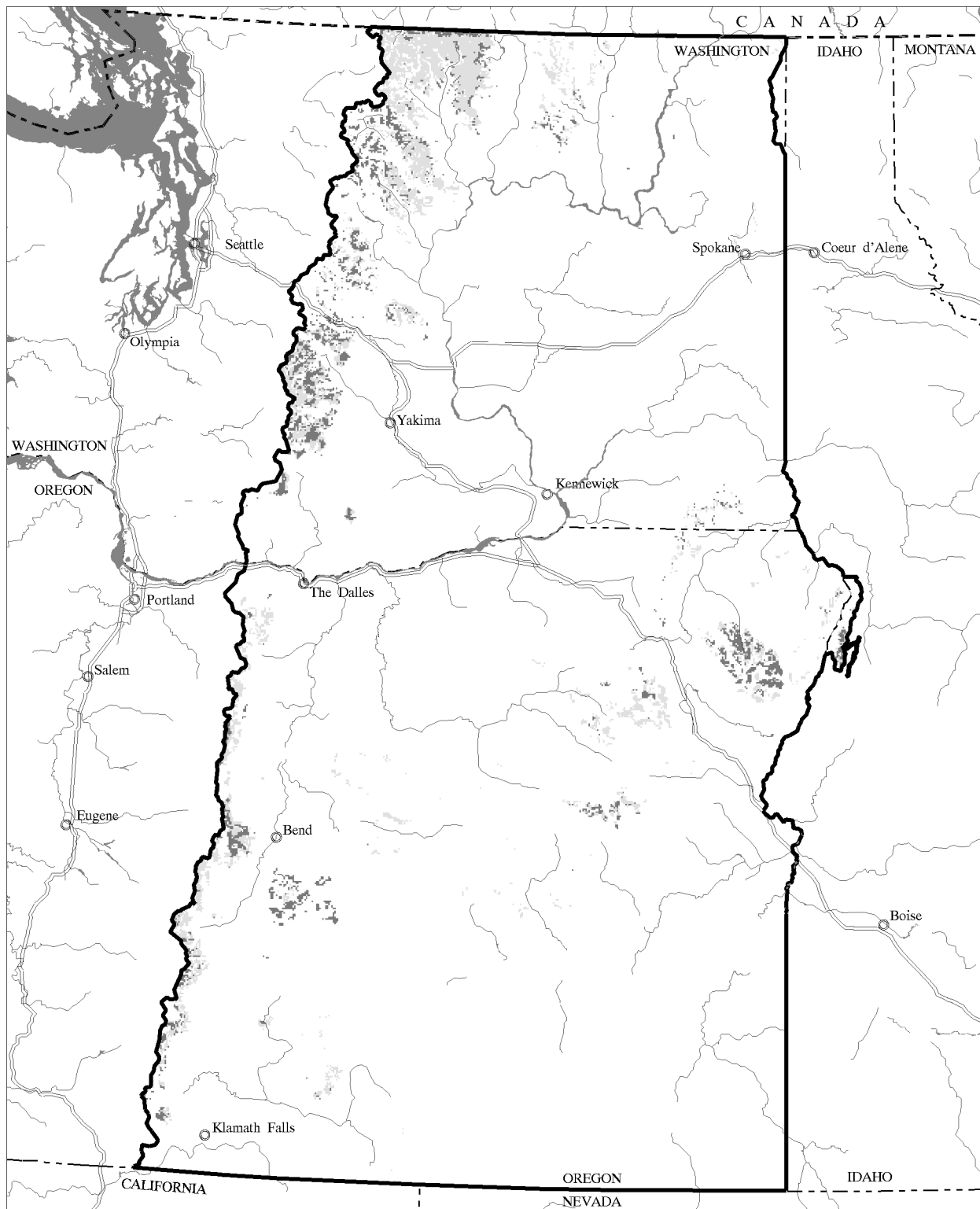


Map 2-19.
Cold Forest Distribution
Historical

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1996

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|---|--------------------------------------|---|-------------------------|
|  | <i>Shade-tolerant Tree Species</i> |  | <i>Major Rivers</i> |
|  | <i>Shade-intolerant Tree Species</i> |  | <i>Major Roads</i> |
| | |  | <i>EIS Area Border</i> |
| | |  | <i>Cities and Towns</i> |



Map 2-20.
Cold Forest Distribution
Current

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|---|--------------------------------------|---|-------------------------|
|  | <i>Shade-tolerant Tree Species</i> |  | <i>Major Rivers</i> |
|  | <i>Shade-intolerant Tree Species</i> |  | <i>Major Roads</i> |
| | |  | <i>EIS Area Border</i> |
| | |  | <i>Cities and Towns</i> |

Wilson's warbler, Brewer's blackbird, and song sparrow. The loss of old stands and large trees is especially prevalent in the Blue Mountains and Northern Glaciated Mountains (ERUs 6 and 7; Collopy and Smith 1995).

Summary of Changes from Historical to Current

The following summarizes by ecological reporting unit, by potential vegetation group (PVG), and by terrestrial community for BLM/Forest Service-administered lands.

ERU 1 ~ Northern Cascades

Cold Forest PVG.

- ◆ A 25 percent increase in early-seral montane forest.

Dry Forest PVG.

- ◆ A 35 percent decrease in late-seral ponderosa pine single story forest.

Moist Forest PVG.

- ◆ A 30 percent increase in early-seral montane forest.

ERU 2 ~ Southern Cascades

Cold Forest PVG.

- ◆ A 35 percent decrease in mid-seral subalpine forest.
- ◆ A 35 percent increase in late-seral montane multi-story forest.

ERU 3 ~ Upper Klamath

Cold Forest PVG.

- ◆ A 25 percent decrease in mid-seral montane forest.
- ◆ A 25 percent decrease in late-seral montane single story forest.
- ◆ A 40 percent increase in late-seral montane multi-story forest.

Dry Forest PVG.

- ◆ A 25 percent increase in late-seral montane multi-story forest.

Moist Forest PVG.

- ◆ A 25 percent decrease in mid-seral montane forest.
- ◆ A 45 percent increase in late-seral montane multi-story forest.

ERU 4 ~ Northern Great Basin

Moist Forest PVG.

- ◆ A 45 percent increase in late-seral montane multi-story forest.

ERU 5 ~ Columbia Plateau

Dry Forest PVG.

- ◆ A 30 percent decrease in late-seral ponderosa pine single story forest.

Moist Forest PVG.

- ◆ A 25 percent decrease in late-seral ponderosa pine single story forest.

ERU 6 ~ Blue Mountains

Cold Forest PVG.

- ◆ A 25 percent increase in early-seral subalpine forest.

Dry Forest PVG.

- ◆ A 35 percent increase in late-seral ponderosa pine single story forest.

ERU 7 ~ Northern Glaciated Mountains

Dry Forest PVG.

- ◆ A 30 percent increase in mid-seral montane forest.

Moist Forest PVG.

- ◆ A 35 percent increase in mid-seral montane forest.

ERU 10 ~ Owyhee Uplands

Dry Forest PVG.

- ◆ A 60 percent increase in mid-seral ponderosa pine forest.

Moist Forest PVG.

- ◆ A 80 percent increase in mid-seral montane forest.

Rangelands

Key Terms Used in This Section

Exotic Species ~ A plant or animal species introduced from a distant place; not native to the area.

Extirpation ~ Localized disappearance of a species from an area.

Grazing pressure ~ The ratio of forage demand to forage available, for any specified forage, at any point in time. Thus, as forage demand increases relative to forage available, grazing pressure increases, and vice-versa.

Herbaceous ~ Green and leaflike in appearance or texture with soft stems, not woody; includes grasses, grass-like plants, and forbs.

Herbivore ~ An animal that subsists principally or entirely on plants or plant materials. Herbivory is the act of the animal consuming the plants.

Introduced forage grasses ~ Grasses that (1) are not a part of the original mix of plants in an area, (2) provide forage for herbivores, including livestock and wildlife, and (3) often are planted to stabilize soil.

Native species ~ Species that normally live and thrive in a particular ecosystem.

Noxious Weed ~ A plant species designated by federal or state law as generally possessing one or more of the following characteristics: aggressive and difficult to manage; parasitic; a carrier or host of serious insects or disease; or non-native, new, or not common to the United States. According to the Federal Noxious Weed Act (PL 93-639), a noxious weed is one that causes disease or has other adverse effects on humans or their environment and therefore is detrimental to the agriculture and commerce of the United States and to public health.

Summary of Conditions and Trends

The following ecological trends have occurred on rangelands in the project area since historical times due to changes in native disturbance and successional processes:

- ◆ Noxious weeds are spreading rapidly, and in some cases exponentially, on rangelands in every range cluster.
- ◆ Woody species encroachment by and/or increasing density of woody species (sagebrush, juniper, ponderosa pine, lodgepole pine, and Douglas-fir), especially on dry grasslands and cool shrublands, has reduced herbaceous understory and biodiversity.
- ◆ Cheatgrass has taken over many dry shrublands, increasing soil erosion and fire frequency and reducing biodiversity and wildlife habitat. Cheatgrass and other exotic plant infestations have simplified species composition, reduced biodiversity, changed species interactions and forage availability, and reduced the systems' ability to buffer against changes.
- ◆ Degradation of riparian areas and subsequent loss of riparian vegetation cover has reduced riparian ecosystem function, water quality, and habitat for many aquatic and terrestrial species (see the Aquatic Ecosystems section).
- ◆ Expansion of agricultural and urban areas on non-federal lands has reduced the extent of some rangeland potential vegetation groups, most notably dry grasslands, dry shrublands, and riparian areas. Changes in some of the remaining habitat patches due to fragmentation, exotic species, disruption of natural fire cycles, overuse by livestock and wildlife, and loss of native species diversity have contributed to a number of wildlife species declines, some to the point of special concern (such as sage grouse, Columbian sharp-tailed grouse, California bighorn sheep, pygmy rabbit, kit fox, and Washington ground squirrel).
- ◆ Increased fragmentation and loss of connectivity within and between blocks of

habitat, especially in shrub steppe and riparian areas, have isolated some habitats and populations and reduced the ability of populations to move across the landscape, resulting in long-term loss of genetic interchange.

- ◆ Slow-to-recover rangelands (in general, rangelands that receive less than 12 inches of precipitation per year) are not recovering naturally at a pace that is acceptable to the general public, and are either highly susceptible to degradation or already dominated by cheatgrass and noxious weeds.
- ◆ Open road densities and human activity have increased. Higher densities cause many species to leave the area to avoid human activity. Recreation, plant gathering, and other uses of all types of habitat have steadily increased recently because of increasing human populations in the project area. These uses can increase wildlife displacement and vulnerability to mortality, fragmented habitat, and allow for access of exotic plants into new locations.

water. Only a few tree species are native to rangelands and these typically are located in wetter areas, especially in riparian areas and areas close to forests. Before Europeans colonized the region, climate and fire played major roles in directing the way rangeland vegetation appeared on the landscape. Humans have altered native fire regimes and their effects on vegetation, and have added new factors responsible for changes observed on rangelands.

Unless otherwise noted, information in this section is derived primarily from the *Landscape Dynamics* (Hann et al. 1996) and *Terrestrial Ecology* (Marcot et al. 1996) chapters of the AEC.

There are 29 potential vegetation types representing rangeland ecosystems which were grouped into the following potential vegetation groups in the *Assessment* (Quigley et al. 1996a,b): dry grass, dry shrub, cool shrub, woodland, alpine, riparian shrub, and riparian woodland. The woodland and alpine groups were not specifically discussed in this chapter because they only represent small portions of the project area and have not changed significantly since historical times. The riparian shrub and riparian woodland potential vegetation groups are discussed in the Aquatic Ecosystems section of this chapter. Table 2-13 lists the potential vegetation types in each rangeland potential vegetation group that are discussed in this section. Maps 2-21 and 2-22 show the three major historical and current rangeland potential vegetation groups (dry grass; dry shrub, and cool shrub).

Introduction

BLM- and Forest Service-administered rangelands make up approximately 37 percent of the project area and 41 percent of the planning area. Rangelands encompass grasslands, shrublands, woodlands, and various riparian areas around permanent and non-permanent

Rangeland Health ~ A Definition

The biological and physical definition of rangeland health is “the degree to which the integrity of the soil and the ecological processes of rangeland ecosystems are sustained.” Rangeland health is synonymous with ecosystem health and integrity as discussed in Chapter 1, but is applied strictly to rangeland ecosystems. Health, however, has been used to indicate the proper function of complex systems; the term is increasingly applied to ecosystems to indicate a condition in which ecological processes are functioning properly to maintain the structure, organization, and activity of the system over time.

Soil integrity is critical for rangeland health and depends on an intact soil profile (layers of soil) and the condition of the soil surface. Important ecological processes in rangelands include the nutrient cycle, nitrogen cycle, and carbon cycle (see Figure 2-3, Nitrogen Cycle and Figure 2-4, Carbon Cycle); energy flows and the terrestrial food chain (see Figure 2-10, Terrestrial Food Chain); and plant community dynamics such as succession (see Figure 2-12, Succession in the Sagebrush Steppe) (Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands).

Table 2-13. Rangeland Vegetation Classifications.

Potential Vegetation Group	Potential Vegetation Types
Dry Shrub	Antelope Bitterbrush Basin Big Sage Steppe Big Sage-Cool Big Sage-Warm Low Sage-Mesic Low Sage-Mesic with Juniper Low Sage-Xeric Low Sage-Xeric with Juniper Salt Desert Shrub Threetip Sage
Cool Shrub	Mountain Big Sage-Mesic - East Mountain Big Sage-Mesic - East with Conifer Mountain Big Sage-Mesic - West Mountain Big Sage-Mesic - West with Juniper Mountain Shrub
Dry Grass	Agropyron Steppe Fescue Grassland Fescue Grassland with Conifer

Source: Hann et al (1996).

Dry Grass Potential Vegetation Group

Distribution

The dry grass potential vegetation group (PVG) makes up only four percent of the project area, compared to nine percent historically. The dry grass PVG makes up only four percent of the planning area as well. The BLM and Forest Service manage 27 percent of what remains of this group within the planning area. The dry grass potential vegetation group can be found in all ecological reporting units, but mostly in the Columbia Plateau (ERU 5) and Blue Mountains (ERU 6).

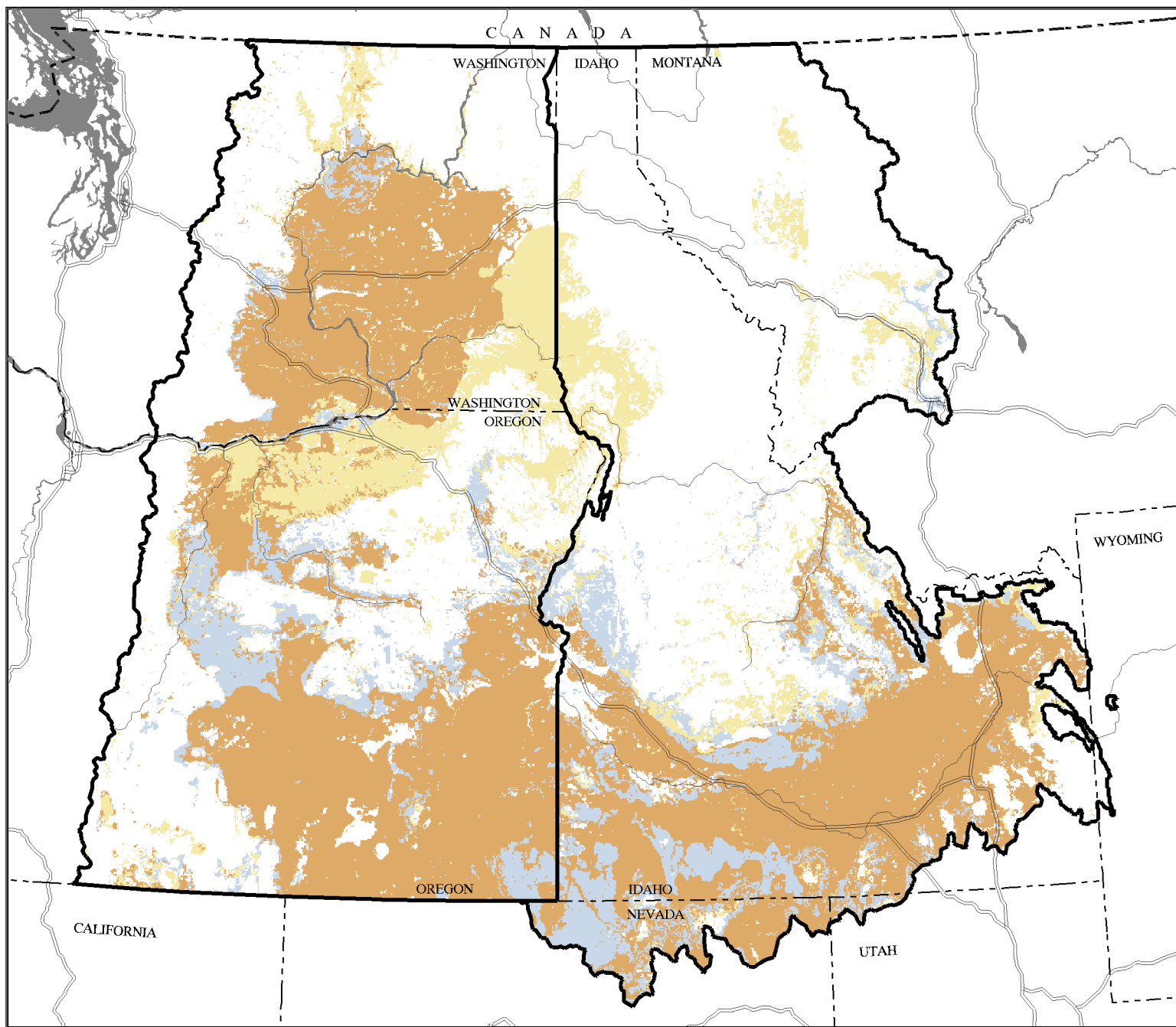
Composition and Structure

Dry grasslands in the project area are dominated by perennial bunchgrasses such as wheatgrass steppe, fescue grassland, and vegetation types that have the potential to be invaded by dry forest vegetation. Dry grasslands also include crested wheatgrass, an exotic perennial grass

that was seeded to rehabilitate dry shrublands in poor condition and to provide a dependable grass forage for livestock.

Dry grasslands have evolved over the past 10,000 years, and plants and animals that inhabited them lived in a constantly changing environment. Historically, disturbances from climate and fire caused the lowlands to be dominated by sagebrush, and included periods of expansion for grasslands, juniper, and shadscale desert (shrublands with sparse rainfall, vegetation, and shallow soils).

In general, vegetation growth and production in dry grasslands is limited by low rainfall and shallow, rocky, or clay soils. Native dry grassland communities, however, are very diverse, hosting a variety of grasses, forbs, and reeds. In years with good winter or spring moisture, grasslands can be fairly productive, but drought is common. Droughts generally last for three to five very dry years over a ten- to twenty-year period, with moist and dry years scattered in-between. Most moisture falls in the cool winter and spring seasons; summers are typically dry. In areas with cloudy or foggy winters, dry grasslands are

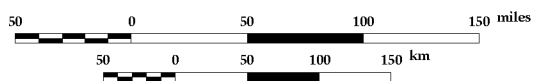
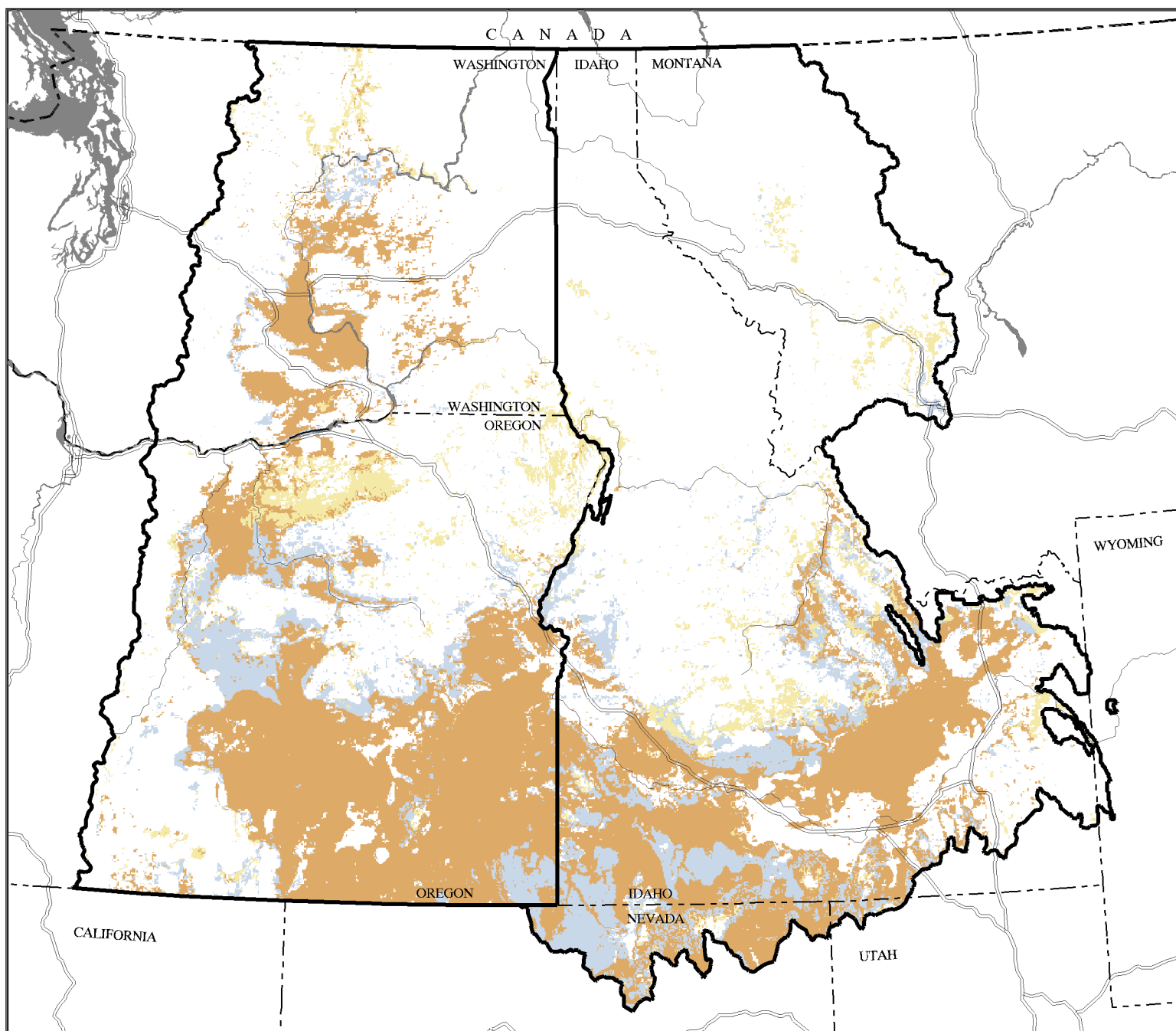


Map 2-21.
Rangeland Potential Vegetation Groups
Historical

INTERIOR COLUMBIA
 BASIN ECOSYSTEM
 MANAGEMENT PROJECT

Project Area
 1996

- | | | | |
|---|------------|---|-----------------|
|  | Cool Shrub |  | Major Rivers |
|  | Dry Grass |  | Major Roads |
|  | Dry Shrub |  | EIS Area Border |



Map 2-22.
Rangeland Potential Vegetation Groups
Current

INTERIOR COLUMBIA
 BASIN ECOSYSTEM
 MANAGEMENT PROJECT

Project Area
 1996

- | | |
|--|---|
| Cool Shrub | Major Rivers |
| Dry Grass | Major Roads |
| Dry Shrub | EIS Area Border |

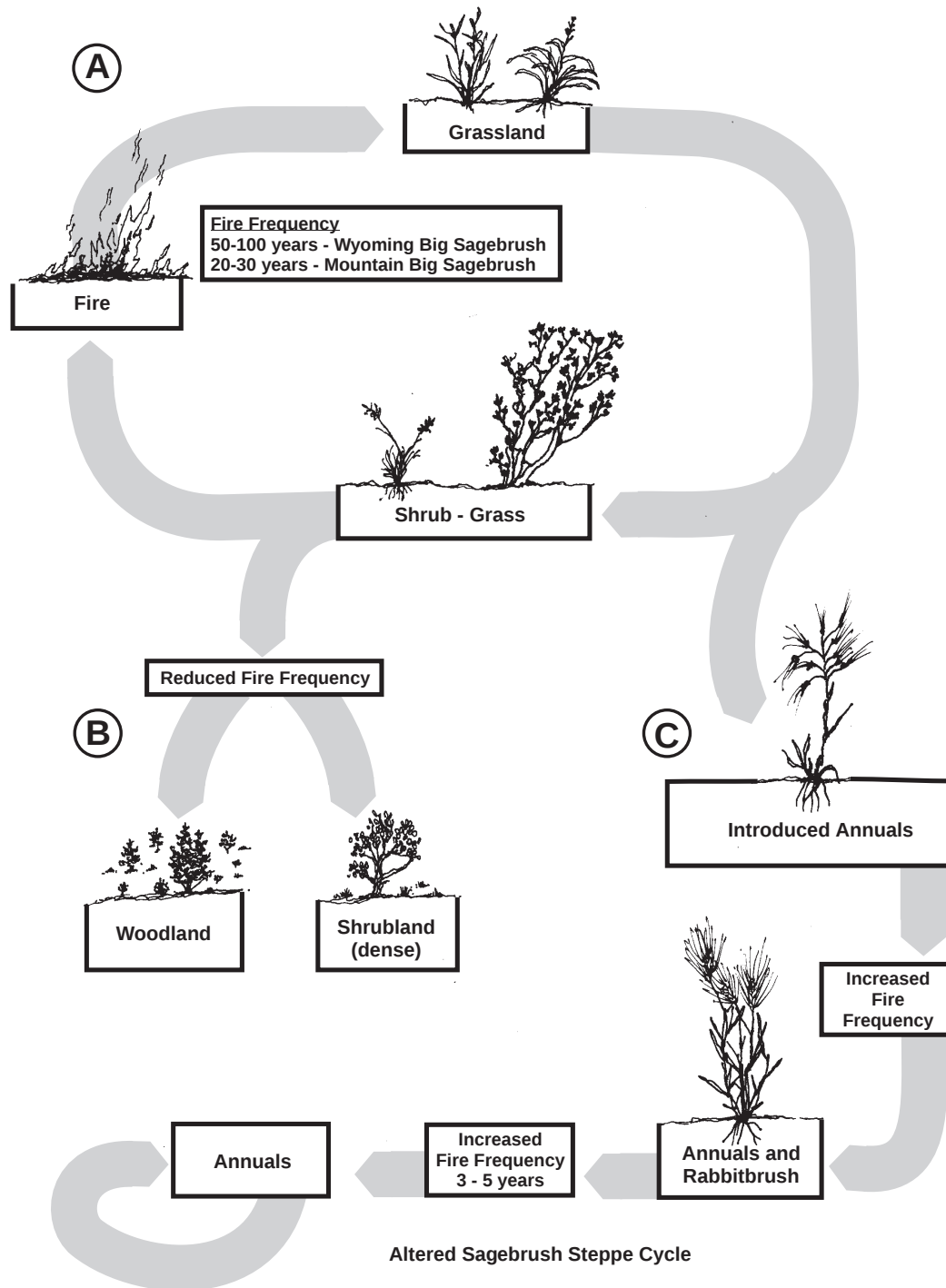


Figure 2-12. Sagebrush Steppe Succession. Three common pathways of succession in the sagebrush steppe. *Pathway A* represents a succession from a grassland to a shrub-grass dominated plant community, with fire acting to move the shrub-grass community back to a grassland. *Pathway B* represents succession of a shrub-grass dominated plant community to either a woodland (dominated mostly by juniper) or a shrubland, caused by a reduction in fire occurrence. *Pathway C* represents succession of a shrub-grass dominated plant community to a community dominated by introduced annual grasses, characterized by an increase in fire occurrence. Introduced annual grasses have invaded these communities partially as a result of excessive grazing pressure. Once dominated by introduced annual grasses, the community tends to remain this way because of frequent fire, which prevents shrubs from establishing. (Adapted from Vavra et al. (editors). 1994. Ecological Implications of Livestock Herbivory in the West.)

common, possibly because sagebrush and other shrub species need sunlight in the winter months. Grassland plants depend on storage of winter moisture in soils because most of their growth takes place during the spring and early summer. Grassland plants do not have deep root systems needed to tap retreating soil moisture. Therefore, they go dormant until fall rains stimulate another growth period (*Terrestrial Ecology* [Marcot et al. 1996] chapter of the AEC).

This potential vegetation group exhibits a high degree of departure from succession and disturbance regimes historically. The primary causes of this departure are related to conversion to agriculture and urban use, improper livestock grazing, invasion of exotics, and changes in fire regimes attributable to fire suppression and grazing. Generally these causes result in lower productivity, higher probability of severe or chaotic events, and less similarity to the diverse native system (for example, cheatgrass encroachment). Large dominant bunchgrasses such as bluebunch wheatgrass and Idaho fescue are being replaced by the smaller bunchgrasses such as Sandberg bluegrass, forbs, and exotic species.

Approximately two-thirds of the fires in the dry grass potential vegetation group were non-lethal, occurring in dried out grass and forb areas. Approximately half of the acreage burned at intervals of less than 25 years, and the rest at 25 to 75 years. Approximately 32 percent of the fires were of mixed severity (non-lethal and lethal fires) at 25- to 75- year intervals.

The current fire regime reflects the encroachment of trees and shrubs, particularly ponderosa pine, Douglas-fir, and mountain big sagebrush, caused by fire exclusion. Presently, approximately one-third of fires are non-lethal. The percent of mixed severity fires, 60 percent, is almost double that of what it was historically, showing that current fires are killing dominant trees and shrubs that have been established. Fires are more likely to have relatively severe effects on the soil surface and herbaceous plants, particularly when they occur during extremely dry years.

Terrestrial Species and Habitats in Dry Grasslands

Species associated with dry grasslands declined as much or more than any group in the project area. Some associated plant and animal species have been identified as at risk in the *Terrestrial*

Ecology (Marcot et al. 1996) chapter of the AEC. Some of these species, including the Columbian sharp-tailed grouse, California bighorn sheep, pygmy rabbit, and kit fox, require individual consideration to prevent listing them as threatened or endangered.

Invertebrates

Little is known about individual invertebrate species. Some of the common groups of invertebrates include arthropods, mollusks, earthworms, protozoa, and nematodes. Adequate soil structure and chemistry is essential for soil invertebrates to survive. Factors that have caused some invertebrate declines include the use of pesticides, loss of litter and dead plant material, and decline in forbs attributable to grazing, range treatments, fire suppression, and disturbance of springs, wetlands, talus slopes, caves, and other special habitats.

Grazing can reduce grass, seeds, forbs, and dead plant material available to invertebrate herbivores and pollinators. Livestock use has caused localized soil compaction, especially in wet areas, which has impacted soil-dwelling species such as earthworms, nematodes, snails, and slugs. Except for species that are being considered for special status, the impact on invertebrates from these disturbances is largely unknown. The greatest change to invertebrate habitat in rangelands is the conversion of grasslands and shrublands to other uses.

According to species estimates made for the project area, approximately 15 percent of potential invertebrate species have been identified. Of those identified, few have been studied, quantified, or had their ranges mapped. Of the known species, many have been accidentally or intentionally introduced. The small size and mobility of invertebrates make them easy to introduce by vehicles, cargo, animals, wind, and other means. Exotic invertebrate species pose an increasing threat to native invertebrates through competition, displacement, and interbreeding, as well as to other plants and animals that they may attack. Invertebrates perform key ecological functions (refer to Terrestrial Wildlife Species and Habitats in the Forestlands section of this chapter) in the environment by decomposing wood and litter that return nutrients to the energy cycle, and serving as food for other groups of animals. Other key ecological functions of invertebrates include turning over soil and increasing its productivity,

pollinating flowers, and dispersing seed. The habitat requirements for invertebrates are generally at a scale so fine that it is difficult to predict how they will be modified by projected management activities, which tend to operate at a much larger scale. For this reason, invertebrates are addressed by conservation strategies and recovery plans. Standards in Chapter 3 addresses the habitat needs of listed and aquatic invertebrates.

Amphibians

Essential for most amphibians is seasonal and permanent wetland habitat, which is a limited habitat in dry grasslands. Salamanders are rare in this potential vegetation group; the tiger and long-toed salamander are found in wet areas. The Great Basin spadefoot toad, Woodhouse toad, and spotted frog are limited to wetlands and pond habitat. The introduction of bullfrogs and exotic predatory fish species, along with water quality problems have caused a decline in native frog abundance and distribution. Many human-caused ponds, catchments, and spring developments on rangelands have increased frog habitat, but groundwater developments and water diversions into troughs and tanks have altered other habitat areas. The key environmental correlates and key ecological functions include helping control insects, turning over soil, creating burrows for other species, and as indicators of water quality and quantity.

Reptiles

Many reptiles in the project area are on the northern-most limits of their ranges, and are more common in the Great Basin and Mojave deserts to the south. In general, reptile diversity is high in rangelands, but species on the edge of their range appear to be especially susceptible to habitat degradation and climate change (Collopy and Smith 1995). Reptile habitat in the lowlands is influenced more directly by elevation, aspect, and physical features (rock, talus, terrain, and soil characteristics), rather than by vegetation. Thus, some of the vegetation changes attributable to grazing, exotic species invasion, and fire suppression may not have impacted reptiles. Common reptiles found in dry grasslands include the garter snake, western fence lizard, short-horned lizard, yellow-bellied racer, striped whipsnake, gopher snake, and ringneck snake. Highways, reservoirs, and other human-created structures are barriers to

movement for reptiles and amphibians. Reptiles are functionally important as predator and prey species to insects, small mammals, and birds. The key ecological functions of reptiles include helping to control rodents and insects, providing food for birds and mammals, and providing burrows for other animals.

Birds

There are 111 bird species in the project area associated with dry grasslands, of which 38 showed significant declines in population censuses over the past 26 years. Neotropical migratory birds breed and nest within the project area, but winter in South and Central America. Thus, a reduction in species may be associated with changes both inside and outside of the project area. The greatest impact to birds appears to be the loss of riparian and wetland habitat, but loss of native grasslands may be linked to some species' declines. Riparian vegetation is used by 64 percent of these neotropical migratory bird species (Saab 1996). Until recently, killdeer, olive-sided flycatcher, willow flycatcher, red-winged blackbird, western meadow lark, and Brewer's blackbird showed consistent long-term declines. The two species primarily associated with riparian habitat degradation, the olive-sided and willow flycatchers, are likely influenced by federal land management. Recent upward trends in neotropical birds may indicate a gradual recovery in riparian habitats (Collopy and Smith 1995), which may account for the recent upward trend in long-billed curlew numbers, although the reasons are unclear. Riparian and grassland habitats in rangelands were identified as conservation priorities. Brown-headed cowbirds, and red-tailed hawks have increased in population during the past 26 years.

Loss of native grasslands and reduction in grassland cover have significantly reduced plant and insect forage, nesting habitat, and hiding cover for several species. Habitat changes have caused dramatic declines in Columbian sharp-tailed grouse, upland sandpipers, mountain quail, and grasshopper sparrows. Sharp-tailed grouse were once a common and popular game bird in eastern Oregon and Washington, but the conversion of grasslands to agriculture and loss of native grasslands led to the extermination of these birds from Oregon in the 1960s. Sharp-tailed grouse have been reintroduced in northeastern Oregon and some habitat areas are being protected in Washington.

Improper livestock grazing and increased fire frequency due to the spread of annual exotic species, such as cheatgrass, also damages nests of many ground-nesting birds, such as killdeer and sandpiper, in grassland habitats (Collopy and Smith 1995). Improper livestock grazing, succession, and increases in fragmentation and edge habitat have favored the cowbird, which is a nest parasite that reduces the reproductive success of other species. The western meadowlark, loggerhead shrike, lark sparrow, and Brewer's blackbird, important for controlling insects and distributing seeds, have declined and should be studied in the future (Collopy and Smith 1995).

Low elevation areas have a rich diversity of predatory birds (hawks, eagles, and owls), especially in the Owyhee Uplands (ERU 10). Canyon walls of the Snake River provide nesting habitat for one of the highest densities of predatory birds in the world. Some earlier declines in predatory birds due to the impact of pesticides, human-caused mortality, capture, and vegetation conversion have been reversed. Some species, such as the Swainson's hawk, golden eagle, red-tailed hawk, burrowing owl, ferruginous hawk, peregrine falcon, and bald eagle, are showing increases. Loss of riparian vegetation and reduced prey forage continue to impact some predators (Collopy and Smith 1995). These predators help control gophers, ground squirrels, deer mice, and other small mammals. The introduction and expansion of exotic plants, such as cheatgrass, in selected habitats has played a key role in the establishment and expansion of an exotic game bird, the chukar. Conversion of native habitats to croplands, especially for grain crops, has also supported populations of the introduced Chinese pheasant.

Mammals

Seventy-three, or approximately half, of the mammal species in the planning area use rangeland ecosystems. Many small mammals rely on grassland ecosystems. Ground squirrels in the area tend to have many subspecies with very narrow distributions. Loss of native plants, poisoning, and soil compaction are impacting Washington ground squirrels and others by reducing available habitat. Conversion to crested wheatgrass and exotic weed species, changes in fire intensity and frequency, and expansion of juniper woodlands have reduced the diversity and species richness of small mammals (Collopy and Smith 1995).

Lowlands support a high diversity of bats, which typically roost in crevices and caves. Structures such as bridges, mines, and buildings have expanded roosting areas for bats, and may help offset human disturbance to bat habitat, such as exploration of caves and old mine shafts. Insect control efforts reduce prey for bats, who help control insect populations. Few bat populations have been monitored and their status is generally unknown.

Big game species (for this discussion, elk, mule deer, pronghorn antelope, and bighorn sheep) have high social values, as indicated by the amount of money spent annually on wildlife related activities. Elk occupy some areas of the dry grass potential vegetation group, especially for winter range. White-tailed deer have benefitted from some human activities and have moved into grasslands in riparian corridors, shrubby riparian areas, and agricultural areas. Competition between livestock and big game has increased where winter ranges are in degraded condition. Livestock grazing management can benefit populations of big game by changing plant species composition, density, and vigor; providing additional water, salt, and nutrient sources; and inhibiting the spread of woody vegetation. Livestock grazing management can also have negative impacts on big game if livestock compete for forage and water, or increase the spread of disease. Forage competition can be reduced by managing the season of use, intensity of use, and the conversion of shrubs and forbs to annual grasses and other exotic species. Conversion of wintering areas to agriculture and urban growth can intensify conflicts with livestock and big game species on remaining undisturbed low elevation ranges (see the Livestock and Big Game Interactions section of this chapter for more information).

Many of the current high populations of some big game species can be partially attributed to access management programs to control the use of roads by hunters as well as to selective harvest strategies. Access management strategies among agencies to reduce the mortality associated with roads is common for elk management. Increases in the density and use of roads across the project area is a major factor in the human-caused mortality of all big game species (Lyon et al. 1995).

There are many successful reintroductions of California bighorn sheep populations within the

project area, but some sheep reintroductions have been unsuccessful and most historic populations have declined. Competition and disease transmitted from direct contact with domestic sheep, as well as changes in habitat are the primary causes for decline in bighorn sheep populations. The vaccination or removal of domestic sheep from direct contact with bighorn, has reversed their decline in some areas in the Northern Great Basin and Owyhee Uplands (ERU 4 and 10).

Fire is an essential element in big game range, since it changes the composition and distribution of vegetation of all types. Fire also improves the palatability and nutritional value of forbs, grasses, and some shrubs, and increases early spring green-up, which is vital nutrition for pregnant animals. In contrast, fire suppression and a change in fire regimes because of exotic plant invasions have reduced the quality of many big game habitats (Lyon et al. 1995).

Carnivore (predator) populations have fluctuated in response to control efforts and changes in food availability. With the removal of gray wolf and grizzly bears from all but the higher elevation forest areas, coyotes, foxes, and skunks have increased. In some areas, packs of domestic dogs and wolf hybrids are causing increased predation and interbreeding with wild dogs. Mountain lion populations have been reduced in a few areas, especially where there is predation on livestock. Animal Damage Control, a government-sponsored program, as well as non-government sponsored activities such as sport hunting and trapping, can reduce local populations of mountain lions, coyotes, and other predators. However, there has been an overall increase in lions in the rural interface zone, causing concern for human safety. Any future decline in food supply, especially deer, rabbits, pronghorns, and ground squirrels, may cause more carnivores to move into areas with livestock grazing and human habitation (Martin et al. 1995).

Herbivory, interspecies relations, and nutrient cycling are some key ecological functions of mammals.

Dry Shrub Potential Vegetation Group

Distribution

The dry shrub potential vegetation group comprises 23 percent of the project area, compared to 30 percent historically. By comparison, this group makes up 28 percent of the planning area. Agriculture and urban development have decreased dry shrublands by approximately 30 percent on those lands not managed by the BLM or Forest Service; the two agencies together manage 54 percent of what remains of this group in the planning area. The majority of this potential vegetation group is distributed throughout the Northern Great Basin and Owyhee Uplands (ERUs 4 and 10).

Composition and Structure

As with the dry grassland potential vegetation group, dry shrublands are limited by low rainfall or shallow, rocky, or clay soils. Native plants are diverse, with many species of shrubs in patterns mixed with grasses, forbs, and reeds. Moisture falls primarily in the winter and spring, and most shrubs have deep roots that can tap moisture deep in the soil. Evergreen shrubs, such as sagebrush and juniper, continue to grow during winters with favorable moisture and ground temperatures, if there is adequate sunlight to allow photosynthesis. The patterns and composition of shrubs with trees, grasses, and forbs varied historically as climate and fire regimes changed. Historically, grasses and forbs covered 10 to 60 percent of dry shrublands; shrubs covered the remaining 40 to 90 percent of the area. The patchy pattern of mixed shrub and grass areas tended to exist in rocky areas and rough terrain. Areas of gentle terrain and deeper soils tended to have more continuous patterns.

Existing without fire for long periods, trees such as juniper and ponderosa pine, sometimes invaded dry shrublands. With frequent fire, grasses and forbs have an advantage because they respond quickly to non-lethal fires by sprouting from bunchgrass root crowns, seeds, or runners whereas tree seedlings are easily killed by most fires. The mixed patterns of trees, shrubs, grasses, and forbs provided a variety of food and cover for animals.

Historically, all fires in the dry shrub potential vegetation group were lethal to the dominant shrub overstory, with 75 percent occurring at 25- to 75-year intervals. A fire-induced cycle between upland herb and shrub dominated stages was created, with no development of early and late seral woodlands. The current fire regime is still almost all lethal fires. However, fire frequency has increased to less than 25 years in 74 percent of the area. This must be partially caused by the current dominance of exotic annual grasses in many locations.

Because of fire suppression, improper livestock grazing, invasion of exotics, and conversion to agricultural and urban land use, the dry shrub group has gone through significant change. Exotics are common components in most plant communities of this group. Woodlands have not increased significantly. The most profound effect is the general change in composition and structure within the upland shrub and herb plant communities as a result of heavy early-season or season-long livestock grazing and seeding to perennial exotic grasses, especially crested wheatgrass.

When averaged for the entire dry shrub potential vegetation group, the current fire regime has not changed much from the historical regime. However, fire frequency has increased in locations where exotic annual grasses have invaded.

The native grazing regime appears to have varied from relatively high intensity, short duration grazing by herds of native ungulates (hoofed animals), to low intensity grazing by scattered native ungulates, to seasonal, moderate levels of grazing by groups of similar native animals. Grazing was strongly influenced by seasonal weather. Grasslands, shrublands, and woodlands were historically mosaics of habitats which were not influenced to any great extent by hoofed animals until horses, and later cattle and sheep, were introduced less than 300 years ago (Collopy and Smith 1995).

Certain areas were identified in the AEC as being inhabited by several rare species and/or species which have very limited distribution (narrow endemics). These areas, shown on Map 2-6, include dry shrubland habitats in central Washington. Only small areas exist on BLM-administered lands, although many species require these remnant habitat blocks. Important habitat also includes some of the dry shrublands

in the Northern Great Basin and Owyhee Uplands (ERUs 4 and 10). These not only contain remnant habitat areas on BLM- and Forest Service-administered lands, but also have thermal hot springs, potholes, lava flows, caves, alkali lakes, and other habitat features. There are also important habitat areas in the canyons and uplands surrounding the Lower Snake River on the border between Oregon and Idaho. This area has remnant dry shrublands and perennial grasslands on BLM-administered lands, but is also on the convergence of the Great Basin, Klamath, Cascade, and Rocky Mountain species ranges. The Snake River Canyon creates unique microsites (small, local variations in habitat) and acts as a corridor to some species moving in the canyon, and a barrier to others trying to cross it.

Areas with relatively intact native populations of species were also identified in the AEC. Dry shrublands in central Washington are included because they represented some of the last relatively undisturbed shrub habitat protected from agriculture and grazing. These areas are currently the site of the U.S. Department of Energy Hanford Reservation and the Yakima Firing Range. Lower Snake River uplands are also in this category because of the high number of native species that live there. The Steens Mountains and other patches of dry shrublands in the Northern Great Basin (ERU 4) are included as remnant habitat patches, some of which are on BLM-administered lands or wildlife refuges (U.S. Fish & Wildlife Service). These areas represent sources of species and seeds to recolonize neighboring habitat areas as they recover, as well as important areas for research and monitoring controls.

Terrestrial Species and Habitats in Dry and Cool Shrublands

The descriptions of terrestrial species and habitats in dry and cool shrublands have been combined for ease of discussion. Most of the species that exist in dry shrublands also exist in cool shrublands, and move between them based on annual weather and climate changes. An example may be a species that needs shrubs for nesting such as the Brewer's sparrow. This species will not nest in trees or on the ground in grasslands, but can be located in both the dry and cool shrubland potential vegetation groups. Some information from the SER Model can

separate species within these two shrubland habitat groupings. This separation will be apparent where appropriate.

Amphibians

The primary need for most amphibians is seasonal and permanent wetland habitat, which is a limiting factor in dry shrublands. Salamander diversity is low, with three species, and probably always was in dry shrublands of the project area. Frog diversity is higher, with six frog species and two toad species in the project area. The cooler climate of cool shrublands limits amphibians. Two species of salamanders are found in cool shrublands, and have probably always been rare.

Birds

There are 93 bird species known to inhabit dry and cool shrublands, which increases to 132 if riparian and wetland areas are included. Birds that use riparian areas within dry shrublands, such as MacGillivray's warbler, killdeer, olive-sided flycatcher, willow flycatcher, Brewer's blackbird, western meadowlark, and Lazuli bunting, have increased, indicating some recovery in riparian systems. Northern flicker, house wren, mountain bluebird, American robin, and grey flycatcher have increasing trends in population, partly due to expansion in juniper woodland habitat (Collopy and Smith 1995).

The decline in species such as sage grouse, and Brewer's and sage sparrows can be attributed to changes in shrubland structure, abundance, and distribution. Habitat is becoming more and more disjunct (areas have become isolated from each other), and blocks of habitat are becoming smaller islands. Changes in riparian, wetland, and native grassland habitats are also linked to some species declines. Loss of grass and shrub cover, and loss of structural diversity, have significantly reduced plant and insect forage, nesting habitat, and hiding cover for several species, including declines in sage grouse, sharp-tail grouse, upland sandpipers, mountain quail, and grasshopper sparrows. The expansion and increased density of juniper woodlands has caused the deterioration of sagebrush and grassland habitats, which appears to have affected the rock wren and chipping sparrow (Collopy and Smith 1995).

Sage grouse populations once common in eastern Oregon and Washington are in decline. There has been at least a 60 percent decline in their population in Oregon since 1940. Sage grouse need grass, forbs, and insects, especially in the spring when they raise their young (Collopy and Smith 1995), as well as sagebrush for cover.

Mammals

Seventy-two species of mammals use the dry and cool shrub potential vegetation group (SER Model). Many small mammals rely on the sagebrush steppe and grassland ecosystems. Several ground squirrels in the area have subspecies with very limited distributions. Loss of native plants, rodent poisoning, and soil compaction are affecting several species such as Washington ground squirrels, pygmy rabbits, and white-tailed jackrabbits. The pygmy rabbit is considered a special status species; it is in rapid decline. Remnant areas of shrub steppe vegetation are critical to its survival. Conversion to crested wheatgrass, extensive planting of introduced grasses (840,000 acres in Oregon and Washington east of the Cascades) and introduction of exotic weed species changes fire intensity and frequency. Increased density of juniper woodlands has reduced sagebrush and bunchgrass understory. This may reduce the habitat diversity and species richness of small mammals in dry and cool shrublands (Collopy and Smith 1995).

Approximately 66 species of mammals use cool shrublands (SER Model). Conversion to agriculture, invasion of exotic weed species, changes in fire intensity and frequency, and expansion and increasing density of juniper woodlands may negatively affect some small mammals (Collopy and Smith 1995). Bushy-tailed woodrats, yellow-bellied marmots, northern pocket gophers, and deer mice are common mammals that provide food for predatory birds and mammals, and help distribute seeds and spores of plants. Porcupines use cool shrublands extensively; they help limit the invasion of conifers and other trees into this type.

Like most native big game species, populations of pronghorn were decimated by unregulated hunting between 1850 and 1920. Since then populations have increased because of regulated hunting and improved range conditions. Improper fencing is not compatible with

pronghorn movements. The loss of habitat, fire suppression, increase in coyotes and dogs, transportation systems, human habitation, and improper livestock grazing have affected available pronghorn habitat (Lyon et al. 1995). The population of this lowland species has become more disjunct (isolated from each other), and blocks of habitat are becoming islands.

Populations of bobcats and other fur-bearing species appear to be increasing with reductions in the demand for their fur. Bobcats have an important interaction with black-tailed jackrabbits and cottontail rabbits in the shrub steppe areas, and may help to reduce crop damage during periods of high jackrabbit population cycles (Collopy and Smith 1995). In some areas, packs of domestic dogs and wolf- or coyote-hybrids are causing increased damage to livestock and big game herds.

For more information on terrestrial species, see the Dry Grasslands Potential Vegetation Group section of this chapter.

Cool Shrub Potential Vegetation Group

Distribution

The cool shrub potential vegetation group occupies only eight percent of the project area, compared to nine percent historically. By comparison, this group makes up seven percent of the planning area. The cool shrub potential vegetation group has declined by approximately 11 percent as a result of agriculture and urban development on lands not managed by the Forest Service or BLM; these two agencies together manage 47 percent of what remains of this group in the planning area. This potential vegetation group is found in nearly all ecological reporting units, but the majority is distributed throughout the Northern Great Basin (ERU 4), Blue Mountains (ERU 6), and Owyhee Uplands (ERU 10).

Composition and Structure

The cool shrub potential vegetation group is represented by mountain big sagebrush and mountain shrub potential vegetation types. This group is generally limited by shorter growing seasons and a lack of late summer moisture. Soils are often shallow, rocky, or high in clay content, which limits soil moisture and

encroachment of trees in some areas. Historically, cool shrublands had fairly short cycles of dominance by either grasses and forbs or by shrub species.

This group departs to a high degree from historical succession and disturbance regimes. The leading causes of this departure relate to improper livestock grazing, changes in fire regimes, and exotic forb and grass dominance. This results in lower productivity, higher probability of severe or chaotic events, and less similarity to the temporal, spatial, and habitat diversity of the native system (for example, noxious weed encroachment). Where declines have occurred, the large dominant bunchgrasses have usually been replaced by smaller bunchgrasses such as Kentucky bluegrass, native forbs, and exotic forbs and grasses. Woodlands have increased to cover 25 to 30 percent of cool shrublands, and upland grass and forb areas have almost been lost, with only 4 percent remaining.

Historically, approximately 71 percent of fires in this type were lethal to the dominant shrub overstory, with 38 percent occurring at intervals of 26 to 75 years. Mixed severity fires accounted for approximately 27 percent of burned acreage, mostly at 76- to 150-year intervals. Grasses and forbs covered 10 to 40 percent of the cool shrub, and shrubs covered the remaining 60 to 80 percent, depending on the occurrence of fire. Conifers occupied approximately three to ten percent of the area of the cool shrub potential vegetation group.

The current fire regime is 52 percent lethal fires, at 26- to 75-year intervals. Mixed severity fires have increased to 46 percent, reflecting the decrease in grass and forb dominated stages, and the increase in woodlands. The most significant invading conifer is western juniper, particularly in the Northern Great Basin (ERU 4), Blue Mountains (ERU 6), and Owyhee Uplands (ERU 10).

Terrestrial Species and Habitats in Cool Shrublands

This discussion parallels that found under Terrestrial Species and Habitats in Dry and Cool Shrublands. Refer to that discussion for specific details on cool shrublands species and habitats.

Disturbance Processes and Patterns

Unless otherwise noted, information in this subsection is derived primarily from Leonard and Karl et al. 1995a, 1995b.

Major elements that influence rangeland vegetation include: (1) livestock grazing, (2) fire and fire suppression, (3) introduction of noxious weeds, exotic plants, and non-native forage grasses, (4) soils and their productivity, and (5) climate. These elements act together to create vegetation patterns seen on the landscape. Although vegetation in the project area has always been grazed by herbivores, the introduction of large numbers of livestock into the region in the late 1800s subjected the vegetation to stresses it had not adapted to. Fire, sometimes fanning out over large expanses of rangeland, occurred frequently before the arrival of Europeans. The introduction of livestock resulted in consumption of a portion of the vegetation that had provided fuel for fires. Fire frequency declined as a result of this and of subsequent fire suppression efforts. Plant communities formerly composed of native species are now being converted in many areas to exotic weed species. Most of these exotic weed species require disturbance to become established, but once established they will often displace native species.

Soils and their productivity are integral to productivity of rangeland plants, and to plant composition within communities. Soil productivity depends both on soil (for example, depth, texture, and supply of nutrients) and non-soil (for example, slope and rainfall) factors. These factors vary greatly across rangelands. Certain rangeland soils are fertile, but because of low rainfall are not highly productive for vegetation. Some rangeland soils are shallow and do not retain water for long periods of time, thus are not highly productive either (see the Physical Environment section for more information on soils and climate).

Climate, especially drought, is a frequent but unpredictable force that plays a significant role in the pattern, composition, and structure of vegetation. The effects of livestock grazing, fire or its suppression, exotic plants, soils and their productivity, and other factors that alter vegetation are only fully understood if climate is considered, because climate governs the full response of vegetation.

Livestock Grazing

Rangeland vegetation in the project area adapted to relatively light grazing pressure compared to the vegetation of current times. Although large herbivores were present in the project area prehistorically, there are no accurate estimates of prehistoric population sizes of various herbivores and their distributions on the land, especially compared to historical and current livestock numbers and distributions. Historical and prehistorical herbivory, as proposed by Burkhardt (1994), were strongly influenced by seasonal weather. Under this scenario, low elevation valleys were grazed in winter. Herbivores moved to higher elevations in spring with the growth of herbaceous species, permitting regrowth in the lower elevations in spring and early summer, and fuel accumulation for periodic summer fire. The animals then moved back to lower elevations in fall.

Horses were introduced by humans approximately 300 years ago, and cattle and sheep were introduced later when extensive settlement of the West began. Unlike wildlife species, livestock do not migrate. Livestock tend to stay in place as long as they have food, water, and other needs; this can damage vegetation, soils, streams, and other resources.

Rangeland Vegetation Successional Models

Current scientific thinking regarding livestock grazing pressure and its relation to vegetation succession typically falls into two general categories of models. The first, older model of vegetation succession is the traditional "climax" model. The second, more recent model is the "state and transition model." The climax model asserts that reduction or elimination of livestock grazing pressure will permit improvement in rangeland vegetation through secondary succession. Range scientists are beginning to accumulate convincing evidence, however, that not all rangeland vegetation types respond according to the climax model. Relatively new, multiple stable models, of which the "state and transition" model of vegetation succession (regarded by Laycock [1994]), is most useful, have been proposed as equally effective on many arid and semiarid rangeland vegetation types. See Appendix 2-2 for a more detailed discussion of these two models.

Current land ownership patterns and grazing permits (forage allocations on grazing allotments) add complications that make it difficult for livestock to move seasonally and graze rangelands as they probably were grazed historically. The sedentary behavior currently observed of livestock in riparian areas would have been discouraged in wild herbivore populations by the abundance of predators.

Grazing management in the project area has been guided by principles of the climax model during the 20th century. Potential vegetation types on rangelands in the project area that best fit this model of successional advancement of vegetation include: (1) all riparian types (willow/sedge, saltbrush riparian, mountain riparian low shrub, riparian graminoid, riparian sedge, cottonwood riverine, and aspen), (2) grasslands, (such as agropyron steppe, fescue grassland, and fescue grassland with conifer), (3) cool shrub types (such as mountain big sagebrush, and mountain shrubs), and (4) open ponderosa pine-grassland types (such as interior ponderosa pine). There are exceptions within these types where improvement may not be observed, especially in cases of extreme past grazing abuse, noxious weed invasion, and within drier portions of these vegetation types that are adjacent to even drier vegetation types, such as Wyoming big sagebrush.

Vegetation succession and vegetation types do not necessarily parallel changes in livestock grazing pressure. For example, arid and semiarid potential vegetation types on rangelands can remain stable at a successional stage lower than climax for long periods of time after reduction or elimination of livestock grazing pressure. These vegetation types apparently fit the state and transition model better than the climax model. Examples of these potential vegetation types include dry sagebrush steppe with or without juniper (Basin big sagebrush, Wyoming big sagebrush, and low sagebrush), and salt desert shrub.

In much of the project area, past livestock grazing pressure probably has contributed to an increased dominance of sagebrush species and encroachment or increased dominance of juniper (Archer 1994). This occurs through the modification of microclimate, plant competitive interactions, soil fertility, and fire frequency and severity caused by livestock consumption of grasses and forbs that act as fuel. Reduction or

elimination of livestock grazing pressure will not necessarily convert dominance by woody plants to dominance by grasses and forbs, especially on sites with dense woody plant cover and sparse grass and forb understory. Adjustments in livestock grazing pressure or rest from livestock grazing can, however, result in improved soil stability, soil water levels, and nutrient levels, especially on sites that have yet to reach a peak in woody plant cover. In the project area, an example of increased dominance by woody plants is the expansion of western juniper, most notably in the Upper Klamath Basin (ERU 3), Northern Great Basin (ERU 4), Columbia Plateau (ERU 5), Blue Mountains (ERU 6), and Owyhee Uplands (ERU 10).

Some potential vegetation types, especially Wyoming big sagebrush and more recently salt desert shrub, are susceptible to invasion by exotic annual grasses such as cheatgrass and medusahead, which are flammable. If these exotics dominate a site, a deceptively stable vegetation state results, because these flammable exotics create fire-return intervals as low as five years, which does not permit perennial grasses or shrubs to establish and produce seed, even if a seed source is nearby. Reduction or elimination of livestock grazing pressure can make the situation worse by allowing grass and forb plant material to accumulate and provide fine fuels for fire. These conditions of flammable exotics are found in the more arid portions of the planning area, especially the Owyhee Uplands (ERU 10).

Achieving the goal of sustaining the rangeland resource by grazing management should involve stocking rates (number of cows on a site) and grazing intensities compatible with drought frequency and magnitude. Flexibility within grazing systems is required as part of any grazing strategy intended to prevent rangeland vegetation from becoming more degraded, especially because of climate variability on rangelands. In this regard, maintaining stocking rates at near-normal levels during moderate to severe drought is probably the greatest cause of range deterioration (Vallentine 1990).

The potential for drought-related damage to rangelands in the project area is high, especially in dry shrublands such as Wyoming sagebrush sites in the Northern Great Basin and Owyhee Uplands (ERUs 4 and 10). Drought-related degradation is a concern on BLM-administered

lands where livestock are normally already out on the range before it is realized that a drought is in effect. By the time a drought is inevitable, livestock have been out on the range for months, and the ability for most livestock operators to round up their cattle and take them to another area or home is limited. Therefore, much effort has been taken to try and accommodate cattle on BLM-administered lands, which increases the potential for drought-related damage to the dry shrubland types. Reduced grazing intensities during drought and for some time after drought are necessary to minimize damage and hasten recovery of perennial vegetation.

For a more detailed discussion of livestock grazing in riparian areas, see the Aquatic Ecosystems section of this chapter.

Changes in Fire Regimes

Alterations in natural fire regimes have greatly influenced the distribution, composition, and structure of rangeland vegetation. In many locations, the frequency of fire has decreased because of fire suppression and removal of carrier fine fuels (grasses) by livestock grazing. Changes resulting from decreased fire frequency include (1) encroachment of conifers (for example, ponderosa pine and Douglas-fir) into non-forested vegetation at the forest-steppe boundaries; (2) increased tree density in former savanna-like stands of juniper and ponderosa pine; and (3) increased density and/or coverage of big sagebrush and other shrubs, with an accompanying loss of herbaceous vegetation. In contrast, fire frequency has increased in other areas, particularly in drier locations where exotic annual grasses such as cheatgrass have become established. These changes in the fire regime have caused greater homogeneity of many landscapes.

Increased fire frequency has caused a loss of shrub cover, particularly sagebrush and bitterbrush, and a reduction in bunchgrasses. At the same time, frequent fire has favored dominance by exotic annual grasses. More fuel for fires accumulates under encroaching shrubs and trees, or in grasslands where fires have been suppressed and grazing has not helped remove the buildup in plant material. This added fuel makes it more likely that future fires will be lethal and will kill the root crowns of bunchgrasses, which will make it easier for exotic species, annuals, and pines to displace native grasses.

In dry grasslands where fire has typically been absent, shrubs are more competitive than grasses, in part because shrubs have deeper root systems than grasses, allowing them to tap soil moisture in dry years. When dry grassland sites are invaded by shrubs or trees, soil characteristics and nutrient cycling that developed under grassland ecosystems are disrupted. Cover on the soil (vegetation and litter) also decreases, which in turn exposes more soil to erosion. Improper livestock grazing of remaining grasses and forbs can further expose the soil, and erosion by wind and water can lead to permanent gully formation and changes in water tables.

Noxious Weeds, Exotics, and Introduced Forage Grasses

Noxious Weeds

Noxious weeds can reduce the diversity and abundance of native vegetation, forage, diversity and quality of wildlife habitat, increase erosion, and decrease water quality. The beginning of agriculture, including livestock grazing in the project area, permitted introduction of seeds from exotic plants onto rangelands. The establishment and spread of these species is fostered by disturbance to the soil surface. Noxious weeds, in general, are opportunists and are typically prolific producers of seed. These seeds are usually dispersed by vehicles, wind, wildlife, livestock, water, machinery, and pack animals, often over long distances. They are commonly referred to as “pioneer” species because after a disturbance to the soil surface which results in loss of the native plant cover, they are often the first species to arrive and colonize. They typically germinate under a wide variety of conditions, show fast seedling growth, and thus establish quickly and take up water and nutrients that are then not available for native species. Some noxious weed species, however, currently are showing an ability to invade relatively undisturbed sites as well, including wilderness areas. Some of the densest infestations of noxious weeds are near roads, which provide a route for the spread of noxious weeds by human-related actions, and for an increase in the exposed bare ground.

Many noxious weeds are already present on rangelands in nearly every county of the project area (*Landscape Dynamics* [Hann et al. 1996] chapter of the AEC). These weeds include bull thistle, Canada thistle, dalmatian toadflax,

diffuse knapweed, hoary cress (whitetop), leafy spurge, musk thistle, Russian knapweed, Scotch thistle, spotted knapweed, yellow starthistle, and yellow toadflax. Many of these same weeds are also a problem in forested areas, as discussed in the Forestlands section of this chapter.

Rangeland cover types are plant communities characterized by existing vegetation on the area. Thus these cover types represent the vegetation on the ground, and are useful for land managers and others who are interested in searching for and controlling infestations of these weeds. Rangeland cover types (plant communities) in the project area that have declined in area from historical to current times, partly because of the invasion of noxious weeds, can be found in Table 2-14. Weeds that are relatively recent invaders, or that soon will be new invaders of rangelands in the project area, and are of critical concern to weed experts, include but are not limited to: Syrian bean-caper, African rue, Iberian starthistle, purple starthistle, distaff thistle, squarrose knapweed, camelthorn, saltcedar, and matgrass.

Dewey et al. (1991) proposed that “The precision and usefulness of federal weed control Environmental Assessment (EA) and Environmental Impact Statement (EIS) documents would be significantly improved by knowing the exact location and extent of lands vulnerable to specific noxious weeds.” In this regard, a measure of the susceptibility of rangeland cover types to invasion by 25 weed species (24 noxious weeds plus cheatgrass) is presented in Karl et al. (1995) along with regional (Washington, Oregon, Idaho, Montana, and Wyoming) distribution maps of these 25 species at the county scale. The county maps show the distribution of each species over the past 121 years (1875 to 1995). The susceptibility of rangeland cover types to invasion by noxious weeds and cheatgrass was coded and defined as follows:

- (1) Disturbed $\approx$ moderate susceptibility $\sim$ cover type is susceptible to invasion by weed species following disturbance that affects the soil surface or removes the canopy cover;
- (2) Invasive $\approx$ high susceptibility $\sim$ cover type is susceptible to invasion by weed species even in the absence of disturbance;
- (3) Closed $\approx$ negligible susceptibility $\sim$ cover type does not provide suitable habitat for the weed species to typically invade; and

- (4) Unknown $\approx$ negligible susceptibility $\sim$ data were insufficient to allow a determination of susceptibility.

Tables A and B (see Appendix 2-2) display information on susceptibilities of rangeland cover types, for the use of land managers and the concerned public. These rangeland cover types are described in Table B and are recognized by the Society for Range Management. The rangeland cover types coded as moderate or high susceptibility in Table A are what are referred to in the standards for noxious weeds in Chapter 3. Information from Tables A and B is summarized here in Table 2-15. Table 2-15 shows, for each of the 15 selected noxious weed species assessed in Karl et al. (1995), the rangeland cover types that are most susceptible to invasion.

Specific location of and current acreage information for noxious weeds is not available for the project area. In addition, susceptibilities of rangeland cover types to each weed, in Table A, will require further revision as more knowledge becomes available. Predicting noxious weed distributions in the future requires knowledge of specifically what rangeland cover types are susceptible to invasion by each weed and where these types are on the landscape, in relation to where the noxious weeds are currently distributed.

Noxious weed control on BLM- or Forest Service-administered lands has generally been ineffective. Limited budgets, lack of consistency and coordination by all concerned entities (private, county, state, and federal), and an inability to get ahead of the weed problem have allowed noxious weeds to continue to spread throughout the project area. Control methods have focused on mechanical and chemical efforts, usually along major roads and right-of-ways, as funding allows. Both large and small noxious weed infestations have been the focus of efforts in the past, mostly treated through contracts with counties. In some cases, noxious weeds are treated by qualified federal agency personnel from the administering agencies.

The least expensive, most effective, and highest priority weed management technique is prevention, especially prevention of new infestations of noxious weeds and establishment of new exotic weeds not currently residing in the region. The magnitude and complexity of noxious weeds on rangelands in the project area, combined with their cost of control, necessitates using Integrated Weed Management. Integrated

Table 2-14. Rangeland Cover Types in the Project Area.

Potential Vegetation Group	Rangeland Cover Type	Noxious Weeds
Dry Grass	Agropyron Bunchgrass	diffuse knapweed, spotted knapweed, yellow starthistle, rush skeletonweed, sulfur cinquefoil, medusahead, Dyers woad, dalmatian toadflax, yellow toadflax, common crupina
Dry Grass	Fescue-Bunchgrass	spotted knapweed, leafy spurge, sulfur cinquefoil, oxeye daisy
Dry Shrub	Antelope Bitterbrush-Bluebunch Wheatgrass	diffuse knapweed, cheatgrass ¹ , dalmatian toadflax, rush skeletonweed, sulfur cinquefoil
Dry Shrub	Big Sagebrush	cheatgrass ¹ , medusahead, diffuse knapweed, rush skeletonweed, dalmatian toadflax, Dyers woad, Mediterranean sage, yellow starthistle
Riparian Herb	Herbaceous Wetlands	Kentucky bluegrass ¹ , Canada thistle, purple loosestrife, leafy spurge, saltcedar, musk thistle, Russian knapweed, spotted knapweed, Scotch thistle, yellow starthistle, hoary cress (whitetop), Mediterranean sage
Riparian Shrub	Shrub Wetlands	Canada thistle, leafy spurge, musk thistle, purple loosestrife, saltcedar, Russian knapweed, Mediterranean sage

This table shows rangeland cover types (plant communities) that have declined in the project area from historic to current, partially because of invasions of noxious weeds listed in column 3. Column 1 lists the associated potential vegetation groups within which each cover type resides.

¹ Not legally declared noxious in eastern Oregon and Washington.

Source: Hann et al. (1996).

Weed Management involves the use of several control techniques in a well-planned, coordinated, and organized program to reduce the impact of weeds on rangelands. This strategy, discussed in more detail in Appendix 2-2, is proposed in Chapter 3 for implementation of noxious weed control efforts in the project area.

Exotic Vegetation

Altered sagebrush steppe represents a landscape where the invasion of exotic (non-native) annual grasses and forbs into some sagebrush communities has resulted in plant communities where native perennial plants are lacking and annuals dominate the site (Based on

Pellant 1995). Past overgrazing of the perennial grasses and forbs in these sagebrush communities made these areas more susceptible to invasion from exotic annuals such as cheatgrass, medusahead, Russian thistle, and mustards. As the annuals increased in these communities, so did the fire frequency. Where these sagebrush communities would normally burn every 25 to 100 years in the past, they now can burn every 5 years as a result of the dominance of annuals. This short-duration fire cycle, in combination with overgrazing, reduces the presence of perennial plants in the community and increases the dominance of annual plants. In addition, adjacent areas susceptible to invasion from annuals can also burn, which

Table 2-15. Noxious Weeds in the Project Area.

Noxious Weed	Rangeland Cover Types Most Susceptible to Invasion ¹
Bull Thistle	Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass Idaho Fescue-Slender Wheatgrass Idaho Fescue-Threadleaf Sedge Rough Fescue-Bluebunch Wheatgrass Rough Fescue-Idaho Fescue Riparian
Canada Thistle	Alpine Idaho Fescue Aspen Woodland Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass Idaho Fescue-Slender Wheatgrass Idaho Fescue-Tufted Hairgrass Riparian Rough Fescue-Bluebunch Wheatgrass Rough Fescue-Idaho Fescue Tufted Hairgrass-Sedge
Dalmatian Toadflax	Bluebunch Wheatgrass Bluebunch Wheatgrass-Sandberg Bluegrass Curlleaf Mountain Mahogany Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass
Cheatgrass	Antelope Bitterbrush-Bluebunch Wheatgrass Antelope Bitterbrush-Idaho Fescue Bitterbrush-Bluebunch Wheatgrass Big Sagebrush-Bluebunch Wheatgrass Big Sagebrush-Idaho Fescue Big Sagebrush-Rough Fescue Bitterbrush-Idaho Fescue Bitterbrush-Rough Fescue Bluebunch Wheatgrass Bluebunch Wheatgrass-Sandberg Bluegrass Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass Idaho Fescue-Slender Wheatgrass Mountain Big Sagebrush Rough Fescue-Bluebunch Wheatgrass Rough Fescue-Idaho Fescue
Dyers Woad	Basin Big Sagebrush Big Sagebrush-Bluebunch Wheatgrass Big Sagebrush-Idaho Fescue Big Sagebrush-Rough Fescue Bittercherry Black Sagebrush Bluebunch Wheatgrass Bluebunch Wheatgrass-Sandberg Bluegrass

Table 2-15. Noxious Weeds in the Project Area (continued).

Noxious Weed	Rangeland Cover Types Most Susceptible to Invasion ¹
Halogeton	Bluegrass Scabland Chokecherry-Serviceberry-Rose Crested Wheatgrass Idaho Fescue-Bluebunch Wheatgrass Idaho Fescue-Slender Wheatgrass Idaho Fescue-Threadleaf Sedge Low Sagebrush Mountain Big Sagebrush Rough Fescue-Bluebunch Wheatgrass Rough Fescue-Idaho Fescue Snowbrush Stiff Sagebrush Threetip Sagebrush Threetip Sagebrush-Idaho Fescue Wyoming Big Sagebrush
	Salt Desert Shrub
Leafy Spurge	Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass Idaho Fescue-Slender Wheatgrass Riparian Rough Fescue-Bluebunch Wheatgrass Rough Fescue-Idaho Fescue
Mediterranean Sage	Bluebunch Wheatgrass Bluebunch Wheatgrass-Sandberg Bluegrass Curleaf Mountain-Mahogany Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass Wyoming Big Sagebrush
Musk Thistle	Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass Idaho Fescue-Slender Wheatgrass Idaho Fescue-Threadleaf Sedge Riparian Rough Fescue-Bluebunch Wheatgrass Rough Fescue-Idaho Fescue
Orange Hawkweed	Tufted Hairgrass-Sedge
Purple Loosestrife	Riparian
Spotted Knapweed	Bluebunch Wheatgrass Bluebunch Wheatgrass-Sandberg Bluegrass Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass Idaho Fescue-Slender Wheatgrass Idaho Fescue-Tufted Hairgrass Riparian

Noxious Weed	Rangeland Cover Types Most Susceptible to Invasion ¹
	Rough Fescue-Bluebunch Wheatgrass Rough Fescue-Idaho Fescue Tufted Hairgrass-Sedge
Squarrose Knapweed	Crested Wheatgrass
Sulfur Cinquefoil	Bluebunch Wheatgrass Bluebunch Wheatgrass-Sandberg Bluegrass Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass Idaho Fescue-Slender Wheatgrass Idaho Fescue-Threadleaf Sedge Idaho Fescue-Tufted Hairgrass Rough Fescue-Bluebunch Wheatgrass Rough Fescue-Idaho Fescue Tufted Hairgrass-Sedge
Yellow Starthistle	Bluebunch Wheatgrass Bluebunch Wheatgrass-Sandberg Bluegrass Curlleaf Mountain-Mahogany Idaho Fescue Idaho Fescue-Bluebunch Wheatgrass

¹ Society for Range Management cover types listed in Shiflet (1994).

Source: Summarized from Appendix 2-2 and Marcot et al. (1996).

expands the size of the annual-dominated rangeland. Invasion of annuals is most serious in the Columbia Plateau and Owyhee Uplands (ERUs 5 and 10), where cheatgrass has literally taken over some range sites.

Cheatgrass is an annual grass that was probably introduced to western rangeland via contaminated grain from Europe in the late 1890s. Currently, cheatgrass exists in every county within the project area. Given its high seed production and highly germinable seed, cheatgrass is a successful intruder of native plant communities that are under stress or have been disturbed. The litter and standing dead material produced by cheatgrass makes up a flammable fuel that results in more frequent wildfires compared with fire frequency prior to the arrival of Europeans. As a result of frequent fire, (1) critical big game winter range and habitat supporting North America's densest concentration of nesting raptors has been reduced, (2) native sensitive plant species are threatened, (3) native plant diversity is reduced at both the local and landscape scale, and (4) recovery periods are extended.

Cheatgrass has adapted to the post-fire environment and uses the abundant nutrients and soil water to establish an environment that is less favorable to perennial plants. Cheatgrass has adapted to many communities including low elevation salt desert shrub and higher elevation ponderosa pine. Populations of cheatgrass also differ genetically, which contributes to the evolution of specialized types adapted to different environments. The "cheatgrass-wildfire cycle" presents the greatest risk to the Wyoming big sagebrush portion of the big sagebrush cover type and to the more moist salt desert shrub plant communities within the salt desert shrub cover type.

During the growing season for cheatgrass (from fall to June of the following year), it can produce more plant material than native vegetation or seeded forage wheatgrass species; however, the variability from year to year associated with production of cheatgrass is greater than native or introduced perennial grasses. The period when its material is palatable and nutritious for herbivores is considerably shorter than with native perennial species on rangelands.

Once established, cheatgrass can inhibit the growth of perennial plants native to the site, thereby perpetuating the cheatgrass fire cycle and causing depletion of volatile nutrients and accelerated soil erosion. Livestock grazing can reduce the amount of cheatgrass on the range and thus the spread of fire, because if cheatgrass is grazed down in the spring, less cheatgrass is available to burn later. However, it is not desirable to allow continuous spring grazing, which may cause a further decrease of native perennial grasses. Once native perennial grasses are lacking to the point of being only remnants on the site, then methods involving seeding would be the only recourse if the objective is to use perennial plants to re-establish rangeland function.

Cheatgrass continues to expand, including into forests and deserts. Although once established it tends to form a stable state, with frequent fire maintaining the stand, even less desirable weeds such as medusahead and yellowstar thistle are now invading cheatgrass-dominated rangelands and are further degrading site potential. This scenario places even more urgency on controlling or rehabilitating cheatgrass rangelands.

Introduced Forage Grasses

Introduced forage grasses (Based on Miles and Karl 1995a.) are grasses that were not native to the project area, which have been introduced primarily through seeding, typically for the purposes of forage production and soil protection. Environmental and site conditions including climate, geomorphology, soil type, salinity, slope, aspect, seed sources, existing vegetation, human impacts, and management determine the fate of a plant species on a site. Plants are most competitive in environments where they are best adapted, and competitiveness declines as the environment becomes less favorable. At the extreme, even the most “aggressive” of plants do not exist in areas outside their tolerance limits.

Rangeland damage has prompted management decisions to plant introduced forage grasses. In arid regions, hydrology is altered, soils erode, and soil and nutrient processes are impaired when the vegetative cover is removed. In the absence of native species that are adapted to human-altered environments, the planting of introduced forage grasses can help to stabilize soils, provide forage for livestock and wildlife, and preserve ecosystem processes in general.

The introduction of forage grasses creates biodiversity concerns. Certain seeded species (such as crested wheatgrass, the intermediate-pubescent wheatgrass complex, Kentucky bluegrass, hard fescue, and orchardgrass) have become established as monocultures in situations where all competing vegetation was removed before seeding, and no other well-adapted species, such as noxious weeds, are present that potentially would encroach and take over the new seeding. Therefore, if vegetation has been removed by fire, grazing, or cultural practices before seeding of introduced forage grasses, the likelihood is increased that a monoculture will form as a result of the seeding. In general, there is little likelihood that the introduced forage grasses themselves would encroach into undisturbed areas or replace existing vegetation. Converting vegetation types from a variety of native species to one or a few selected species has been a strategy to protect watershed function following wildfires, and to provide forage, mainly for livestock. In most cases, the seeding of the rangelands has initially resulted in less plant and animal diversity than what was there historically. Such changes in diversity and structure can markedly alter the food sources and the thermal and visual cover for wildlife, resulting from a new habitat of more uniform height and spacing. These changes affect the abundance and numbers of wildlife species that were dependent on the vegetation that was there historically.

Within the planning area, approximately 840,000 acres of BLM-administered land have been seeded to introduced forage grasses. Crested wheatgrass is the predominant species that was seeded, mostly in the dry shrubland potential vegetation group within the Northern Great Basin and Owyhee Uplands (ERUs 4 and 10).

Climate and Disturbance Stresses

Climate is a driving variable affecting site susceptibility to stresses on both vegetation and soils, and affecting resiliency to recover from stresses. Arid areas that receive less than 12 inches of average annual precipitation (see Map 2-3), in particular, are subject to extremes and/or episodic events that in conjunction with other ecosystem stresses can lead to degradation and inhibit recovery. While the exact status of soil and vegetation indicators must be determined by on-site investigations, there are indicators of

relative susceptibility to disturbance stresses. Soil properties that may make certain sites more susceptible to range health stress include erodibility by water or wind, salinity and sodium content, and shrink-swell potential. Vegetation indicators of susceptibility might include composition of flammable exotic or noxious weed species; however, these plant community characteristics are more appropriately analyzed at a finer scale than in this EIS, using inventory data or on-site determinations.

The 10- to 12-inch precipitation zone appears to be particularly susceptible to invasion by exotic annuals. However, this zone is proposed as *moderately* susceptible, rather than *highly* susceptible, because it is at the lower range for reseeding of perennial species, provided that soil factors are not limiting. An annual precipitation zone less than 10 inches may be somewhat less susceptible to initial invasion by annuals, but once established, the likelihood of recovery by reseeding or other means is exceedingly diminished.

Leonard and Karl (1995a) summarize the frequency of drought and occurrence of favorable years for seedling establishment for climate divisions in the project area. Periodic drought may facilitate woody plant establishment and canopy development or result in high weed biomass, including flammable exotics, in succeeding years of high rainfall. The more arid the area, the more frequent the occurrence of drought years. Seedling establishment of perennial species usually requires two or more favorable years in a row, which occurs infrequently and unpredictably in the project area, and in most cases is preceded or succeeded by at least moderate drought conditions. Frequent incidence of drought and few favorable periods of precipitation for plant recruitment can worsen grazing disturbances if not managed properly. Regardless of the grazing strategy, continued stocking at near normal levels during moderate to severe drought is probably the greatest cause of range deterioration. Areas that are especially susceptible to range deterioration by improper grazing during and directly after drought in the planning area are dry shrublands in the Northern Great Basin and Owyhee Uplands (ERUs 4 and 10), where thousands of acres of rangeland have been taken over by altered sagebrush steppe.

Other Factors Influencing Rangeland Health

Western Juniper and Other Woody Species Expansion and Density Concerns

Western juniper is a relatively small to medium size native tree of the Pacific Northwest. Since the late 1800s, western juniper has increased its acreage by approximately three to ten times, with most of the current acreage lying within the Columbia Plateau, Blue Mountains, and Owyhee Uplands (ERUs 5, 6, and 10; see Map 2-23). Western juniper also has increased in density.

Climate and fire contributed to the prehistoric expansion and contraction of western juniper's distribution. Settlers initiated fire suppression policies which probably contributed to the expansion of young juniper woodlands. Contraction of western juniper distribution was accomplished by burning seedlings and young junipers. The loss of fine fuels to carry fire, caused in large part by improper livestock grazing, probably played a larger role in fire frequency reduction than active suppression did. The combined impacts of improper livestock grazing, reduced fire frequency, and possibly climate change are probably responsible for expansion of western juniper woodlands during the past 100 years. The result is a reduction in grasses, forbs, shrubs, and young juniper that provide forage for livestock and protection from soil erosion.

As western juniper woodlands increase in density, understory vegetation production declines. Conversely, after reduction of western juniper density, site productivity of understory species typically increases. However, undesirable species, especially cheatgrass and noxious weeds, increase following juniper removal if they were present before removal.

Healthy western juniper woodlands, with a full complement of understory non-vascular species (for example, species composing microbiotic crusts), grasses, forbs, and shrubs, represent one of the most diverse plant communities in the project area. However, biodiversity is reduced on sites where density of western juniper has increased to the point that understory vegetation

is excluded. Therefore, the expansion and increasing density of western juniper on rangelands poses a threat to plant species in the understory, and other species that depend upon those plants for habitat.

Western juniper expansion has also affected hydrologic functions. Western juniper intercepts rain and snow with its canopy, which results in less water reaching the soil surface, especially in low intensity storm events. On sites where western juniper has excluded understory vegetation, particularly in spaces between canopies, infiltration has probably declined and runoff and erosion have probably increased, especially under high intensity storm events. The hydrological effects of western juniper increase are difficult to separate from those resulting from improper livestock grazing, but where improper livestock grazing has contributed to the decline in understory vegetation, it has probably contributed to increased runoff and erosion as well.

The reduction of fires, as a result of fire suppression or a reduction in flammable fuels, has also affected other woody species. Conifers (ponderosa pine, lodgepole pine and Douglas-fir) have encroached at various rates onto mostly grasslands, cool shrublands, and meadow-type habitats in the Cascade Range. Fire suppression and climate have been considered the primary reasons for this encroachment. Sagebrush, mainly mountain big sagebrush within cool shrublands, has increased in density in many areas, especially in higher elevations in eastern Oregon. As with juniper, the denser these woody species are, the more understory vegetation is affected. Productivity is normally reduced in the denser areas with biodiversity reduced as a result of the understory being out-competed for available nutrients and water by the larger, deeper-rooted woody species. If fire is reintroduced into these dense areas prior to the loss of the native understory vegetation, then productivity and biodiversity can be enhanced. However, if undesirable exotic vegetation such as cheatgrass becomes a major component of the understory, then fire may lead to altered sagebrush steppe. In addition, if most of the understory is lost or lacking to the point of not providing a seed source, then removal of woody species may expose the soil to accelerated erosion until either native or exotic species get a foothold in the area.

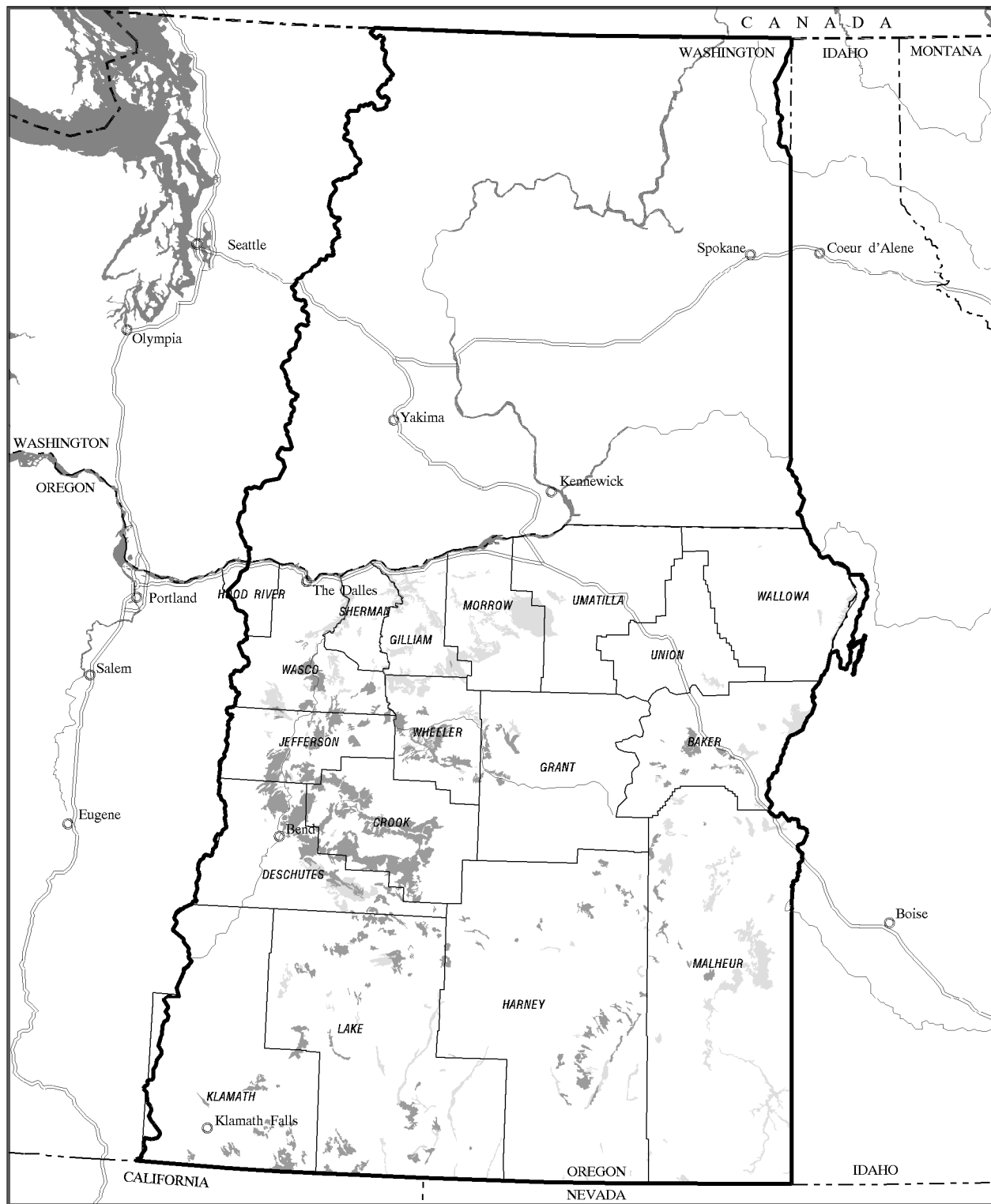
Microbiotic Crusts: Ecology and Implications for Rangeland Management

Microbiotic crusts consist of lichens, mosses, algae, fungi, cyanobacteria, and bacteria growing on or just below the soil surface in a thin layer. Microbiotic crusts are found in open spaces between larger plants. These crusts play a role in nutrient cycling, soil stability and moisture, and interactions with vascular plants. Microphytic (plant community comprising only lichens or algae) plants in the crusts provide forage for invertebrates, and some lichens growing on or at the soil surface (such as non-attached lichens) provide forage for big game species during critical winter periods. Some microphytic plants are also potential environmental indicators, for example, of air quality. The ecological role of microbiotic crusts is probably most notable on sites that support relatively sparse vegetation cover. These sites are mostly found in the Northern Great Basin (ERU 4), Columbia Plateau (ERU 5), and Owyhee Uplands (ERU 10). Potential vegetation types in the project area associated with substantial microbiotic crust components include: (1) salt desert shrub, (2) many of the sagebrush types, and (3) the xeric (drier) juniper types.

Soils stabilized by microbiotic crusts tend to have greater concentrations of organic material, nitrogen, exchangeable manganese, calcium, potassium, magnesium, and available phosphorous. Microbiotic crusts can be the major source of nitrogen in juniper-sagebrush woodlands that apparently contain no other nitrogen-fixing organisms. However, in a natural setting, questions remain concerning the availability of nitrogen fixed by microbiotic crusts to vascular plants.

Microbiotic crusts can comprise 70 to 80 percent of the ground cover in some areas. They can contribute to aggregate structure, and thus soil stability, by binding soil particles within the physical structures of the microphytes, and trapping soil particles.

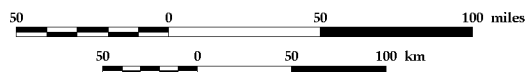
The influence of microbiotic crusts on infiltration and soil moisture has been noted as positive, negative, or neutral. This is so because many factors, including soil type, degree of microbiotic crust development, types of organisms in the crust, climate, disturbance history, and state of wetness of a given soil type when it is rewetted,



Map 2-23.
Distribution of Western
Juniper in Eastern
Oregon Counties

INTERIOR COLUMBIA
 BASIN ECOSYSTEM
 MANAGEMENT PROJECT

Draft EASTSIDE EIS
 1996



- Lands Where Western Juniper Exists in Woodlands
- Lands Where Western Juniper Exists as an Occasional or Isolated Tree
- Major Rivers
- Major Roads
- EIS Area Border
- Cities and Towns

all have a bearing on infiltration and soil moisture. The fact that microbiotic crusts will develop quite well on soil types characterized by clay and fine silt with an inherently low capacity for soil water infiltration confuses the picture and makes it more difficult to truly depict the crust's role in infiltration.

Surface-disturbing activities, such as grazing, off-road recreational and military vehicle use, and recreational hiking, reduce the maximum potential development of microbiotic crusts. Fire also depletes microbiotic crusts, at least temporarily. Except where habitat is completely displaced, such as in urbanization or dominance by exotic annuals, recovery of microbiotic crusts ranges from a few years to 100 years after removal of the activity. Following fire, algal components of the crust can recover substantially within 5 to 10 years whereas lichens and mosses take 10 to 20 years or more. Average return frequencies of natural fire ranges from 50 years in the shrub steppe, to as high as 100 years in the more arid Snake River Plain, and are adequate to restore advanced development of crust components. Current fire intervals of less than five years can occur on the annual grasslands (altered sagebrush steppe) of the Snake River Plain, because the cover of exotic annuals, for example cheatgrass and medusahead, and their associated litter perpetuates the fire cycle. This results in substantial risk to microbiotic crusts. Management practices that reduce fire size and frequency would enhance microbiotic crust development.

Desired levels of microbiotic crusts should be based on site capability and rangeland health indicators of site stability and nutrient cycling. Additional research is needed to establish realistic microbiotic crust objectives in most potential vegetation types.

Microbiotic crusts are generally lacking in the sagebrush and salt desert shrub potential vegetation types in the project area, especially in the Northern Great Basin (ERU 4) and on altered sagebrush steppe in the Owyhee Uplands (ERU 10). Inappropriately high livestock grazing pressure during the dry seasons is believed to be responsible to a large degree, and may be related to past grazing practices.

The role of microbiotic crusts in the project area is not conclusive at this time. Most of the studies on microbiotic crusts have been conducted in the southern Great Basin and Colorado Plateau. Strict extrapolations of findings from these studies to the project area and prescriptive management direction would be premature until more definitive studies of microbiotic crusts are conducted in the project area. For these reasons, microbiotic crusts are discussed only in the guidelines section of the alternatives (Appendix 3-2).

Livestock and Big Game Interactions

Concerns over livestock use of big game ranges and vice-versa have been debated between rangeland professionals and wildlife biologists for years. When mismanaged, either big game (elk, mule deer, pronghorn antelope, and bighorn sheep) or livestock can have substantial effects on the other, especially during critical times of the year on rangelands in poor condition. An understanding of livestock and big game habitat, diet, diet overlap, and impacts on vegetation is necessary to minimize conflicts between livestock and big game.

Dietary and habitat overlap does not necessarily mean serious (population reduction) competition is occurring. Patterns of use, time of use, condition of the range, health of the wildlife population, weather, and closeness to water affect the seriousness of the situation. Competition between livestock and big game is increased where winter ranges are in degraded condition. This limits the type, quality, and quantity of forage available for both livestock and big game.

Elk and cattle competition has the potential to be highest on foothill rangelands used by cattle in the fall and elk in the winter. However, cattle prefer the bottoms and lower slopes, whereas elk prefer the upper slopes and steeper terrain. Elk foraging habitats may sometimes be influenced by cattle presence or use, and stocking rates and types of grazing systems may substantially alter elk foraging habits. Elk and sheep competition has the potential to be highest on winter range used by both species. Summer range use by both species also has potential for competition because of high forb use by both species, although elk may use different species of forbs in their diet than sheep. Deer and cattle have the greatest potential for competition in the winter and spring. Competition is especially high on

winter ranges lacking in browse, or on those winter ranges that are in degraded condition and lack grass cover.

Detailed information is lacking on domestic sheep and bighorn sheep social tolerance and forage competition. The negative effects of disease transmission between the two species probably overshadows potential negative effects from forage competition. The largest impediment to restoring bighorn sheep is the potential for disease transmission from domestic sheep that graze near or within historical and occupied bighorn sheep ranges.

Pronghorn antelope and cattle have the greatest potential for competition on degraded rangelands where brush is the main forage and grasses are lacking. Otherwise, a dietary overlap seldom exceeding 25 percent precludes serious competition between these two ungulates as cattle are mainly eating grass and pronghorn are eating forbs and brush.

Stocking rate and type of grazing system affect the quantity and quality of key forage plants, such as bluebunch wheatgrass and bitterbrush, in the project area. Light stocking rates increase production of some grasses and browse species, especially in riparian and forest habitats, compared to heavier stocking rates. Heavy, long-term stocking rates decrease the amount of key forage plants and increase the amount of less desirable plants. Heavy livestock use of grasses increases shrub cover. Heavy livestock use of browse, such as aspen, bitterbrush, and willows, decreases the competition with grasses.

Big game overbrowsing of shrub and tree species in riparian zones alters the plant composition, or in some cases eliminates the shrub or tree species. In general, big game has had negative effects on riparian areas on both winter and summer ranges. Big game negatively affects stands of native grasses where heavy winter and spring use occurs because of high population levels.

Specific locations where livestock and big game conflicts are a serious concern have not been identified in the *Integrated Scientific Assessment*. Generally, these conflicts occur throughout the planning area where limited habitat is available for wildlife. The potential for conflicts can be very high, especially during severe winters on limited winter range, where large populations of big game exist, such as in eastern Oregon in the

Blue Mountains (ERU 6). Serious conflicts occur when winter ranges are degraded to conditions where biodiversity is lacking, such as in altered sagebrush steppe areas, and when winter conditions become severe.

Summary of Changes from Historical to Current

This summary is by ecological reporting unit, by potential vegetation group (PVG), and by terrestrial community for BLM- and Forest Service-administered lands.

ERU 1 ~ Northern Cascades

Cool Shrub PVG.

- ◆ A 40 percent increase in upland shrub.

ERU 3 ~ Upper Klamath

Cool Shrub PVG.

- ◆ A 25 percent decrease in upland shrub.

ERU 4 ~ Northern Great Basin

Dry Shrub PVG.

- ◆ An extensive invasion of exotic species.

ERU 6 ~ Blue Mountains

Dry Grass PVG.

- ◆ An extensive invasion of exotic species.

ERU 7 ~ Northern Glaciated Mountains

Dry Shrub PVG.

- ◆ A 30 percent decrease in upland shrub.

ERU 10 ~ Owyhee Uplands

Dry Shrub PVG.

- ◆ An extensive invasion of exotic species.