INTERIM PROTECTION FOR LATE-SUCCESSIONAL FORESTS, FISHERIES, AND WATERSHEDS: A SUMMARY OF THE REPORT OF THE EASTSIDE FORESTS SCIENTIFIC SOCIETY PANEL

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ABSTRACT

This paper briefly summarizes the findings and recommendations of a scientific panel convened at the request of Congress to assess conditions in forests of eastern Oregon and Washington. Only a fraction of the original old-growth forests (OG) in eastern Oregon and Washington remain. The greatest reductions have been in lower elevation forests, where we estimate old-growth now covers less than 15% of its original area, with a relatively small proportion of the remaining protected. The increasing shift of logging over the past 25 years into high elevations and onto steep slopes has reduced the abundance of old-growth in these forest types as well. Continued logging in unprotected areas could reduce old-growth of all forest types to less than 10% of total forest area in eastern Oregon and Washington, raising concerns about potential impacts on species and ecological processes. Fisheries and riparian zones are generally in poor condition. Numerous terrestrial species have lost significant amounts of habitat and their status is uncertain but of concern. The panel recommended eleven interim measures to protect resources while a more detailed plan is developed, including a moratorium on logging old-growth forests and restoration of the landscape to a higher proportion of older ponderosa pine forests.

INTRODUCTION

The Eastside Forests Scientific Society Panel originated in May, 1992, when seven bipartisan members of Congress requested scientific societies to: (1) identify areas east of the Cascades crest in Oregon and Washington where "...damage to forest ecosystems could result in compromising the long-term ecological viability of these forests, their fisheries, and other resources that depend on them"; and (2) recommend management guidelines that would protect these critical areas in the interim while a long-term conservation plan is being developed. Team members (the authors of this paper) were appointed by The American Fisheries Society, The Wildlife Society, The American Ornithological Union, The Society for Conservation Biology, and The Ecological Society of America. The logistics of assembling data along with GIS mapping and computer analyses were handled by Steve and Eric Beckwitt of the Sierra Biodiversity Institute. A final report (Henjum et al. 1994) was issued in August, 1994, and is available from the Wildlife Society (5410 Grosvenor Lane, Bethesda, MD 20814).

The objective of this paper is to give a brief overview of the approach, findings, and recommendations of the Panel.

APPROACH

The report focused on national forests east of the crest of the Cascades in Oregon and Washington. Analyses fell into five general categories:

1. Identifying the extent, location, and status (protected or unprotected) of existing old-growth forests;
2. Locating watersheds considered to be critical for fisheries;
3. Mapping roads, streams, and roadless areas (by size);
4. Reviewing existing knowledge concerning the status of fish and terrestrial species likely to be impacted by forest management (e.g., species requiring old-growth or large dead wood);
5. Assessing the status of habitats with respect to the needs of species of concern and recommending measures for interim protection of species and ecosystems.

A total of 50 map layers representing physical, biological, and administrative information were compiled and transferred to GIS. Time and resources limited analyses to existing information, i.e., no original data was gathered. Old-growth was located for the most part using maps produced by the Audobon Society's Adopt-A-Forest Project, which worked in conjunction with U.S. Forest Service (USFS) personnel. Briefly, the Adopt-A-Forest Project used USFS timber type maps to identify stands with average diamaters greater than 21 inches. This initial mapping was then updated using recent aerial photographs and stand visits. Finally, field crews from Audobon and the USFS gathered data within stands to verify that they met USFS regional definitions for old-growth.

Where necessary, Adopt-A-Forest maps were supplemented by other data, including local USFS maps, aerial photographs, and maps produced by the Interagency Grizzly Bear Team.

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Our maps were verified in three ways:

1. Previous verification during the Adopt-A-Forest process (discussed above);
2. By USFS employess in 1993 (at our request);
3. By USFS personnel as part of timber sale screening after our process was complete.

We concluded that Adopt-A-Forest maps were reasonably accurate, although the degree to which they had been field-verified differed depending on the national forest. In visiting individual national forests, it became apparent that the area of old-growth mapped by Adopt-A-Forest during in the late 1980s and early 1990s had been reduced by logging and wildfire. Our maps were adjusted accordingly when new information allowed that to be done reliably, however, in many cases our maps are likely to overestimate the actual amounts of old-growth existing today. Nevertheless, they are probably the best available (as of 1994), and are being used by the USFS to identify remaining old-growth.

In Oregon, critical watersheds for fisheries ,"Aquatic Diversity Areas (ADAs)" had been previously identified by the Oregon Chapter of the American Fisheries Society (AFS). Critical watersheds in Washington were identified by a team of fisheries biologists associated with the North Pacific International Chapter of the AFS.

Other map layers (e.g., roads, elevation) were scanned into GIS from existing maps. Not all data were available for all national forests. The current extent of old-growth was calculated for 8 of the 10 national forests, size distribution of roadless areas for 6 national forests, and road densities for 3 national forests. Table 1 lists the types of data compiled for each of the eastside national forests, and Table 2 summarizes the statistics.

Table 1.—Key to data presented in Henjum et al. (1994) for eastside national forests. Mapping and data compilation by Sierra Biodiversity Institute.

Information available	Forest[a]									
General statistics	CO	DE	FR	MA	OC	OK	UM	WW	WE	WI
LS/OG[1] stand data	CO	DE	FR	MA	OC		UM	WW		WI
LS/OG density within watersheds	CO		FR	MA	OC		UM			WI
LS/OG classification by slope	CO	DE		MA	OC		UM	WW		WI
LS/OG-riparian relationship	CO			MA	OC		UM	WW		WI
Roadless region patch size and distribution	CO			MA	OC	OK	UM	WW	WE	WI
Relationship between LS/OG and roadless regions	CO			MA	OC		UM[b]	WW		WI
Relationship between roadless regions and ADAs				MA	OC		UM[b]	WW		WI
Road density within watersheds	CO				OC	OK				WI
Roads in riparian zone										WI
Classification of Eastside Panel roadless regions by slope and land use	CO					OK				
Relationship between LS/OG and designated old-growth					OC					WI
Extent of potential climax and seral pondersoa pine stands										WI

[a] CO = Colville National Forest, DE = Deschutes, FR = Fremont, MA = Malheur, OC - Ochoco, OK = Okanogan, UM = Umatilla, WW = Wallowa-Whitman, WE = Wenatchee, WI = Winema

[b] Oregon only

[1] LS/OG = late successional/old-growth

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Table 2. —State of eastside national forests. Except where otherwise noted, values represent means for those forests (number of forests in parentheses) where data was available. From Henjum et al. (1994).

Total area, 10 national forests	14.6 million acres
Total percentage forested	79%
Total percentage of national forest suitable for timber management	57%
Wilderness area, average acreage per forest	238,000 acres
Percentage of wilderness that is forested (3 forests)	83%
Percentage of wilderness that is LS/OG (7 forests)	9.7% (range, 2-34%)
LS/OG, percent of total area (6 forests)	16%
LS/OG, percent of forested lands (8 forests)	25%
Designated old-growth that is actually LS/OG (average for 7 forests)	54% (range, 7-91%)
Designated old-growth sites containing more than 70% LS/OG	47% (range,7-91%)
Designated old-growth containing no LS/OG	31% (range, 3-67%)
Protected LS/OG[a] (in wilderness or administratively protected [8 forests])	22%
Unprotected LS/OG (8 forests)	78%
Within management areas scheduled for timber cutting	58%
Within management areas not scheduled for cutting	20%
LS/OG patches smaller than 100 acres (8 forests)	82%
LS/OG patches larger than 5000 acres (3 forests)[b]	None
LS/OG patches larger than 5000 acres (3 forests)[c]	7 (1 protected, 6 unprotected)
LS/OG within watersheds of 3000-10,000 acres (6 forests)	12%[d]
Watersheds containing less than 10% LS/OG (6 forests)	58%
Watersheds containing more than 60% LS/OG	
4 forests[e]	None
2 forests[f]	3%
Percentage of roadless regions smaller than 500 acres (6 forests)	36%
Percentage of roadless regions larger than 5000 acres (6 forests)	15%
Road density (miles of road per square mile) (3 forests)[g]	3.2 (range, 2.5-3.7)

[a] Protected LS/OG tends to be disproportionately located on steep slopes. In Deschutes National Forest, for example, less than 1% of the forest consists of slopes steeper than 60%, but 9.8% of wilderness consists of slopes steeper than 60%.
[b] Western Colville, Wallowa-Whitman, and Winema National Forests.
[c] Malheur, Ochoco, and Umatilla.
[d] No watershed is 100% LS/OG.
[e] Western Colville, Fremont, Malheur, and Umatilla (0 of 648 watersheds).
[f] Ochoco and Winema (8 of 234 watersheds).
[g] Western Colville, Ochoco, and Winema.

FINDINGS

Status of Old-Growth Forests in Eastern Oregon and Washington

The extent of old-growth forest ecosystems on the eastside has been dramatically reduced during the 20th century. We estimate that as of the late 1980s/early 1990s, old-growth composed 25% of forested lands on eight eastside national forests, approximately 22% of which was protected by statute (wilderness areas) or administratively (Figure 1 shows some representative maps). Continued logging of currently unprotected old-growth would reduce the area of these unique ecosystems to between 11% and 15% of total forest lands on eastside national forests. If all ownerships are considered, currently protected old-growth drops to less than 10% of eastside forest lands.

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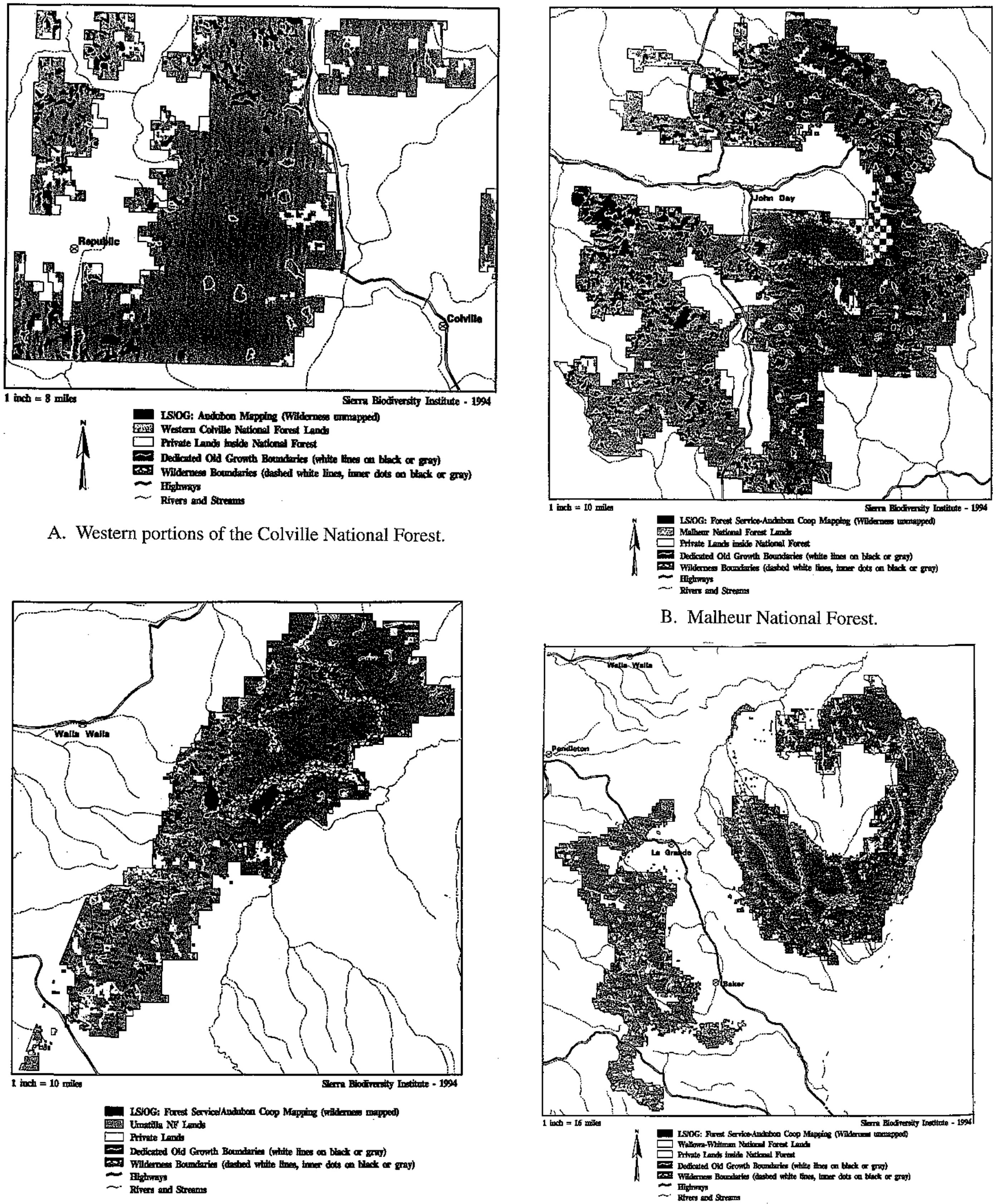

A. Western portions of the Colville National Forest.

B. Malheur National Forest.

C. Northeast portion of the Umatilla National Forest.

D. Wallowa-Whitman National Forest.

Figure 1.—An illustration of national forest maps showing public and private lands, wilderness areas, designated old-growth stands, and actual late-successional/old-growth forests (LS/OG). The national forests shown were selected arbitrarily to illustrate the type of maps produced by Henjum et al. (1994), not to represent conditions necessarily particular to those forests.

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Remaining old-growth is heavily fragmented, with 80% of patches covering less than 100 acres. Three forests (Colville, Wallowa-Whitman, and Winema) contain no patches larger than 5000 acres; three other forests (Malhuer, Ochoco, Umatilla) contain seven patches larger than 5000 acres, but only one is protected. Forests outside of roadless areas are permeated with roads. (Figure 2 shows an example of mapped road density for a portion of one national forest; the objective of this figure is not to single out any one national forest, but to illustrate the type of mapping done by the panel and to graphically display the density of roads typical throughout the region).

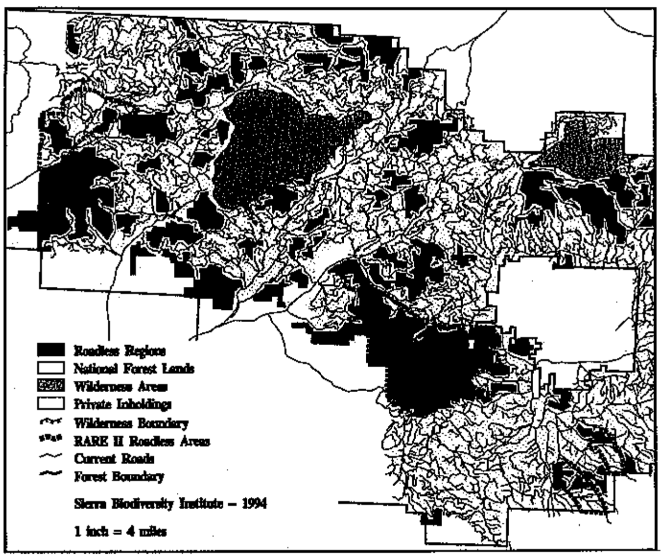

Figure. 2.—Network of roads in the western portion of the Ochoco National Forest. Roads density on the Ochoco is typical of eastside national forests.

Lumping all forest types together does not accurately portray the current status of eastside old-growth. Low and mid-elevation forests, once dominated by old-growth ponderosa pine or, in some areas, Douglas-fir, have been most heavily logged. The available data do not allow precise determination of how much old-growth ponderosa pine remains today, but we estimate that for the region as a whole it is less than 15% of the original. In some areas, such as the Klamath Plateau and east slopes of the Cascades in central Oregon, less than 5% of the original climax ponderosa pine remains (W. Hopkins personal communication).

Because wilderness areas tend to be located at higher elevations, a relatively small proportion of the remaining lower elevation late successional old-growth (LS/OG)—primarily ponderosa pine in Oregon and ponderosa pine and Douglas-fir in Washington—is currently protected. In the four national forests within the Blue Mountains, 48% of the land base above 6000 feet is in wilderness, while only 10% of lands below 6000 feet are in wilderness. A similar pattern exists on the Okanogan National Forest, where only 15% of the remaining lower elevation old-growth is currently protected. Of stands set aside by the USFS as "Designated Old-Growth" (DOGS), our maps show that only 47% of these contain more than 70% old-growth, while 31% contain no old-growth at all. Apparently, the rules used to define DOGS varied depending on the national forest. On the Umatilla National Forest, for example, 91% of DOGS are actually old-growth while only 50% on the Malheur National Forest.

Historic Perspectives

Although conditions prior to settlement by Euroamericans are not precisely known, there is no doubt that the area of old-growth has been sharply reduced during this century. Forests dominated by ponderosa pine were especially impacted because they had big valuable trees that grew at lower elevations and, hence, were accessible. Early settlers of eastern Oregon wrote of extensive forests dominated by large, old ponderosa pine, with grassy understories maintained by frequent, light ground fires. The first comprehensive survey of forest resources in eastern Oregon and Washington (excluding Stevens and Spokane Counties in northeast Washington) was completed in 1936, at which time "(t)he area of commercial forest land (was) characterized by a high proportion of old-growth..." (Cowlin et al. 1942). The 1936 survey found old-growth of all forest types composed 89% of sawlog-sized stands, and 73% of all commercial forest lands in eastern Oregon and Washington.

Nearly two-thirds of eastside forest lands encompassed by the 1930s study (Cowlin et al. 1942) were dominated by ponderosa pine which, even after a period of heavy cutting that began in the early 1920s, was still mostly old-growth. Accounting for logging prior to 1936, the original low and mid-elevation ponderosa pine forests comprised nearly 90% old-growth. These stands typically contained trees up to 60 to 70 inches diameter breast height (DBH), with most of the stand volume concentrated in trees from 20 to 44 inches DBH (Cowlin et al. 1942). This picture is supported by survey notes from the late 1800s on what is now the Ochoco National Forest. There, ponderosa pine was recorded at 93% of section corners in all but the most moist forest types (north slopes above 5000 feet in elevation), where ponderosa pine was recorded at 69% of the corners. On average, 40% of witness trees on all but the most moist sites were 21 inches or larger in DBH.

As elsewhere, the history of logging in eastern Oregon and Washington has been one of progressively moving from high value accessible stands in the lowlands, to lower value stands in the higher mountains. Logging began in earnest in the region during the 1920s. At that time, large-scale cutting occurred almost exclusively in the extensive stands of old-growth ponderosa pine on the Klamath plateau and the east slopes of the Cascades in Oregon, and in old-growth ponderosa pine in northeast and central Washington (Wall 1972). Cowlin et al. (1942) estimated that logging, insects, and catastrophic fire (much of the latter a consequence of logging) had reduced the area of ponderosa pine old-growth in the region from "an original" 12 million acres to 9.1 million acres at the time of the 1936 survey. "Originally a virgin forest of this type extended the length of Oregon along the east slopes of the Cascade Range from within a few miles of the summit to the deserts edge. From about 10 miles in

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width on the north it ranged to nearly 100 miles on the Klamath Plateau in the south, interrupted only by comparatively small openings of nonforest land. Extensive cutting from Bend south has broken it up with large areas of pine second growth..." (Cowlin et al. 1942).

Heavy logging did not begin in the Blue Mountains of northeast Oregon and southeast Washington until the 1950s. At the time of the 1936 inventory, forests containing a significant proportion of ponderosa pine occupied about 80% of commercial forest land on all ownerships in the Blue Mountains (Cowlin et al. 1942). As was the case on the Klamath Plateau and the east slopes of the Cascades, by far the majority of pine forests in the Blue Mountains were old-growth (86%). By the mid-1960s, the proportion of commercial forests dominated by ponderosa pine had dropped to 40% in the Blue Mountains (Bolsinger and Berger 1975), a loss of one-half over a thirty year period. Bolsinger and Berger (1975) concluded that "(c)utting in (ponderosa pine) has greatly exceeded the growth rate. Prospects for increased growth of ponderosa pine in the near future are poor, especially on private lands where cutting has removed a large percentage of the trees where growth could be occurring; the remaining stands are often poorly stocked, made up of inferior trees left after logging, or consists of other species such as Douglas-fir or true firs".

Loss of ponderosa pine in the Blue Mountains was accompanied by a declining abundance of large trees of all species. Referring to the 1960s inventory, Bolsinger and Berger (1975) wrote "(s)ince the previous inventory (in the 1950s), the forests of the Blue Mountains have been heavily logged. In the mid-1950s, the acreage in saw timber trees 21.0 DBH and larger was 2.5 million acres; the present inventory shows 1.4 million acres—a reduction of 44 percent". Heavy logging has continued since the 1960s, and Wickman et al. (1993) estimate that "...remaining commercial ponderosa pine easily could be reduced now to 20-25% of the total forest area in the Blue Mountains".

It should not be construed that losses of ponderosa pine are the only concern. Douglas-fir forests were abundant at low and mid-elevations in northeast and southcentral Washington. The 1936 survey found that 60% of these were either old-growth or "large second growth" characterized by trees large enough to qualify as old-growth under current definitions. Whereas the earliest logging in Washington was predominantly in ponderosa pine, by 1970 roughly equal amounts of pine and Douglas-fir were being logged. We do not know how much old-growth Douglas-fir remains today, but it is almost certainly well below historic levels.

With the depletion of lower elevation forests, the cut has increasingly come from higher elevation and less accessible areas, and increasingly from public lands (Wall 1972). Between 1949 and 1958, timber harvests from eastside Oregon and Washington were split about equally between private and public lands. The cut from private lands plateaued in the mid-1950s, while cutting from public lands accelerated. During the latter half of the 1960s, two-thirds to three-quarters of the total regional cut came from national forests in Oregon and a mix of national forest and Indian lands in Washington. This trend has held, at least in Oregon, where two-thirds of the cut between 1983 and 1987 was from public lands (Sessions et al. 1990; we don't have comparable data for Washington).

Coincident with the increasing importance of public lands in the overall harvest was a sharp increase in cut level. Log production from national forests in eastern Oregon and Washington increased nearly four-fold between 1949 and 1968. By the late 1960s, harvest levels from all ownerships combined were 50% higher than Cowlin's et al. (1942) most optimistic estimate of sustained yield possible from eastside forests. We do not have more current log production data for Washington, but log production in eastern Oregon during the mid-1980s was similar to that occuring in the late-1960s and early 1970s (Sessions et al. 1990). Depletion also continued on private industrial lands in eastern Oregon, where harvest beteen 1986 and 1992 exceeded gross growth by 61% (McKay et al. 1994).

Status of Aquatic Resources

Anadromous stocks of salmon and trout are declining throughout the Columbia River Basin. At least 106 major populations (or stocks) of salmon and steelhead have been extirpated on the West Coast—most from rivers in the Columbia Basin. Production in the Columbia has declined to about 5% of historic levels (Nehlsen et al. 1991). The conservation group, Oregon Trout, has classified 76 salmonid populations from the Columbia Basin as either at-risk of extinction or meriting special attention—most of these inhabit watersheds east of the Cascades crest (Nehlsen et al. 1991). Declining fish production in eastern Oregon and Washington is not restricted to migratory salmon and steelhead. Many resident species that spend their entire life cycle within freshwater habitats are also threatened. The Endangered Species Committee of the American Fisheries Society lists 25 resident fish species or subspecies as at risk in Oregon, 24 of which occur only in eastside waters, and 14 of which inhabit watersheds within or immediately downstream from national forests (Li and Castillo 1994). In total, 40% of the 52 native fish species that occur in forests of eastern Oregon and Washington have been identified as at-risk in one or both states. The U.S. Fish and Wildlife Service recently filed petitions to review the status of bull trout for potential listing under the Endangered Species Act. More than 80% of remaining bull trout populations in Oregon face either a moderate risk of extinction or are of special concern, most from east of the Cascades crest. Of 31 populations of bull trout in eastern Washington, 12 are considered stable and 7 declining, while the status of the remaining 12 is unknown (Mongillo 1992).

A variety of factors contribute to declining fish populations. The Northwest Power Planning Council attributes decreased productivity of Columbia River salmon to dams, habitat degradation, and overharvest of wild populations in mixed-stock fisheries (NPPC 1986). Superimposed on these factors are fluctuations in nearshore marine environments which markedly influence survival of juvenile coho. Similarly, various factors may contribute to declines in resident fish species, including habitat destruction, hybridization, and introduction of exotics. A common thread in the coincidental decline of so many different fish taxa—those that do and do not migrate to the sea, those that are and are

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not harvested in fisheries, those found in areas affected and unaffected by large dams—is the degradation and simplification of freshwater environments by human landuse practices (Bottom et al. 1985; Williams et al. 1989; Hicks et al. 1991; Nehlsen et al. 1991; Walls et al. 1992; Frissel 1993; Rhodes and McCullough 1994). Stream and riparian ecosystems in many eastside watersheds have suffered continuous degradation for the past century or more (Wissmar et al. 1994), including: loss of riparian vegetation; reduction of large wood in streams; higher water temperatures; accumulation of fine sediments in pools and on spawning grounds; and altered hydrological processes (including loss of cool water seeps). Different factors contribute to degradation in different places, but in the region as a whole the primary agents are agriculture and irrigation, timber management, road construction, livestock grazing, and mining (McIntosh et al. 1994; Wissmar et al. 1994).

Wherever eastside information has been gathered, results indicate that riparian systems have been severely degraded. In the early 1980s, for example, more than one-half of 3062 miles of stream inventoried in the Deschutes, John Day, Grande Ronde, and Umatilla basins were deemed in need of restoration (Bottom et al. 1985). In USFS and BLM evaluations of grazing allotments in the Silvies, Malheur, John Day, and Burnt River systems, Phillips (1987) found streams without woody vegetation, with incised stream channels, and with lowered water tables. He concluded that past grazing practices, particularly season-long grazing by cattle, were responsible for most of the damage; logging, road building, and browsing by big game contributed to a lesser degree. A recent survey of eastside river systems (Oregon and Washington) that had been previously surveyed in 1941 found that "managed" portions had lost 31% of their large pools since the earlier survey, while the number of large pools in "unmanaged" portions (e.g., in wilderness areas) had increased three-fold (McIntosh 1992; McIntosh et al 1994). Unmanaged streams also had approximately 50% more large wood than managed streams. Impacts have been more severe in Oregon than in Washington. Streams within managed portions of Oregon's Grande Ronde basin have shown decreases in large pool habitat ranging from 43-83% since 1941. Beschta et al. (1991) reported widespread damage to stream and riparian systems of the Grande Ronde basin, which they attributed to grazing, logging, road building, and mining. Among the 16 sites they evaluated, including 7 in the Umatilla and Wallowa-Whitman National Forests, no new cottonwood, alder, or willow dominated communities had become reestablished in 50 to 100 years. These researchers concluded that the degraded condition of riparian vegetation was one of the factors most responsible for loss of salmonid habitat in the Grande Ronde basin.

Many eastside rivers and streams have lost the capacity to support cold-water fish because of high summer temperatures associated with loss of riparian cover from grazing and logging, often exacerbated by irrigation withdrawals. This problem is particularly severe in the upper Grande Ronde, where average stream shading averages only 39% of its potential (Anderson et al. 1992, 1993). Forest Service monitoring data for many streams in the Malheur, Umatilla, and Ochoco National Forests verify that temperatures exceed state water quality standards, reaching well above the 64°F limit suitable for adult bull trout and the 68°F limit that may impair the growth of or indirectly kill salmon (USFS 1991, 1992b, 1993).

Sedimentation caused by the cumulative effects of past land-use practices has had widespread impact on fish habitat in eastside watersheds. Results of a detailed evaluation in the Bear Valley Basin of the Middle Fork Salmon River (USFS 1992; Burton et al. 1993) probably also apply to other, geologically similar eastside watersheds, such as the North Fork John Day, upper Grande Ronde, and portions of the middle fork John Day. Surface fine sediments in Bear Valley Creek today average 56%, compared with 29% in 1941. In contrast, relatively "pristine" meadow streams in other portions of the Middle Fork basin register fine sediment levels between 15% and 30%. The total number of large pools in a sample section of Bear Valley Creek decreased from 42 in 1941 to 13 in 1991 (USFS 1992). A little over one-half (52%) of the increase in sediment since 1941 was attributed to bank erosion caused by grazing, and most of the rest to past mining.

Although precise amounts are unknown, the extensive road network in eastside forests is considered to be a major source of sediment to streams (Anderson et al. 1992; McIntosh et al. 1994). Road mileage in the Wallowa-Whitman National Forest doubled from 4500 to 10,000 miles between 1978 and 1989, and now stands at 7.1 mi/mi^2 outside of roadless areas (McIntosh et al. 1994). Road densities on a forest-wide basis (i.e., calculated without excluding roadless areas) average 2.5 mi/mi^2 on the Colville National Forest, 3.7 mi/mi^2 on the Ochoco National Forest, and 3.5 mi/mi^2 on the Winema National Forest (Henjum et al. 1994). The location of roads has an important influence on stream and riparian habitat. We estimate, for example, that 36% of stream miles on the Winema National Forest have a road within 328 feet (100 m) of the main channel. Upslope logging may influence streams through sediment inputs and altered hydrologic flows, however the degree to which that has happened in eastside forests is poorly understood. Soils vary in their potential for surface erosion following logging, but some generalities are possible. Predictably, erosion potential is greater on steep than on shallow slopes. On pumice soils, clearcutting slopes greater than 30% can cause significant erosion (Harvey et al. 1989); granitics (e.g., the Idaho Batholith) are also highly erodible. Clearcutting slopes greater than 60% is likely to cause significant erosion on most soil types.

Logging may have changed flow conditions in the upper Grande Ronde River basin, where base flow has nearly doubled despite declining precipitation since 1904 (McIntosh et al. 1994). The timing of peak discharge in the basin has also advanced by as many as 30 days (McIntosh et al. 1994). A hydrologic model developed for the Wallowa-Whitman National Forest predicts that proposed timber harvest could further increase peak flows and advance the peak another 6 to 12 days, changes that could interact with unstable stream banks to add even more sediment to streams (NMFS 1993).

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Catastrophic wildfire can also impact fish habitat through increased sedimentation and altered hydrologic flows, as documented following the 1979 Mortar Creek fire in central Idaho (Minshall 1990). Potential sedimentation from an unsalvaged wildfire cannot be compared to that from a clearcut, because dead boles in the former serve as natural check dams. Heavy salvage of course changes that equation. The long-term effectiveness of grass seeding to reduce erosion following wildfire has been called into question by a recent experiment in the Klamath Mountains that shows seeded grasses completely disrupt recovery of native shrubs (Amaranthus et al. 1993). The Eastside Forests Scientific Societies Panel recommended five steps toward restoring eastside stream habitats (see Henjum et al. 1994 for more detail):

1. Define a system of reserves and restoration sites to protect the full variety of aquatic ecosystems and faunal assemblages found in the eastside landscape.

2. Protect watersheds large enough to maintain self-sustaining populations of their full complement of native taxa.

3. Protect multiple examples of each watershed type (a) to minimize the risks that catastrophic events will threaten associated assemblages and populations and (b) to accomodate multiple populations and subpopulations with diverse life histories and gene pools.

4. Begin restorations at headwater streams, working downstream and outward from healthy "core" areas to reconnect habitats and to promote colonization of nearby streams and watersheds.

5. Restore and protect functional riparian, flood plain, and groundwater systems to reconnect fragmented stream habitats and to maintain conditions and processes supporting native fish assemblages.

Status of Terrestrial Species

Because animals that live on land occur dispersed across the landscape rather than being restricted to well defined areas such as streams, and because they are often shy and reclusive, accurately determining the status of terrestrial species is difficult and expensive, hence seldom done (Ruggiero et al. 1994). Numerous terrestrial vertebrates in eastside forests use habitats that are either known or suspected to have been reduced during this century. Table 3 lists 17 bird and 2 mammal species that use old-growth, mature forests, or large dead wood, and that we identified as requiring particular attention when developing management guidelines for eastside forests (Henjum et al. 1994). We stress, however, that these represent a small proportion of the species that are potentially at risk in eastside forests if existing habitats are not protected and future habitats provided for.

One of the more comprehensive analyses of wildlife habitat performed anywhere in the world was undertaken for the Blue Mountains of eastern Oregon and Washington (Thomas et al. 1979a). Results showed heavy dependence on old-growth and mature forests, large dead wood, and riparian zones. Of 378 terrestrial vertebrate species known to occur in the Blue Mountains:

- old-growth and mature forests are used by 268 species for either reproduction or feeding; ponderosa pine and mixed conifer forests are particularly species rich (Thomas et al. 1979b);

- thirty-nine bird and 23 mammal species use snags for nesting or shelter (Thomas et al. 1979c), and 179 species make some use of logs (5 amphibians, 9 reptiles, 116 birds, and 49 mammals [Maser et al. 1979]); additionally an unknown number of invertebrates and fungi use dead wood;

- two hundred and eighty five species either directly depend on riparian zones or utilize them more than other habitats (Thomas et al. 1979d).

As discussed previously, eastside riparian zones are highly degraded, and old-growth is well below historic levels. Moreover, much of the old-growth that does remain is highly fragmented, which significantly reduces the probability that it will serve as long-term quality habitat (fragments are vulnerable to fire and wind, and deep forest species may be more vulnerable to predation and parasitism in fragments than in intact forests [Noss and Cooperider 1994; Perry 1994]).

The status of large dead wood, a critically important habitat, is more problematic. While some snags are left following logging (especially in recent years), our impression is that large dead wood is deficient in clearcuts and plantations on the eastside. We agree with biologists who have argued that retaining a few

Table 3.—Preliminary list of old-growth associated species that should be considered in the development of interim conservation and management guidelines for eastside forests. From Henjum et al. (1994).

Common name	Scientific name
Birds	
Bald eagle	*Haliaetus leucocephalus*
Northern goshawk	*Accipiter gentilis*
Flammulated owl	*Otus flammeolus*
Spotted owl	*Strix occidentalis*
Boreal owl	*Aegolius funereus*
Vaux's swift	*Chaetura vauxi*
White-headed woodpecker	*Picoides albolarvatus*
Three-toed woodpecker	*Picoides tridactylus*
Black-backed woodpecker	*Picoides arcticus*
Pileated woodpecker	*Dryocopus pileatus*
Red-breasted nuthatch	*Sitta canadensis*
Pygmy nuthatch	*Sitta pygmaea*
Brown creeper	*Certhia americana*
Golden-crowned kinglet	*Regulus satrapa*
Swainson's thrush	*Catharus ustulatus*
Hermit thrush	*Catharus guttatus*
Townsend's warbler	*Dendroica townsendi*
Mammals	
Pine marten	*Martes americana*
Fisher	*Martes pennanti*

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scattered snags is not sufficient to provide nesting and foraging habitat into the future (McClelland et al. 1979; Mannan et al. 1980, Raphael and White 1984; Bull and Cooper 1991). The degree to which dead wood from recent fires and insect infestations will make up for deficits is unclear; obviously it will contribute little if heavily salvaged.

The following summarizes conclusions reached by the Eastside Forests Scientific Societies Panel regarding terrestrial habitat.

1. Protection of existing old-growth is a necessary step toward ensuring long-term viability of eastside forest species, ecosystems, and landscapes. This conclusion received significant support from a recent modelling study which predicted that the more fragmented a habitat already is, the greater the number of extinctions caused by added habitat destruction (Tilman et al. 1994). The model also predicted that extinctions often occur generations after habitat loss, hence represent in the authors' words "...a debt—a future ecological cost of current habitat destruction" (Tilman et al. 1994).

2. Low-elevation ponderosa pine old-growth is the most endangered eastside forest type. Greatly reduced in area during the 20th century, ponderosa pine forests serve as habitat for 154 species of terrestrial vertebrates (Thomas et al. 1979b).

3. Old-growth lodgepole pine communities merit protection because they furnish important wildlife habitat. All forest types furnish important wildlife habitat; we mention lodgepole pine specifically because its habitat values are often overlooked. Ninety-three vertebrate species use lodgepole pine forests, including at least two on our list of those "of concern" (black-backed and three-toed woodpeckers; Table 1).

4. Large and well-distributed patches of old-growth and mature forests are critical for conservation of species that require these types. Among the fundamental tenents of conservation biology are (Ruggiero et al. 1994): "(1) connected habitats are better than disjointed habitats; (2) suitable habitats in close proximity to one another are better than widely distributed habitats; (3) late stages of forest development are often better than younger stages". The last must be interpreted with some caution in the dry forest types of the interior west, where forests with a high proportion of shade tolerant, late-successional tree species (especially grand fir) are more vulnerable to fire, insects, and pathogens than the midsuccessional old-growth pine forests that they have replaced. We return to this point below.

5. Small, isolated patches of old-growth may protect specialized plants, fungi, and arthropods, or other unique resources such as small bogs. Little is known about the requirements of arthrods and microbes in eatside forests, despite the fact that they function as critical links in ecosystem processes. In southwestern Oregon, Amaranthus et al. (1994) found that 2 mature forest fragments, each approximately 3.5. ha in size, supported 13 species of truffle-forming mycorrhizal fungi not found in nearby plantations; 8 of these species were associated with large dead wood.

6. Salvage cuts that remove a large proportion of standing, downed, or potential future coarse woody debris are likely to be detrimental to the numerous species that use these habitats.

7. High road densities harm many forms of wildlife. Roadless areas serve as critical refuges for wildlife sensitive to human disturbance.

8. Timber harvesting and overgrazing of riparian areas are likely to have adversely affected avian populations. Although research on this is lacking in eastside forests, the large number of birds that use riparian zones (155 species [Thomas et al. 1979a]), the critical importance of riparian zones in the west for feeding, nesting, overwintering, and migrating (Knopf et al. 1994), and the degraded condition of riparian zones in eastside forests all point toward a high probability that at least some bird species have been negatively impacted.

Forest Health

Forest health is discussed by a number of other papers in this book. Briefly, the Eastside Forests Scientific Societies Panel recognized that the dramatic change in the structure of many low and mid-elevation eastside forests has significantly increased vulnerability to crown fires, insects, and pathogens, and that steps to improve this situation are warranted. However, we are quite concerned about the potential for environmental damage arising from the implementation of hasty and ill advised practices. In our view, forest health goes beyond the health of trees to include the integrity of habitats, processes, and functional linkages. Furthermore, the health of trees cannot be separated from the health of ecosystems and landscapes. For example, numerous vertebrates and invertebrates that require dead wood or old-growth/mature forest feed on insects that feed on trees and, as such, help maintain tree health (Torgersen et al. 1990). Soil damage resulting from use of heavy ground equipment, excessive erosion, or excessive loss of organic matter will almost certainly exacerbate forest health problems in the future, and at least with regard to compaction will be virtually impossible to cure. Finally, not all forests are unhealthy, and not all tree death is undesireable.

The challenge in improving forest health is to solve one set of problems without creating new ones or exacerbating old ones. That cannot be done without a set of clear ecosystem and landscape objectives and a strategy to achieve those objectives, something that we do not see emerging from the current crisis mode. Perry (this volume) discusses this issue in more detail.

INTERIM RECOMMENDATIONS

1. Do not log late-successional old-growth (LS/OG) forests in eastern Oregon and Washington.

2. Cut no trees of any species older than 150 years or with a diameter at breast height of 20 inches or greater.

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3. Do not log, build new roads, or mine in aquatic diversity areas.
4. Do not construct new roads or log within existing (a) roadless regions larger than 1000 acres or (2) roadless regions smaller than 1000 acres that are biologically significant.
5. Establish protected corridors along streams, rivers, lakes, and wetlands. Restrict timber harvest, road construction, grazing, and cutting of fuelwood within these corridors.
6. Prohibit logging of dominant or codominant ponderosa pine from any forest, regardless of whether the stand meets criteria for old-growth.
7. Permit timber harvest in areas prone to landslides or erosion only if peer-reviewed scientific study conclusively demonstrates that harvest does not degrade the soils or release sediment to streams.
8. Permit livestock grazing in riparian areas only under strictly defined conditions that protect those riparian areas from degradation.
9. Do not log or mine on fragile sites until peer-reviewed scientific study conclusively demonstrates that soil integrity is protected and that forest regeneration after logging is assured.
10. Establish a panel with broad expertise to develop long-term management guidelines for increasing the ability of eastside forests to resist drought, crown fires, and catastrophic outbreaks of insects and pathogens.
11. Establish a second panel to develop a coordinated strategy for restoring the eastside landscape and its component ecosystems. Emphasize protecting the health and integrity of regional biological systems as well as the processes on which they depend.
12. Establish a comprehensive quantitative biological monitoring program. Data on a broad range of biological conditions within eastside forests are simply not available. This shortfall, added to inconsistency in what data are available and inadequate synthesis of those data, prevents comprehensive assessment of resource conditions and poses a challenge to resource managers. Good intentions alone will not make ecosystem management work, basic information on the state of the resource will be essential.

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