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Alternatives for Management of Late-Successional Forests of the Pacific Northwest

A Report to the Agriculture Committee and The Merchant Marine and Fisheries Committee of the U.S. House of Representatives

By
The Scientific Panel on Late-Successional Forest Ecosystems

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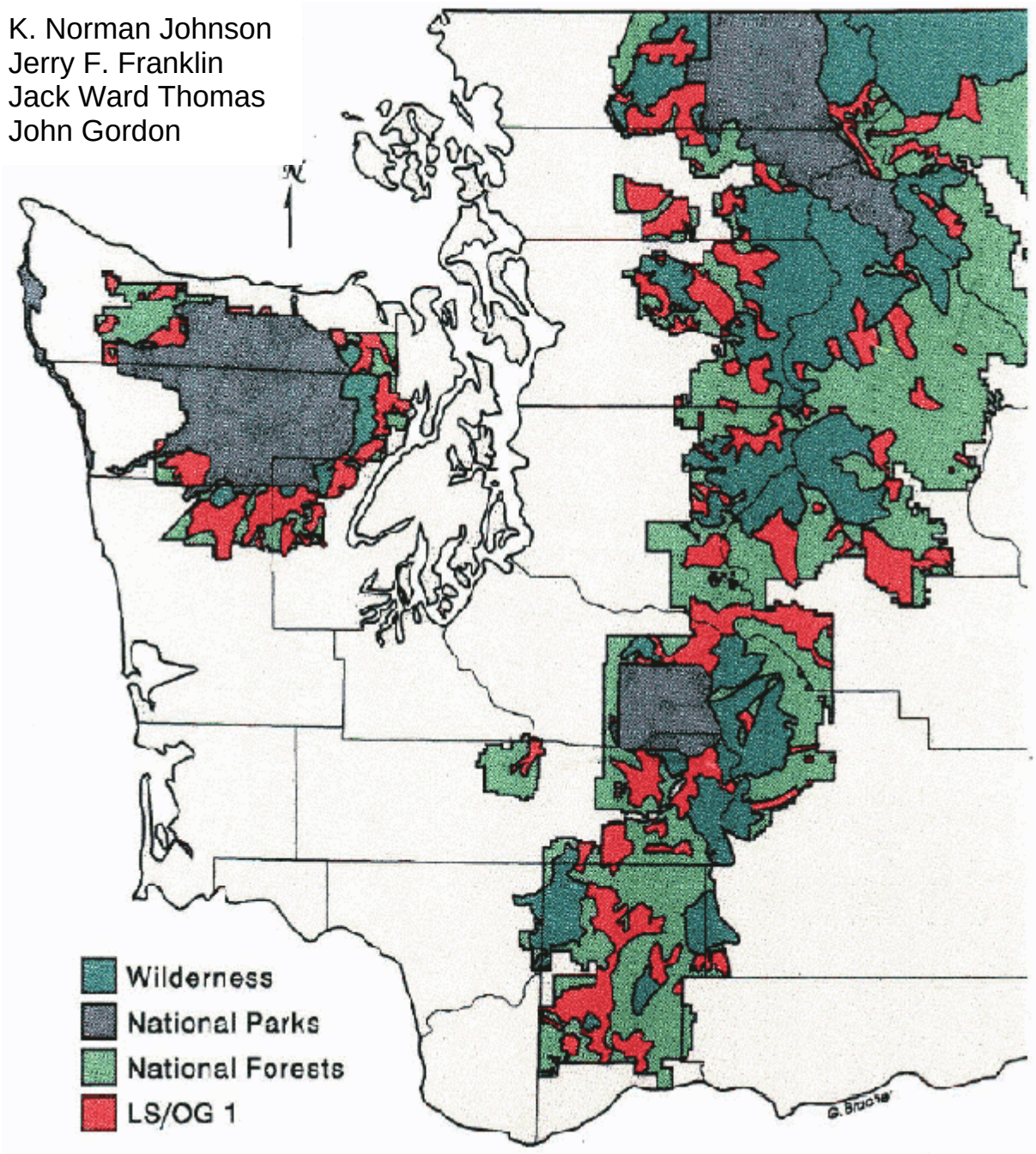

Alternatives for Management of Late-Successional Forests of the Pacific Northwest

A Report to the U.S. House of Representatives

Committee on Agriculture
Subcommittee on Forests, Family Farms, and Energy

Committee on Merchant Marine and Fisheries
Subcommittee on Fisheries and Wildlife,
Conservation, and the Environment

By

The Scientific Panel on
Late-Successional Forest Ecosystems

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DISCLAIMER

Although several hundred people from the USDA Forest Service, USDl Bureau of Land Management, US. Fish and Wildlife Service, state wildlife agencies (Washington, Oregon, and California), and other affiliations carried out tasks necessary to compile the report, this report is the sole responsibility of the authors and should not be interpreted as reflecting the thinking or position of any government agency or other group or institution.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASQ: allowable sale quantity

BLM: USDI Bureau of Land Management

DBH: diameter at breast height

ERSAL: Environmental Remote Sensing Applications Laboratory

FORPLAN: FORest PLANning model

FP: Forest Plan for each National Forest and BLM District

FS: USDA Forest Service

HCA: habitat conservation area (for northern spotted owls, from the ISC strategy)

ISC: Interagency Scientific Committee to Address Conservation of the Northern Spotted Owl

LS/OG: late-successional and/or old-growth forest areas

LS/OG1: most significant late-successional and/or old-growth forest area

LS/OG2: significant late-successional and/or oldgrowth forest area

LS/OGS: all other late-successional and/or old-growth forest areas

M: thousands (of acres, of board feet)

MMBF: millions of board feet

NF: National Forest

R-5: Region 5 of USDA Forest Service (National Forests in California)

R-6: Region 6 of USDA Forest Service (National Forests in Washington and Oregon)

SOHA: spotted owl habitat area (from Forest Plans)

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INTRODUCTION

The old-growth forests of the Pacific Northwest and the wildlife and fish associated with them increasingly have been the subject of controversy and litigation. Local, regional, and national interests and advocacy groups have urged on Congress a complex, often contradictory, set of solutions. In its deliberations on the matter, Congress sought advice from the scientific community, as well as others, through hearings. As an outcome of this deliberative process, two Committees from the House of Representatives requested that a small group of scientists assemble pertinent information and brief Members on the extent and character of late-successional and old-growth(LS/OG) forests, the management options available for LS/OG forests, and the effects of those options (Appendix A).

Thus, in late May 1991 the Agriculture Committee and the Merchant Marine and Fisheries Committee of the U.S. House of Representatives and the relevant subcommittees formed the Scientific Panel on Late-Successional Forest Ecosystems. In early June, we began to carry out our charge to:

(1) Identify, map, and classify the ecologically significant LS/OG forests on federal lands within the range of the northern spotted owl as the basis for establishing an LS/OG reserve system;
(2) Develop options for management of lands outside of reserves;
(3) Develop and evaluate different alternatives for protecting LS/OG ecosystems and associated species: and
(4) Quantify the effect of each LS/OG reserve system and associated management option for lands outside of reserves on sustainable harvest levels.

In pursuit of this assignment, we also:

(1) Considered potentially endangered fish species and stocks;
(2) Conducted a risk analysis of alternatives as they related to retaining over the long term a functional LS/OG network, to ensuring viable populations of northern spotted owls, and to providing habitat on federal land for marbled murrelet nesting, for other LS/OG-associated species, and for sensitive fish species and stocks: and
(3) Analyzed effects on timber-based employment and income associated with each alternative.

Our basic assumptions were:

(1) Proposals would be designed for an interim period (of up to 3 years). During the interim, a more carefully considered system of reserves and management options would be developed.
(2) The area to be studied would consist of all federal land within the range of the northern spotted owl.
(3) The universe of LS/OG forests, including classic old-growth and mature and mixed-age stands, would be considered because it is the species, processes, and conditions associated with LS/OG ecosystems that appear to be at risk.
(4) A broad range of alternatives would be evaluated--from some with a high timber yield to others that retain the maximum amount of LS/OG forest.
(5) Broad areas (aggregation of stands), rather than individual stands, would be identified, with the objective of mapping LS/OG areas that were logical management units.
(6) Complete precision in mapping LS/OG would not be essential for an interim solution because adjustments in boundaries would be part of the longer term solution suggested in (1).

This report, along with the map products already delivered to the Agriculture Committee, completes our charge and documents the briefings delivered in late July to Members and Staff of the U.S. Congress, the USDA Forest Service (FS), the USDI Bureau of Land Management (BLM), the press, and interest groups. The report's purpose is to present as concisely as possible a representative range of management alternatives for LS/OG forests, associated timber harvest levels, and risks to wildlife and fish on those federal lands within the range of the northern spotted owl. Within this scope and time, the report represents our best scientific judgment.

MAPPING OF LS/OG FOREST

Administrative Units

We considered lands administered by the FS and BLM in Washington, Oregon, and northern California within the range of the northern spotted **owl** (the "owl region"). National Forests and BLM Districts

(which, in general, are administratively equivalent to National Forests) included in our analysis are listed in Table 1. These administrative units are collectively referred to as the "owl forests." FS and BLM Plans that guide management of the owl forests are collectively called the "Forest Plans." We also considered the LS/OG and suitable spotted owl habitat in the National Parks managed by USDl National Park Service to the extent that they contributed to networks of LS/OG habitat or helped satisfy the standards and guidelines provided by the Interagency Scientific Committee's (ISC) Conservation Strategy for the Northern Spotted Owl.1 In addition, we analyzed limited acres outside the known range of the spotted owl on several National Forests east of the Cascade Range crest to establish easily identifiable boundaries (e.g., highways and rivers) for the study area.

Resources and Data Bases

The FS provided three types of information: (1) maps prepared by Pacific Meridian Resources under FS contract for identification of potential LS/OG for nine National Forests on the west side of the Cascades, (2) maps for these and other National Forests showing suitable owl habitat. locations of owl pairs, and mature and overmature forest stands, and (3) aerial photographs. The Audubon Society (Adopt-a-Forest Program) and The Wilderness Society provided their data bases and maps of old growth. BLM provided age-class maps for forests on its Districts, as well as other wildlife-related maps and relevant materials. The Environmental Remote Sensing Applications Laboratory (ERSAL) at the College of Forestry, Oregon State University, made available satellite imagery helpful in delineating LS/OG.

The FS and BLM provided us with teams of 2-4 resource specialists per Forest and District to assist in the mapping. Working under our direction, these teams mapped the LS/OG on each National Forest or BLM District, The process was aided by qualified personnel from FS Regions 5 and 6 (R-5 and R-6) and the Oregon State Office of BLM. Agency line officers and administrators were excluded unless they had unique, applicable resource knowledge.

The FS, BLM, and U.S. Fish and Wildlife Service cooperated fully in meeting our request for personnel and resources to assist in this mapping. In addition, the Washington, Oregon, and California state wildlife agencies assigned their leading spotted owl experts to help as needed. Ten of the 17 members (including four of the six-person "core" team) of the ISC also participated.

With the aid of these resource personnel and multiple data bases, the universe of LS/OG forest

was identified on the 18 National Forests and 7 BLM Districts in Washington, Oregon, and northern California identified in Table 1. This universe includes all natural forests that we judged to provide late-successional forest conditions. In addition to old-growth forests meeting various definitions, including the PNW-447 definition, 2 we considered mature forests (natural stands 80-200 years old) and stands of mixed structure and age (e.g., combination of old and young trees). Areas identified by one of the data bases (i.e., Pacific Meridian Resources, The Audubon and Wilderness Societies, ERSAL, BLM District maps) or from personal knowledge of the mapping teams were considered candidates for late-successional forest. The teams spent little time debating definitions or differences among data sources. Via this ecumenical approach, major areas of late-successional forest rapidly emerged.

LS/OG Classification

Classifying the ecological significance of LS/OG forest was a challenge. Hard, fast, and detailed rules were quickly revealed as inappropriate-hence, professional judgment was critical to the process that involved repeated interaction between us and resource personnel (Figure 1).

We developed a list of criteria (Table 2) for classifying LS/OG as (1) most ecologically significant (called LS/OG1), (2) ecologically significant (called LS/OG2), and (3) the remainder (called LS/OG3). Mapping focused on larger aggregations of LS/OG forest stands which make suitable management units for old-growth reserves rather than small individual patches. This means that some young forests and cutover areas are included in areas mapped as LS/OG. Conversely, thousands of acres of LS/OG fall outside of the LS/OG1 and LS/OG2 classifications and therefore were not proposed for interim protection under most alternatives, Overlays (1/2 inch to the mile scale) showing LS/OG1 and LS/OG2 areas were prepared for each National Forest or BLM District named in Table 1. The LS/OG1 and LS/OG2 areas for each state are shown, respectively, on the base map and overlay #2 of Appendix B.

Young stands within LS/OG1 and LS/OG2 reserves will eventually fill in the blocks as those stands mature if the longer term solution leaves them in a reserve.

Silvicultural treatments such as tree planting, thinning, and fertilization could accelerate this process once the efficacy of such approaches in producing stands with typical LS/OG structure and ecological function is demonstrated.

We reiterate that the mapping of LS/OG was done to support development of interim proposals for reserves which would maintain options for a longer term solution. It was not possible within the time available to assure complete mapping precision and to routinely check maps against conditions on the ground. However, we have a high level of confidence in the general areas identified, if not in exact boundary details.

Although the mapping teams from the National Forests and BLM Districts initially identified and ranked LS/OG areas, we sometimes made significant modifications in developing the final maps, reflecting our analysis of the overall LS/OG systems, connections and consistencies between administrative units, and relation of federal forests to forests on adjacent state and private lands. The age and structure of adjacent nonfederal forests are a significant factor in our analysis of areas along the western boundary of several of the western Cascade National Forests (Gifford Pinchot to Umpqua) and our inclusion of several large, relatively intact tracts of mature forest as LS/OG1 areas.

Gross Area of LS/OG1 and LS/OG2

A total of 5.7 million acres of federal land in the owl region fall into LS/OG1 and 2.3 million acres of federal land into LS/OG2 (Table 3). These totals include all federal acres outside of Wilderness and National Parks3 that fall within these areas: LS/OG forest, young forest, cutover forest lands, and "nonforest" (e.g., lakes and meadows). The LS/OG areas contain some land other than that administered by federal agencies (Table 3); this especially holds true outside the National Forests. Our analysis applies only to federal lands.

Proportion of LS/OG Forest Reserved

The exact acreage of LS/OG forest that now exists on federal lands within the range of the northern spotted owl is unknown. For the purposes of this report, though, we can approximate this acreage for nine National Forests in western Washington and western Oregon-Gifford Pinchot, Mt. Baker-Snoqualmie, Mt. Hood, Olympic, Rogue River, Siskiyou, Siuslaw, Umpqua, and Willamette--and five BLM Districts in western Oregon--Coos Bay, Eugene, Medford, Roseburg, and Salem.

For the nine National Forests, we have acreage information only for the agency's Pacific Meridian Resources data base on "potential old growth"; therefore, we will use this data base to approximate the extent of LS/OG forest. Indications are that this data base underestimates the amount of LS/OG forest on the National Forests in Washington and southwest Oregon but comes close to acreage in this condition in the central Cascades (Mt. Hood, Umpqua, Willamette). For the five BLM Districts, we have acreage information from the agency's own age-class inventory and will consider all age classes over 80 years to be LS/OG forest.

According to these data bases 'and definitions, LS/OG forest amounts to approximately 50 percent of the total forest on FS land and approximately 50 percent on BLM land (Table 4a, Appendix C). LS/OG forest reserved under the land allocations shown in Table 4 ranges from 52 to 100 percent on FS land and 35 to 100 percent on BLM land, with the lowest level associated with the Forest Plans and the highest level associated with reserving all LS/OG (LS/OGI + LS/OG2 + LS/OG3) (Table 4b, Appendix C).

In interpreting these statistics, it should be remembered that total acreage is only one part of the picture in evaluating the extent of LS/OG reserves. The ecological condition of the stands contributing to the total acreage must also be evaluated. Much of the LS/OG forest is extremely fragmented. Many of the Forest Plan reserves will perpetuate this fragmentation by specifying reserves in fairly small to very small blocks or in long stringers. Although these Forest Plan reserves may meet objectives relative to recreation, visual quality, and stream and soil stability, they do not necessarily provide for effective protection of old-growth-dependent species and processes.

Consideration of "edge effects" would yield far smaller acreages and percentages. The term "edge effect" refers to the drastically modified environmental conditions along the margins, or "edges," of forest patches surrounded partially or entirely by cutover lands; these conditions may extend 600 feet or more into the forest from the cutover boundary. Hence, only forested areas at substantial distances from the edge (generally, the central portions of a forest patch

of 100 acres or more) provide unmodified interior forest conditions. It is these interior conditions and old-growth ecosystems and their associated species and processes that are at risk. Alternatives that provide an LS/OG network reserving the large, intact LS/OG stands and allowing the interspersed younger stands to age and attain LS/OG conditions, such as would occur by reserving LSIOG1 or LS/OG1 + LS/OG2. would greatly increase the acreage of effective LS/OG.

PROVISION FOR THE NORTHERN SPOTTED OWL

LS/OG1 areas were reviewed by members of the ISC to see if the network of such areas met the standards and guidelines set forth in the ISC strategy. In this analysis, ISC members made the following assumptions:

(1) Areas designated LS/OG1 would be protected by the same standards as habitat conservation areas (HCAs) described in the ISC strategy: HCAs are reserved from timber harvest until alternative management methods for maintaining viable populations of owls are demonstrated. HCAs are blocks of forest ideally containing habitat suitable to maintain 20 or more pairs of spotted owls: smaller habitat blocks are acceptable when the ideal sue cannot be found. Generally, the 20-pair HCAs should be not more than 12 miles apart and the smaller HCAs not more than 7 miles apart.
(2) Areas between LS/OG1 reserves would, at a minimum, be managed to meet the standards of the "50-11-40" rule developed by the ISC. This rule requires that 50 percent of the forested area in each quarter township be in a condition wherein the average diameter of trees at breast height (DBH) is at least 11 inches and canopy closure is at least 40 percent.

Where the ISC criteria were not met by an LS/OG1 reserve, ISC members added areas, hereafter called 'spotted owl additions," to bring the LS/OG1 reserves into full compliance with the ISC strategy. Map overlays showing the location of these owl additions were prepared at the same scale as those made for the LS/OG analysis. The owl additions for each state are shown on overlay #1of Appendix B.

The ISC concluded that the LS/OG1 areas with modest owl additions, would fully meet the standards and guidelines of the ISC strategy. Out of this effort, a network of late-successional forest reserves consisting of LS/OG1 areas and owl additions was identified which contained approximately 25 percent more known spotted owl pairs than the HCAs managed as part of the ISC strategy.

PROVISION FOR WATERSHEDS AND FISH

Two watershed and fish options were considered (Table 5):

Current option: This option implements the standards and guidelines in the Forest Plans.

Watershed and fish habitat emphasis Option (hereafter also called the "watershed/fish emphasis" option): This option was specifically developed to maintain and restore (1) ecological functions and processes in streams and (2) habitat of potential threatened and endangered fish species and stocks of anadromous salmonids.

The elements described in the watershed/fish emphasis option in Table 5 are aimed at protecting watersheds and fish habitat from disturbance. Congressionally designated areas of Wilderness, National Parks, and Wild and Scenic Rivers form one set of protection. The LS/OG areas and owl additions provide more extensive landscape and watershed protection from harvest-related disturbances. Establishing wider riparian corridors on federal lands across the landscape will provide additional protection from disturbance and help initiate recovery of degraded areas.

Disturbance to watersheds and fish habitat will be further minimized under the watershed/fish emphasis option by two methods: (1) major reductions in road mileage and road drainage improvement programs across the forests, and (2) extended rotations in key watersheds on land suitable for timber production.

Tens of thousands of miles of roads cover the owl forests. Avalanches and debris torrents on the forests are exacerbated by road drainage problems associated with small culverts, too few culverts, and poor road design and maintenance. Although most current road building is undertaken with higher

standards than in the past, a legacy of roads built to lower standards exists. The watershed/fish emphasis option calls for these "problem" roads to be either improved (by, for instance, increasing the number and size of culverts) or removed (that is, the land returned to a natural condition) on federal lands across the landscape to prevent further watershed and fish-habitat degradation.

Roadless areas that remain on the National Forests often contain moderately unstable to unstable soils-which is one reason why they have not been roaded. The watershed/fish emphasis option calls for roadless areas to be left unroaded as timber harvest and other activities (e.g., hunting, fishing) occur.

Intensive timber management on the National Forests often assumes a number of commercial thinnings followed by final harvest at a relatively early age (e.g., 60-90 years). Under the watershed/fish emphasis option, a longer rotation age would be prescribed for key watersheds (see Appendix D). In addition, commercial thinning would be limited to one, or at most two, entries over that time. Fewer entries will help reduce erosion rates and the prevalence of altered streamflows associated with extensive clearcuts.

On numerous federal lands, many watersheds and riparian zones and much of the fish habitat have been degraded. Ecologically sound restoration programs utilizing riparian silvicultural techniques, erosion abatement, landscape design, and in-channel engineering and planning must be undertaken in degraded areas to recover fish habitat. Such programs will complement changes in land-management strategies mentioned previously. Any recovery program for sensitive fish species and stocks will require habitat restoration in both the short and longer term.

To define "key watersheds," National Forest and BLM District fish biologists identified watersheds that (1) contained habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish, or (2) were greater than 6 square miles and had high quality water and fish habitat. In addition, key riparian areas and wetlands in watersheds not meeting (1) or (2) were noted. These watersheds and related areas could form the nuclei of any broad-scale effort to recover potentially threatened fish species and stocks. Map overlays showing the location of these key watersheds and other riparian habitat corridors and wetlands were prepared at the same scale as those made for the LS/OG analysis. The key watersheds for each state, identified in Appendix D, are shown on overlay #3 of Appendix B.

Included in these key watersheds were 90 stocks (genetically distinct populations) of anadromous salmon and trout that were recently identified by the Endangered Species Committee of the American Fisheries Society (AFS) as in need of special concern because of low or declining population numbers. Changes in management of federal forests can directly affect the habitat and recovery of these stocks (see Table 5 and Appendix D). An additional 85 stocks listed by AFS were found in watersheds of National Forests and BLM Districts addressed by this report; however, fish habitat in such watersheds was primarily affected by activities off of federal lands, including water withdrawal, agricultural practices, and private forest management. Such activities are outside the purview of this study.

Also note that the contribution of the watershed/fish emphasis option to maintaining potentially threatened fish species and stocks is highly variable. For example, this option will contribute significantly to the recovery of sea-run cutthroat trout and bull trout but is only part of the strategy required for some spring chinook stocks. In addition, conditions between watersheds and administrative units vary considerably.

MAP PRODUCTS

Maps (1/2 inch to the mile scale) for each National Forest or BLM District named in Table 1 showing LS/OG1 and LS/OG2 areas, owl additions, and key watersheds, and state maps (1 :500,000 scale) showing these areas, have been delivered to the Agriculture Committee, U.S. House of Representatives. These maps have been reproduced at a smaller scale in Appendix B.

FOREST MANAGEMENT

Reserves

Any LS/OG areas that are reserved should be managed to maintain and/or enhance their ecological integrity. We believe that, in general, removing merchantable timber (including salvage) from reserved LS/OG areas is not appropriate to meet this objective

during the interim. Such prohibitions should be applied to timber sales under preparation but not yet awarded to buyers; allowing new timber sales to go forward during the interim could seriously jeopardize the integrity of the reserves, thus foreclosing future options.

Many other management activities may be appropriate during the interim, however, including fire suppression/prescription, precommercial silvicultural treatments of young stands, and restoration of aquatic habitats. Public use of these areas, such as for recreation, hunting, and fishing. may be allowed to continue as long as they do not impair attainment of the overall objectives. Scientific use of reserves is encouraged.

Lands Outside of Reserves

Managing the lands surrounding any system of reserves is critical to any strategy for maintaining LS/OG-associated species. Management practices can facilitate or inhibit movement of organisms between reserves (connectivity), provide habitat for some species, and foster much earlier reestablishment of structurally diverse forests on cutover areas.

Four options for managing the lands outside of reserves were considered:

Current option: The least restrictive of the four, this option implements the Forest Plan standards and guidelines.

Management Option A: This option augments the Forest Plan standards and guidelines with the 50-11-40 rule and increased structural retention on harvested acres. Structural retention should average at least 6 large "green" (live) trees/acre that exceed average stand diameter, 2 large snags (standing dead trees)/acre, and 2 large down logs/acre.

The 50-11-40 rule helps to distribute harvesting in time and space, by controlling timber harvest by quarter township (9 square miles), so as to lessen negative impacts on fish and wildlife and to provide habitat hospitable to dispersing spotted owls. Green trees are retained for their immediate wildlife value and as sources of snags and down logs. All three structures (trees, snags. and down logs) are important habitat for plant and animal species associated with LS/OG forest and enhance connectivity.

Management option B: This option is identical to option A in requiring the 50-1 1-40 rule and retention of green trees, snags, and logs. In addition, at least 10 percent of the forest outside of Wilderness, LS/OG1 reserves, owl additions. and HCAs should be over 180 years old and 10 percent 120-180 years old to provide potential replacement stands for LS/OG forests lost over time. The forest suitable for timber production should be managed using "area control" to achieve a rotation of 120 years. Thus, at most 1/12 of the area would be harvested every decade.

Management option C: This option is identical to option A in requiring the 50-11-40 rule and retention of green trees, snags, and logs. In addition, at least 10 percent of the forest outside of Wilderness, LS/OG1 reserves, owl additions, and HCAs should be over 180 years old, and the forest suitable for timber production should be managed using area control to achieve a rotation of 180 years. Thus, at most 1/18 of the area would be harvested every decade. This option may be considered a "managed LS/OG" scheme whereby managed stands are hypothesized to achieve some LS/OG characteristics. It is used for both key watersheds in the watershed/fish emphasis option and LS/OG2 in the 'managed LS/OG2" alternatives.

THE ALTERNATIVES

Development

An alternative starts with the land allocation from a variation on the Forest Plans that emphasizes wood production (Alternative 1) or from the land allocation in the Forest Plans (all other alternatives). Then any or all of the following are added: (1) additional reserves (HCAs from the ISC strategy and the modified ISC strategy or an LS/OG network), (2) a watershed and fish option (current, watershed/fish emphasis option), and (3) a management option for lands outside of reserves (current, A, B, C).

We developed 14 major alternatives ranging from high timber yield (a reserve system based on a variation of the Forest Plans that emphasizes wood production + the current option for watersheds and fish and for management of lands outside of reserves) to high LS/OG protection (the reserve system from the Forest Plans + reservation of all LS/OG1, LS/OG2, and LS/OG3, owl additions, the watershed/fish emphasis option, and a choice of management options A, B, or C for lands outside of reserves) (Table 6).

The standards and guidelines from the Forest Plans (current option for watersheds and fish and for management of lands outside of reserves) were

applied to Alternatives 1-3; various combinations of the watershed and fish options (current, watershed/fish emphasis) and management options (A, B, or C) were applied to Alternatives 4-14. In total, 34 scenarios were considered.

Risk Analysis

A qualitative analysis was conducted to determine for each alternative the probabilities of meeting the following objectives:

(1) Retaining a functional LS/OG forest network in which viable populations of LS/OG-associated species exist in LS/OG areas and individuals can move between these areas;

(2) Ensuring viable populations of northern spotted owls; and

(3) Providing adequate habitat on federal land for marbled murrelet nesting, for other LS/OG-associated species, and for sensitive fish species and stocks.

Habitat on public lands represents but one facet of life-history requirements for marbled murrelets, other LS/OG-associated species excepting the spotted owl, and sensitive fish species and stocks. Therefore, management policies on federal lands cannot by themselves ensure survival of these species and stocks. Thus, our risk analysis for these species relates to the probability of providing adequate habitat on federal lands rather than to survival of the species themselves.

We developed a seven-point scale of ranking ranging from Very low" to Very high" (Table 7). A very low probability indicated a low chance (considerably less than 50 percent) of attaining the above objectives, while moderate approximated a 50/50 chance. A high probability indicated a high likelihood or reliability (over 90 percent) of meeting the objectives. In each case these rankings refer to probabilities for a species or its habitat (as discussed above) in the long term given permanent adoption of the alternative or option.

We conducted the risk analysis with the assistance of scientists who are expert in the species being considered. With their help, we reviewed the available literature and evidence on the habitats of the species being rated and then applied this knowledge to create the risk ratings in Tables 7 and 8.

We did the analysis without sophisticated mathematical models, but the data base for most species does not support such analysis at this time. In addition, we did it in a short time. Still, we are confident that, in general, further analysis would at most shift the results by one level either way (such as from low to medium low or from low to very low).

Results of the risk analysis (Table 8, Figures 2a-e and 3a-b) suggest the following:

(1) Alternatives 1-3 (high timber yield, Forest Plans, Forest Plans + modified ISC) provide very low to low probabilities of a functional LS/OG forest network and viable populations (or habitat needs) of threatened or potentially threatened species. Although the new Forest Plans for the National Forests represent an improvement over past Plans, their standards and guidelines lack the specificity and control needed to ensure a medium to high probability of species/habitat survival.

(2) Alternative 4 (Forest Plans + ISC) provides a high probability of viable populations of spotted owls and a medium-low to low probability of a functional LS/OG network and the habitat needs of other threatened or potentially threatened species. The ISC had the objective of developing a "scientifically credible plan for conservation of the northern spotted owl." It should not be surprising, then, that the ISC strategy does not provide for a high probability of sustaining habitats for potentially threatened species other than the owl,
The northern spotted owl has been designated an indicator species for old-growth ecosystems by the FS. As such, it is assumed that if the northern spotted owl continues to exist in viable numbers, all species associated with old growth will do likewise. The indicator-species concept has come under criticism, and our analysis confirm that criticism: management to assure the long-term viability of the northern spotted owl will not necessarily provide adequately for all other LS/OG-associated species.5

(3) With Alternative 5 (Forest Plans + LS/OG1) and most alternatives thereafter, medium to medium-high probabilities emerge. With Alternative 8 (Forest Plans + LS/OG1 + owl additions +water-shed/fish emphasis) and some alternatives thereafter, medium-high to high probabilities generally are achieved.

(4) The level of management on lands outside of reserves also influences the risks. In effect, there are trade-offs between management of

lands outside of reserves and the efficacy of any reserve system in terms of risks to LS/OG species and ecosystems. Management with option C, which utilizes rotations approaching 200 years and provides for the greatest retention of late-successional forest conditions while still allowing timber harvest, usually results in higher probabilities for a given alternative than management under options A and B.

These risk ratings reflect an aggregate assessment of all federal forest lands that support northern spotted owls under each alternative. We expect that when more detailed analyses are made, there will be variation among National Forest and BLM Districts, and even among individual watersheds and drainages, with respect to the risk to species (or habitat) under the different alternatives.

Effects on Timber Harvest

Forest Suitable for Timber Production

The forest suitable for timber production can usefully be referenced to two measures of forested area: (1) total forest, and (2) forest "tentatively suitable" for timber production. Total forest includes all lands that now have at least 10 percent tree cover or have had at least that percentage of cover in the past. The forest "tentatively suitable" for timber production is the total forest minus forests (a) legally withdrawn from timber production (such as Wilderness) or (b) judged too unstable for timber harvest, too difficult to regenerate, or too unproductive, To determine the forest actually suitable for timber production, further withdrawals are made from the tentatively suitable base to protect fish and wildlife, watersheds, and other resources, to pursue multiple-use objectives reflecting scenic quality, dispersed recreation, and other values, or to avoid situations in which the benefits of timber production are less than their costs.

On FS lands in the owl region, forest suitable for timber production as a percentage of total forest varies from 47 percent (Forest Plans) to 27 percent (Forest Plans + LS/OG1 + LS/OG2 + owl additions). On BLM lands in the owl region, the percentages range from 72 to 37 percent, depending on the alternative considered (Table 9).

On FS lands in the owl region, forest suitable for timber production as a percentage of forest "tentatively suitable" varies from 72 percent (Forest Plans) to 42 percent (Forest Plans + LS/OG1 + LS/OG2 owl additions). On BLM lands in the owl region, the percentages range from 86 percent to 44 percent, depending on the alternative considered (Table 9).

Estimated Long-term Effects

We conducted a harvest scheduling analysis to estimate the annual sustainable timber harvest level (net volume) that might be expected under the alternatives and options (Table 10).

We estimated harvest levels in several ways. Some estimates were made through additional analyses using the FORest PLANning model (FORPLAN) and BLM simulation models Others were made by calculating the harvest level/acre for land suitable for timber production in the analysis of the ISC strategy (Alternative 4) and using that ratio to estimate harvest impacts as the land suitable for timber production changed because of various LS/OG withdrawals. The area-control analysis for management options B and C was generally straightforward and involved reducing the regeneration harvest rate for option A to that which would be compatible with the implied rotation policy.

Our harvest-scheduling analysis covers the owl forests listed in Table 1. Recent harvest from these forests averaged approximately 4.5 billion beard feet/year in the last 10 years of record (1980-89) and 5.3 billion board feet/year in the last 5 years of record (1985-89) (Table 10). These estimates come from Greber (1991) > after a 10 percent reduction for Region 6 National Forests to convert these volumes from "gross" to “net" measure. The sale program for the Forests in 1990 totaled approximately 4.1 billion board feet (Table 10).

Alternative 1 (high timber yield)

We wished here to represent an alternative for forest management which emphasized timber production, In Region 6, we picked an alternative from the Forest Plan Final Environmental Impact Statements that gave a high timber harvest while meeting the agency’s legal obligations as the Forest Service saw them. In Region 5 and BLM, where new Forest Plans do not exist, we used a recent simulation which came closest (in our eyes) to meeting these objectives (high timber harvest, agency legal obligations). In all cases, spotted owl protection was based on a SOHA approach, and harvest levels were projected to be sustainable.

Alternative 2 (Forest Plans)

The "Hamilton Report"[8] of May 1, 1990, by the federal agencies that evaluated the economic implications of the ISC strategy estimated that "actual or projected forest plans" for the owl forests in the three states could produce 4.4 billion board feet/year. Our estimate for the Forest Plan suggests that these areas could yield 3.4 billion board feet/year (Table 10). In both cases, these results were based on the spotted owl habitat area (SOHA) approach for protecting the northern spotted owl pre-dating the ISC strategy.

Reasons for the difference between our estimates and those of the Hamilton Report include the following:

(1) FS Region 6---The Hamilton Report harvest levels came in part from draft Forest Plans whereas our data were derived from final Forest Plans, which generally showed lower harvest levels than the draft Plans. We further reduced the harvest levels in the final Forest Plans for the owl forests in Region 6 by 15 percent to account for the differences between the upper-limit estimates of those Plans and the levels that appear likely to be sustained under Plan standards and guidelines for management of all resources (for more details, see Appendix E).

(2) BLM--The Hamilton Report estimates were based on anticipated timber harvest levels from the 1980 plans. BLM is currently working on, but has not finished, new Forest Plans. In our analysis, we attempted to simulate the results of combining the land allocation of the 1980 Plans with the knowledge about timber yields and other relationships going into BLM's new Forest Plans. We included the effects on harvest level of the SOHA approach which was put in place after the Plans were adopted and which was not recognized in the BLM estimate of the Hamilton Report. We also increased minimum final harvest age from 40 years to 60 years. BLM officials asked that we use a 60-year minimum final harvest age in the harvest scheduling analysis of LS/OG reserves; for consistency, we used a 60-year minimum throughout.

(3) FS Region 5--The Hamilton Report used harvest levels from the draft Forest Plans for the four Region 5 National Forests we analyzed. Although final Forest Plans have not yet been issued, recent forest-planning analysis in Region 5 suggests that the Plans will result in much lower harvest levels than estimated in the Hamilton Report. We use this latest analysis in this study,

Alternative 3 (Forest Plans + modified ISC strategy)

The ISC strategy (Alternative 4) overlaid network of reserves (HCAs) onto the land allocations of the Forest Plans and also prescribed the 50-11-40 rule for the intervening lands. The modified ISC strategy calls for smaller HCAs with wider spacing between them than suggested in the original ISC strategy and drops the 50-11-40 rule. We did not map the system of reserves associated with the modified strategy as a basis for harvest-level calculations. Instead, we estimated (roughly) that the decline in harvest levels associated with the modified ISC strategy would be about one-quarter of what it would be with the full strategy, partly because a significantly smaller area of reserves would cover land that would otherwise be suitable for timber production and partly because the 50-11-40 rule would not be applied.

Alternative 4 (Forest Plans + ISC strategy)

We estimated that implementing the ISC strategy (including green-tree retention) would reduce the harvest from 3.4 to 2.0 billion board feet on the owl forests--a 1.4 billion board foot drop (Table 10). Approximately 65 percent of this decrease comes from establishment of HCAs, from which timber harvesting is excluded, and the rest from application of the 50-11-40 rule.

Although we did not do an extensive risk analysis for an alternative which implemented the HCAs from the ISC strategy without the 50-11-40 rule, we would expect the long-term probability of owl survival to drop from high (HCAs with the 50-11-40 rule-Alternative 4) to medium (HCAs without the 50-11-40 rule).

The FS and BLM have found the 50~11-40 rule to have considerable impact on harvest in many cases. This result especially holds true where clearcutting in the last 30 years has covered significant acreages in particular quarter townships (BLM) and where natural conditions and partial cutting have led to low stocking on large areas (eastern Washington and Oregon, northern California). Our results reflect these findings.

Applying the 50-11-40 rule generally lowers the harvest rate on the available forest-land base. This has the desirable side effect of reducing somewhat any incompatibility of the standards and guidelines in Region 6 with the harvest levels estimated under the ISC strategy. In addition, many National Forest planning teams in the Region have recently done a "post-FORPLAN" analysis of the harvest potential for their Forests in conjunction with their analysis of the ISC strategy and generally reduced the harvest levels that could be attained as a result.

Thus, Region 6's estimated harvest levels for implementing the ISC strategy appear more attainable than those developed for the Forest Plans. Therefore, we adjusted the Region's harvest estimates for implementing the ISC strategy downward only slightly (10 percent) and only in cases where post-FORPLAN analysis had not been done. These adjustments are included in the 2.0 billion board foot estimate previously mentioned.

Estimates for the Forest Plans + ISC for the BLM and Region 5 were adjusted only for additional green-tree retention, and these adjustments are also included in the 2.0 billion board foot estimate.

Alternatives 5-14 (Forest Plans + LS/OG owl additions + watershed/fish emphasis)

Alternatives 5-12 generally reduced potential annual harvest levels below those of the Forest Plans + ISC (Alternative 4) by anywhere from 75 million board feet (LS/OG1 + management option A) to 1.2 billion board feet (LS/OG1 + LS/OG2 + owl additions + management option C) (Table 10).

Including the watershed/fish emphasis option generally reduced harvest by another 200-350 million board feet. Most of that reduction was due to the increased riparian protection associated with this option (Table 8). Because many watersheds selected for long rotations under the watershed/fish emphasis option contain significant areas in Wilderness or LS/OG1 reserves, the cost of implementing longer rotations on these watersheds was not as great as might have been anticipated.

We did not make detailed estimates for Alternatives 13 and 14, which call for reserving all LS/OG1, LS/OG2, and LS/OG3. Reserving all LS/OG would make most merchantable timber stands off limits to timber harvest; what harvest would occur would be from young natural stands (40-80 years old) through commercial thinning and regeneration harvest. We would expect the harvest level in these two alternatives in the next few decades to be much lower than that possible in the long term because of the shortage of merchantable timber volume. It is difficult to estimate exactly what this would mean to the overall timber harvest level without more extensive analysis than possible here, but we would expect harvest for the next decade to be not greater than about one-half of the harvest shown in Table 10 for Alternatives 11 and 12 for the respective options.

Estimated Short-term Effects

All of the estimates discussed above relate to long-term sustainable harvest levels. We also estimated how reserving LS/OG1 + owl additions (as in Alternative 6) or LS/OG1 + owl additions + LS/OG2 (as in Alternative 11) might affect timber sales under contract and timber sales planned for the interim, For this analysis, we concentrated on the seven National Forests in Region 6--Gifford Pinchot, Mt. Hood, Rogue River, Siskiyou, Siuslaw, Umpqua, and Willamette---scheduled to provide the bulk of timber harvest from the owl forests in Region 6 under most alternatives.

We found that 31 percent of the sale volume was under contract within areas covered by LS/OG1 + owl additions and an additional 13 percent within LS/OG2 areas. Most of these sales pre-dated the ISC strategy. We do not call for the cancellation of existing timber-sale contracts.

Timber sales planned for 1991 and 1992 on these Forests were designed to be "not inconsistent with the ISC strategy"-that is, sales were prohibited from the HCAs recommended by that strategy, and sale layout abided by the 50-11-40 rule. LS/OG1, owl additions, and LS/OG2 sometimes overlap HCAs and sometimes cover land outside of HCAs.

Inspection of the actual placement of LS/OG1, owl additions, and LS/OG2 on these seven Forests revealed that approximately 30 percent of the planned sale volume for 1991 and 1992 fell within LS/OG1 + owl additions and an additional 20 percent within LS/OG2. We estimate impacts on harvest levels (such as reported in Table 10) of moving from the Forest Plans + ISC to the Forest Plans + LS/OG to be close to 20 percent for LS/OG1 + owl additions and 40 percent for LS/OG1 + owl additions + LS/OG2.

Thus, the short-term effects on harvest levels could be greater than the long-term effects, assuming that further timber sales were prohibited from LS/OG reserves, unless the agency is able to relocate timber

sales outside reserve areas during the interim period. We believe that awarding sales now being planned for LS/OG1 or LS/OG2 areas could seriously interfere with the functioning of these areas as LS/OG reserves. Therefore, we urge that further timber sales be prohibited (at least in the interim) from any LS/OG reserve system.

Although such action could be disruptive to the timber sale program, recent efforts by the Forest Service indicate that the agency can react to changing conditions in a rapid, timely manner. Environmental analysis documents were prepared quickly and efficiently for salvage of timber following the Mt. St. Helens eruption, the Silver fire in southwestern Oregon, and the Shady Beach fire on the Willamette National Forest. Additionally, timber sale contracts were prepared and awarded expeditiously. Recent actions by the agency regarding insect-induced mortality of forest stands in eastern Oregon also demonstrate the ability of the Forest Service to adapt to changing conditions.

We believe that the Forest Service, with its rich history of accomplishments and a staffing level for a substantial timber-sales program, can relocate sales in a timely manner and avoid much of the short-term impact beyond the long-term reduction in harvest. However, at least three things will be needed for this to occur. First, the agency needs clear instructions on where and under what rules timber can be harvested. Second, adequate resources must be made available to lay out timber sales in an environmentally sound manner. Third, it will be necessary in some places to relax the "adjacency requirement" for dispersion of cuttings in the placement of timber sales where this can be done without significant environmental impact. The Forest Service appears (to us) reluctant to shift from its traditional approach of dispersed clearcuts with new road construction to aggregated (low fragmentation) cuts with few new roads. It also may be helpful to gain scientific advice on harvest priorities that will minimize reduction of options, during the interim, relative to LS/OG species and processes.

Effects on Employment and Income

The region containing the owl forests covers portions of three states (recall Table 1) and stretches from the Canadian border south to the upper Sacramento Valley. Federal lands in this region have contributed approximately 34 percent of the total annual regional harvest of 14.5 billion board feet over the last decade (1980-89) and approximately 36 percent the total annual regional harvest of 16.2 billion board feet over the last 5 years (1985-89). The remaining harvest came predominantly from private lands.[9]

Timber-industry employment in the owl region averaged approximately 135,000 jobs during 1985-89, or 5 percent of the total employment in the region, and 111,000 jobs, or 9.5 percent of the total employment in the "non-metropolitan" portion of the region. According to Greber (1991), 9 studies in Oregon have shown that about 2 other jobs in the economy can be linked to each timber-industry job. On this basis, total timber-dependent employment would approach 405,000 jobs, or 15 percent of total regional employment, and 333,000 jobs, or 29 percent of the non-metropolitan employment. These numbers include timber-industry jobs, other manufacturing jobs, and non-manufacturing jobs.

Greber estimates that changes in timber supply would yield a smaller factor (approximately 1 1/4 other jobs in the economy for every timber-industry job). The marginal effect of changes in timber-industry employment is less than the average effect for at least two reasons: (1) a certain proportion of the *other" jobs is somewhat "fixed" (e.g., administrative and supervisory positions and government workers including teachers) and does not respond to changes in the number of timber-industry jobs unless they are very large indeed, and (2) some workers in the "other" jobs will find employment elsewhere, albeit often at a lower wage: the net loss in jobs to the economy will not be as great as might first appear. Our estimates of total employment effects come close to the "net" estimate of 1 1/4 "other" jobs lost or gained in the rest of the economy for each timber-industry job lost or gained.

We estimated effects on employment and income of federal harvest levels associated with the alternatives for two different historic harvest rates (1980-89 and 1985-89) (Table 11a) and the Forest Plans + ISC (Table 1 l b) as a basis for comparison. Estimating employment and income effects with the historic harvest rates helps us understand how the future may compare to the past. Estimating employment and income effects with the Forest Plans + ISC helps us understand how alternatives relate to what the Forest Service and other observers consider the "status quo."

A range of employment and income factors--10.7 (low) to 13.6 (high) jobs per million board feet timber and 340 (low) to 640 (high) thousand dollars personal income per million board feet of timber--

was used to estimate economic impact. These estimates, from Dr. Brian Greber, College of Forestry, Oregon State University (Appendix F), represent the net effect of changing timber harvest levels on total employment (timber-industry jobs, and other manufacturing and non-manufacturing jobs dependent on the timber harvest) and total income after considering the effect technological change may have on employment and income and potential reemployment of displaced workers in other jobs in the economy. The "low" estimates reflect likely impacts of relatively slight changes in harvest in the context of a healthy and growing economy; the "high" estimates reflect likely impacts of relatively large changes in harvest in the context of a somewhat stagnant economy. Because these estimates exclude forestry services (such as tree planting) and proprietorships (self-owned businesses), they are somewhat conservative--total employment and income impacts might be up to 10 percent higher than estimated here (see Appendix F).

When the historic harvest levels were the basis for comparison (Table 11a), only Alternative 1 (high timber yield) approximately maintains historic harvest and timber-based employment levels. All other alternatives would allow lower levels: 11,000-61,000 jobs (in total) would be lost in Alternatives 2-12 depending on alternative, harvest base, and whether the low or high estimate of job impacts is chosen. Even more jobs would be lost under Alternatives 13 and 14.

When the Forest Plans + ISC was the basis for comparison (Table 1 lb), a number of alternatives (1-3) would allow higher levels of employment, whereas other alternatives (4B-12C) would allow lower levels: 4000-16,000 jobs would be lost. Again, more jobs would be lost under Alternatives 13 and 14.

Actually, any alternative can be selected as a basis for comparison. Then the net change associated with moving between alternatives can be determined by comparing the jobs gained or lost for the selected alternative with another alternative of interest.

We emphasize that the potential economic effect of a reduced FS and BLM work force due to lower timber harvest has not been considered in this analysis. Any other reductions could be very significant, under some alternatives, for rural communities with relatively large FS and BLM administrative units unless Congress provides support for other resource management activities (see later, "Opportunities for Resource Management').

Evaluating the Benefits and Costs of Different Alternatives

Benefits and costs of the various alternatives can be determined by comparing data within and among the tables and figures in this report. The comparisons quickly reveal that there is no "free lunch." In general, increases in the probability of retaining a functional LS/OG forest network, viable populations of northern spotted owls, or habitats of other LS/OG associated species and potentially threatened fish species and stocks decrease sustainable harvest levels, which in turn result in decreased regional employment and income levels. The degree to which such opportunity costs may be offset by other factors (such as tourism or recreation) was not analyzed because of time constraints and because such factors are not apt to operate at significantly higher than current levels during an interim period.

The degree to which options for addressing the stated objectives are foreclosed during the interim can be crudely evaluated via Table 12. Generally, as harvest levels increase, the loss of unreserved LS/OG increases, as measured by the amount of LS/OG timber cut per year during the interim. In evaluating the situation, it is important to consider not only the acres to be cut but also where such cutting will take place. The functioning of an LS/OG network and a successful conservation strategy for the northern spotted owl and other LS/OG-associated species are highly dependent on habitat block size, proximity of such blocks to one another, and degree of connectivity between
blocks.

RELATED ISSUES

Designing a Longer Term Solution

We feel that an independent, interdisciplinary task force should be formed to develop the longer term solution for the LS/OG forest strategy, including establishment of final boundaries and management guidelines for reserves and the intervening lands, and to adjudicate issues during the interim. This task force should be drawn from scientists and professionals from universities and public (state and federal) agencies.

Broader scientific review of the task force's activities and findings could be provided by a consortium of professional and scientific societies or the National Academy of Sciences. We do not believe that the Academy provides the right forum to develop a longer term solution, but that the Academy could provide valuable review and oversight.

Status of the Northern Spotted Owl

We believe that if any one of the alternatives that preserves the most significant old growth (LS/OG1) plus owl additions (Alternatives 6 or 8-14) implemented as a longer term solution, it may be reasonable to "de-list" the northern spotted owl as a threatened species over significant portions of its range. The same practical effect might be achieved by U.S. Fish and Wildlife Service promulgating a "special rule" whereby activities on lands so managed are considered in compliance with regulations governing protection of the northern spotted owl. This conclusion is particularly germane to federal lands.

Opportunities for Resource Management

Through our analysis, we became aware of many critical resource-management activities needed on federal lands that require retention and further development of a strong, multidisciplinary work force in the FS and BLM and the employment of woods workers.

Exemplary needs in resource management include:

(1) Dramatically expanded programs for monitoring a broad range of natural resources to assure that Forest Plan objectives are achieved and that innovative management techniques, such as the 50-11-40 rule and green-tree retention, are working. Effective monitoring programs are almost nonexistent at this time.

(2) Development and institution of proactive fish and wildlife, recreation, and watershed enhancement programs--that is, more attention to nontimber aspects of the multiple-use mandate.

(3) Watershed restoration programs such as have been identified on the Olympic and Mt. Baker-Snoqualmie National Forests, including creation of stream structures, road removal, road reconstruction and maintenance, and revegetation of upland and riparian areas.

(4) Development and implementation of large-scale prescribed burning programs in southwestern Oregon and eastem Oregon and Washington.

(5) Management activities in young stands to enhance productivity for both timber and wildlife.

(6) Expanded support for layout and administration of the more complex timber sales inevitable in the future.

(7) Improved resource inventory along with sophisticated mapping systems, especially the acquisition of Geographic Information Systems (GIS) technology by the FS.

Implementing such resource-management programs would serve the multiple objectives of improving the condition of forest resources, employing rural work forces, and maintaining federal payrolls in small communities.

Need for Research

Major expansion in research activity is fundamental to any LS/OG strategy. Apart from the significantly increased contribution to human knowledge that would result, increased understanding of LS/OG organisms and ecosystems is essential both to managing any reserve system and to developing management alternatives that can reduce the need for permanent reservation. Otherwise, we may be attempting to create conditions which we cannot fully describe, let alone understand.

We encourage research within any LS/OG reserve system, including experiments that involve forest manipulations, such as tree cutting. However, this research should represent bona fide scientific investigation based on appropriate statistical designs and led by qualified scientists. Uncontrolled and/or large-scale management demonstrations should not be permitted.

Several Experimental Forests lie wholly or partly within areas mapped as significant LS/OG forest (H. J. Andrews, Wind River, Pringle Falls, and Cascade Head). These administratively established areas have produced many important scientific findings in ecology, wildlife, forestry, and other relevant sciences. The large, long-term data bases and scientific

cadres associated with these sites make them extraordinarily valuable for future research. Hence we strongly recommend that Experimental Forests be excluded from restrictions associated with the LS/OG reserve system.

We also recommend that the Forest Service and BLM seriously consider establishing additional Experimental Forests. Such centers for ecosystem and resource research should be created in geographic locations and forest types other than those in which they now exist-for example, on the western Olympic Peninsula, in southwestern Oregon, and on the eastern slopes of the Cascade Range.

LS/OG Analysis on the East Side of the Cascade Range

An analysis similar in scope to that undertaken for this report may be desirable for federal forests east of the Cascade crest in Washington, Oregon, and California (approximately as far south as the junction of the Cascades and the Sierra Nevada). Federal lands involved would include all or part of 12 National Forests not included in this report: Colville, Okanogan, Umatilla, Wallowa-Whitman, Malheur, Ochoco, Deschutes, Fremont, Winema, Modoc, Lassen, and Klamath. Some BLM land would also will be included.

In deciding whether to do this analysis, a number of points should be considered:

(1) Although only sketchy information is available, it appears that relatively little of the LS/OG forests extant in 1900 on federal land on the "east side" now remains. LS/OG ponderosa pine stands are especially rare. Because many LS/OG stands are scheduled for harvest over the next decade, delaying analysis will reduce the options for an LS/OG network.

(2) A history of fire suppression and partial cutting of fire-, disease-, and insect-resistant tree species has left the LS/OG forests of the east side in highly altered and somewhat unstable condition (see Appendix G). These activities have profoundly affected the east-side LS/OG forests, changing many stands from relatively open single- or two-storied stands of fire-tolerant, disease-resistant species to relatively dense multilayered stands of mainly shade-tolerant, disease-susceptible species. Repeated disease and insect attacks have so affected the forests that, in some people's eyes, the forest ecosystem is "unraveling." This instability will make it difficult to select a functional system of reserves and also increases the urgency to clarify which LS/OG stands should be salvaged and which left as ecological reserves.

(3) More human-caused factors affect LS/OG species and habitats on east-side forests than on west-side forests, where timber harvest and road building seem to dominate. Grazing and mining, in addition to timber harvest and road building, would need to be considered in any comprehensive LS/OG analysis of east-side forests.

(4) Much less forestry-related research has been done on east- than west-side forests because research funding over many decades has been directed primarily at west-side problems—with concomitant lack of information on east-side ecosystems and processes. Therefore, identifying significant LS/OG and developing an LS/OG network for the east-side federal forests will be more difficult than the task completed herein for the west side because the necessary preliminary attention to LS/OG identification is more incomplete. Thus, we would expect that any east-side analysis would produce a less sophisticated product than the one reported here.

(5) The lack of data and research results, coupled with the ecological complexities and human influences described earlier, suggests that an LS/OG analysis on the east side would be a formidable task. In our opinion, at least 2-3 months would be needed to develop alternatives for managing LS/OG forests on the east side and 3-5 months to complete a report—assuming full cooperation of the agencies involved and availability of adequate money and other resources. Such an effort would also require the temporary shift of significant numbers of agency personnel, many of whom are already fully occupied with the severe problems associated with widespread tree mortality and the resultant planning for extensive salvage sales.

CONCLUDING OBSERVATIONS

We believe:

(1) A wide range of alternatives exists for managing late-successional forests in the Pacific Northwest. We have provided what we believe to be a full range of practical choices.

(2) Current Forest Plans do not provide a high level of assurance (low risk) for maintaining habitat for old-growth-dependent species.

(3) Projected harvest levels in the Forest Plans often overstate what can be achieved. Thus, our calculations started from a somewhat lower base than previous efforts.

(4) De-listing of the northern spotted owl over a significant portion of its range may be a realistic consideration under several of the alternatives presented.

(5) There is no "free lunch"-that is, no alternative provides abundant timber harvest and high levels of habitat protection for species associated with late-successional forests.

(6) We have described the beginnings of a practical "ecosystem approach" to conserving biological diversity. Nature does things in twos and threes rather than singly. So should we in seeking to preserve or mimic nature.

(7) We have provided a sound basis for decisions, given the time and information limits within which we operated. Science (at least as exemplified by the four of us and those who assisted us) has done what if can. The process of democracy must go forward from here.

FOOTNOTES

[1]Thomas, J, W., E. D. Forsman, J. B. Lint, E. C. Meslow, B. R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. USDA Forest Service, USDI Bureau of Land Management. U.S. Fish and Wildlife Service, and USDI National Park Service. Portland, OR. 427 pp.

[2]Old-Growth Definition Task Force. 1986. Interim definitions for oldgrowth Douglas-fir mixed conifer forests in the Pacific Northwest and California. USDA Forest Service Research Note PNW-447, Pacific Northwest Forest and Range Experiment Portland, Oregon.

[3] LS/OG1 and LS/OG2 exclude Wilderness and Parks by definition, but owl additions (see "Provision for the Northern Spotted Owl") could include them to bring the LS/OG1 areas into compliance with the standards and guidelines of the ISC strategy. We have excluded owl additions in Wilderness and National Parks in these statistics and have not shown them on the maps (Appendix B).

[4] Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

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[5]Landres, P. B., J. Verner, and J. W. Thomas. 1988. Ecological uses of indicator species: a critique. Conservation Biology 2(4): 316-328.

[6]For more information on FORPLAN, see Iverson, D. and R. Alston. 1966. The genesis of FORPLAN: a historical and analytical review of Forest Service planning models. USDA Forest Service General Technical Report INT-214. Intermountain Forest and Range Experiment Station, Ogden, Utah. 31 p. For more discussion of the simulation model used by BLM (TRIM+), contact P. Tedder, Resource Economics international, Corvallis, Oregon.

[7]Greber, B. J. 1991. An overview of forest resource industries and the economy of the owl impact region of the Pacific Northwest. Report prepared for the U.S. Fish and Wildlife Service as part of the economic analysis of Critical Habitat Designation for the Northem Spotted Owl. (Available from the author at Department of Forest Resources, Peavy Hall, Oregon State University, Corvallis, OR 97331 .)

[8]Hamilton, T. and others. 1990. Economic effects of implementing the ISC st3"ategy. USDA Forest Service, Washington, DC.

[9]For more information, see Appendix F and Greber (1991) (op. cit.).

GLOSSARY

(Refer to the report's "List of Abbreviations" as necessary.)

50-11-40 rule: one of the standards and guidelines of the ISC strategy designed to provide dispersal habitat for northern spotted owls on lands outside of reserves; calls for maintaining 50 percent of forested land within each quarter township (9 square miles) in forested condition with stands of trees averaging at least 11 inches DBH and with a stand canopy closure of at least 40 percent.

adjacency requirement: the requirement that openings created through harvest cannot be placed next to each other. An opening created by harvest must "close" through a new timber stand growing to a certain height before another harvest unit can be placed next to it. This requirement has led to the "staggered setting" approach to timber harvest in which clearcut units, usually of 20-60 acres, are scattered over the landscape. See staggered sorting.

administrative unit: the organizational unit recognized in this study for analysis: for the Forest Service, the National Forest; for the BLM, the District.

age classes: a grouping of stands based on the age of their overstory trees.

allowable sale quantity: the planned volume of timber sales on a National Forest. Generally, these volumes reflect the upper limit on timber harvest defined in a long-term Forest Plan. The actual amount of timber to be harvested depends on more detailed "project planning" that applies the standards and guidelines for management of the forest to particular areas.

alternative: in this study, a strategy for the management and/or reservation of LS/OG forests.

anadromous: pertaining to fish species that ascend rivers from the sea to reproduce.

aquatic ecosystem: any body of water, such as a stream, lake, or estuary, and all organisms and non-living components, functioning as a natural system.

biological diversity: the variety of life and its processes, including complexity of species, communities, gene pools, and ecological functions.

block (of forest, habitat): geographical area of trees or vegetation that is distinct from surrounding conditions. Block size may vary greatly.

"blowdown": trees blown down by strong winds.

canopy closure: the degree to which tree crowns in a forest close together.

catastrophic event: a large-scale, high-intensity natural disturbance that occurs infrequently.

cavity nester: wildlife species, most frequently birds, that require cavities (holes) in trees for nesting and reproduction.

classic old growth: forest stands with unusually old and very large trees that also meet criteria for old-growth forests (see old-growth forest); stands that meet the definition in Forest Service publication PNW-447 (see main-text footnote for citation).

clearcut: a harvest in which all or almost all of the trees are removed.

commercial forest land: land declared suitable for producing timber crops and not withdrawn from timber production for other reasons.

commercial thinning: the removal of generally merchantable trees from an even-aged stand, usually to encourage growth of the remaining trees (see even-aged silviculture).

community: pertaining to plant or animal species living in close association and interacting as a unit.

connectivity: a measure of the extent to which conditions among LS/OG forest areas provide habitat for breeding, feeding, dispersal, and movement of LS/OG-associated wildlife and fish species.

corridor: a defined tract of land, usually linear or nearly so, through which organisms may travel to reach suitable habitat for reproduction and other life-sustaining needs.

cumulative effects: the combined effects of all management activities on a defined area of land, a body of water, or both; assessment may occur at several scales (watershed, sub-basin, or basin); cumulative effects are further defined in 40 Code of Federal Regulations 1508.7.

debris torrent: rapid movement of a large quantity of materials (wood and sediment) down a stream channel during storms or floods; generally occurs in smaller streams and results in scouring of stream bed.

desired future condition: for this report, an explicit description of the physical and biological characteristics of aquatic and riparian

environments believed necessary to meet fish, aquatic ecosystem, and riparian ecosystem objectives.

dispersal: the movement, usually one way and on any time scale, of plants or animals from their point of origin to another location where they subsequently reproduce.

disturbance: a natural (such as wind or fire) or human-caused (such as harvest) force that suddenly and significantly changes the landscape.

down log: portion of a tree that has fallen or been cut and left in the woods. Particularly important as habitat for some LS/OG-associated species.

drainage: a large area mostly bounded by ridges, encompassing part, most, or all of a watershed and enclosing on the order of 5000 acres (see subdrainage and forest watershed).

"east side": east of the Cascade Range.

ecological health: the state of an ecosystem in which processes and functions are adequate to maintain diversity of biotic communities commensurate with those initially found there.

ecologically significant: species, stands, and forests considered important to maintaining the structure, function, and processes of particular ecosystems. To understand the characteristics of LS/OG forests that make them ecologically significant, see Table 2.

ecosystem: a unit comprising an interacting group of organisms and their environment.

ecosystem approach: a strategy or plan to manage ecosystems to provide for all associated organisms, as opposed to a strategy or plan for managing individual species.

edge effects: the drastically modified environmental conditions along the margins, or "edges," of forest patches surrounded partially or entirely by harvested lands; these conditions may extend 600 feet or more into the forest from the harvest boundary. Only forested areas at substantial distances from the edge (generally, the center of a forest patch of 100 acres or more) provide unmodified interior forest conditions.

employment effect: the estimated total number of jobs that will be lost or gained because of a change in the harvest level, including timber-industry jobs and other manufacturing and non-manufacturing jobs dependent on timber harvest.

even-aged silviculture: manipulation of a forest stand to achieve a condition in which trees have less than a 20-year age difference.

experimental forests: forest tracts, generally on National Forests, designated as areas where research and experiments involving forestry, wildlife, and related disciplines can be conducted.

final harvest: see regeneration (cut or harvest); rotation. fire suppression: the practice of controlling and extinguishing wild fires.

fire-tolerant species: plant species that have evolved to survive low-intensity ground fires.

forest land: at least 10 percent land area covered by forest trees or formerly having had such tree cover and not currently developed for other use.

forest not suitable for timber production: forest withdrawn from commercial timber production (see reserved lands; reserves).

forest plan: a land management plan designed and adopted to guide forest management activities on a National Forest or BLM District.

forest suitable for timber production: forest identified as appropriate for commercial timber production. Generally, this area equals the forest tentatively suitable for timber production minus further withdrawals to protect fish and wildlife, watersheds, and other resources, to pursue multiple-use objectives reflecting scenic quality, dispersed recreation, and other values, or to avoid situations in which the benefits of timber production are less than the costs.

forest tentatively suitable for timber production: total forest minus forests (1) legally withdrawn from production (such as Wilderness) or (2) judged too unstable for timber harvest, too difficult to regenerate, or too unproductive.

forest watershed: the forested area contributing water and sediments to a stream or lake.

fragmentation (of LS/OG stands): the process of reducing the size and connectivity of LS/OG areas.

functional LS/OG network: a connected series of blocks of late-successional and/or old-growth forest that, because of their size, their distribution, and the presence of certain environmental conditions, provide habitat for viable populations of associated plant and animal species.

green tree: a live and growing tree.

green-tree retention: the silvicultural practice of retaining live, growing trees on a site during timber harvest as a future source of snags.

habitat: the full set of physical, chemical, and biological factors that influence the presence, abundance, and distribution of species.

habitat conservation area (HCA): a contiguous block of habitat to be managed and conserved for breeding pairs, connectivity, and distribution of northern spotted owls, as specified in the ISC strategy.

habitat fragmentation: see fragmentation.

Hamilton Report: a federal assessment of the economic impact of the ISC strategy.

hard snag: a recently dead standing tree that typically still has an intact top, a high degree of bark cover, and most limbs; hard snags are required by a number of wildlife species, including cavity nesters.

harvest scheduling analysis: an analysis of the harvest level possible over time under assumptions about the land available for timber production, land productivity, management intensity, and fluctuation in harvest level permitted from period to period.

high grade: as it pertains to timber harvest, the practice of selectively removing the most valuable (highest quality)trees in a stand.

income effect: the estimated total amount of personal income that will be lost or gained because of a change in the harvest level, including income from displaced workers and workers employed at lower wages as well as the impact of “cooling" the labor market through increased labor supplies (see employment effect).

Interim (short-term) solution: for this report, a 2-4-year period.

ISC strategy: the set of management standards and guidelines, and associated monitoring and research studies, proposed by the Interagency Scientific Committee to Address Conservation of the Northern Spotted Owl; this strategy ensures a high probability of long-term persistence of viable owl populations on federal lands in the Pacific Northwest.

key watershed: as defined by National Forest and BLM District fish biologists, a watershed containing (1) habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish or (2) greater than square miles with high-quality water and fish habitat.

land allocation: in this report, the specification in Forest Plans of where activities, including timber harvest, can occur on a National Forest or BLM District.

late-successional forest: a forest in its mature and/or old-growth stages; see old*growth forest and succession.

longer term solution: for this report, a period of a century or more.

LS/OG forest (or stands): forests or stands consisting of trees and structural attributes and supporting biological communities and processes associated with old-growth and/or mature forests.

managed forest: forest land that is silviculturally treated and harvested on a scheduled basis and that contributes a specified harvest level.

managed LS/OG2: ecologically significant LS/OG forests not set aside (reserved from timber harvest) and in which timber harvest is permitted under management option C of this report (see next glossary entry).

management options (current, A, B, C): in this report, four options for managing lands outside of reserves. The current option implements the standards and guidelines of the existing Forest Plans. Option A follows FPs with the addition of the 50-11-40 rule and guidelines for green trees, snags, and down logs: options B and C build on A but provide for increasing levels of extended and long rotations (see rotation).

marbled murrelet: a small, robin-sized seabird (Brachyramphus marmoratus) that nests in oldgrowth forests within 50 miles of marine environments. Recently proposed for listing as a threatened species by the U.S. Fish and Wildlife Service.

mature stand: a forest stand that has reached peak growth but not yet achieved old-growth characteristics; in the study area for this report, stands that are generally greater than 80-1 O0 years old and less than 180-200 years old.

merchantable (trees, stands, timber): trees or stands that people will buy for the wood they contain.

model: see simulation.

modified ISC strategy: in this report, an alternative based on the Interagency Scientific Committee's strategy for conserving the northern spotted owl but having smaller and fewer HCAs than the original strategy and not employing the 50-11-40 rule.

monitoring: the process of collecting information to evaluate if objective and anticipated or assumed results of a management plan are being realized or if implementation is proceeding as planned.

monitoring program: the administrative program used for monitoring.

most significant LS/OG forests (LS/OG1): the largest, most strategically located blocks of existing LS/OG stands, often at lower elevations, that provide for spotted owls, marbled murrelets, other late-successional forest plant and animal species, sensitive fish species and stocks, and other important ecosystem processes and functions (see significant LS/OG forests).

multiple use: the management of all the various renewable surface resources so that they are utilized in the combination that best meets the needs of the American people. This combination is not necessarily the one that will give the greatest dollar return or greatest unit output.

natural forest ecosystem: a forest ecosystem not interfered with by humans.

northern spotted owl: one (Strix occidentalis caurina) of three subspecies of the spotted owl which ranges from southern British Columbia, Canada, through western Washington and Oregon, and into northwestem California; listed as a threatened species by the U.S. Fish and Wildlife Service.

old-growth forest: a forest stand usually at least 180-220 years old with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; high incidence of large trees, some with broken tops and other indications of old and decaying wood (decadence); numerous large snags; and heavy accumulations of wood, including large logs on the ground.

opportunity cost: benefit which could result from a course of action but which is forgone when that course of action is not pursued.

owl additions: see spotted owl additions.

owl forests: in this report, the National Forests and BLM Districts supporting populations of northern spotted owls.

owl region: the geographic area within the range of the northern spotted owl.

overmature stands: trees of an age at which they decline in vigor and soundness.

partial cutting: the practice of removing a portion of the trees in a harvest unit.

patch: a small (20-60 acre) part of the forest. This term is often used to indicated a type of clearcutting (patch cuts) associated with the "staggered setting" approach to distributing harvest units across the landscape. See also adjacency requirement, staggered setting.

population: a collection of individual organisms of the same species that potentially interbreed and share a common gene pool. Population density refers to the number of individuals of a species per unit area, population persistence to the capacity of the population to maintain sufficient density to persist, well distributed, over time. See viable population.

precommercial thinning: the removal of young trees not yet of commercial value from an even-aged stand, generally to encourage more rapid growth of the remaining trees.

prescribed burning: Controlled fire deliberately set to meet various resource objectives.

Record of Decision: pertaining to the National Environmental Policy Act, a document prepared following the analysis of the environmental effects of a project; the document specifies the alternative selected and provides the rationale for that selection.

regeneration (cut or harvest): in silviculture, cutting a mature forest stand generally to harvest timber and prepare the site for a new forest stand.

Region 5: the National Forests of California; the Forest Service's Pacific Southwest Region.

Region 6: the National Forests of Washington and Oregon; the Forest Service's Pacific Northwest Region.

reserved lands: federal lands, often of legally protected status, that have been withdrawn from timber production--for example, Wilderness Areas, National Parks, and Research Natural Areas.

reserves: in this report, Wilderness plus either SOHAs or HCAs or a combination of LS/OG areas and owl additions.

riparian area: the aquatic ecosystem and adjacent upland areas that directly affect it.

risk analysis: for this report, a qualitative assessment of the probability of persistence of wildlife species and ecological systems under various alternatives and management options; generally also accounts for scientific uncertainties.

risk-analysis scale: in this report, a continuum of values (from "very low" through ~very high") describing the likelihood that a functional LS/OG forest network and habitat for associated wildlife species and fish will persist.

rotation: the planned number of years between regeneration of a forest stand and its final harvest (regeneration cut or harvest). A forest's age final harvest is referred to as rotation age. In this report, an extended rotation is 120-180 years (management options B and C), a long rotation 180 years (management option C).

sensitive fish species and stocks: fish species and stocks (genetically distinct populations) anadromous salmonids identified by the American Fisheries Society's Endangered Species Committee as needing special management considerations to avoid extinction.

seral species: species that occur at one or several stages in plant succession from bare ground to climax (final, serf-perpetuating community that will persist as long as the same conditions prevail); see succession.

shade-tolerant species: plant species that have evolved to grow well in shade.

significant LSIOG forests (LSIOG2): blocks of existing mature and old-growth forest stands, sometimes fragmented or small in size, that help connect most significant LS/OG forest and that contribute to the viability of LS/OG-associated plant and animal species and other important ecosystem processes and functions (see most significant LS/OG forests).

silvicultural practices (or treatments): the set field techniques and general methods used to modify and manage a forest stand over time to meet desired conditions and objectives.

silviculture: the science of manipulating forest stand structure and composition to meet desired objectives including but not limited to timber production, and fish and wildlife habitat.

simulation: the use of a computer or mathematical model to predict effects from a management scenario not yet enacted.

site productivity: the ability of a geographic area to produce biomass, as determined by conditions (e.g., soil type and depth, rainfall, temperature) in that area.

snag: a standing dead tree; snags are vital habitat for many wildlife species in the Pacific Northwest, particularly cavity nesters.

spotted owl additions: areas of LS/OG or suitable spotted owl habitat or potential owl habitat added to most significant LS/OG forest (LS/OG1) to ensure compliance with the ISC strategy.

spotted owl habitat area (SOHA): an area reserved from timber harvesting to provide forest habitat for a pair of northern spotted owls; the current spotted-owl management system described in Forest plans for National Forests and BLM Districts.

staggered setting: an approach to timber harvesting in which harvest units, separated by uncut units of at least the same size, are scattered across the landscape.

stand: a contiguous forest area with homogeneous species composition and structure (generally tree size or age).

standards and guidelines: instructions for carrying out a forest-resource management strategy.

stocking: the number of trees per unit of area.

structural retention: harvest practices that leave physical elements (i.e., green trees, snags, down logs) of LS/OG forests on site after harvest.

structure: the various horizontal and vertical physical elements of the forest.

subdrainage: a land area bounded by ridges, encompassing only part of a forest watershed, and enclosing on the order of 5000 acres; smaller than, and part of, a watershed (see drainage and forest watershed).

succession: in ecology, the sequence of changes in plant and animal communities on a site over time; forest succession generally leads to late (old-growth) stages at 180-220 years in Pacific Northwest forests.

suitable (spotted owl) habitat: an area of forest vegetation with the age class and species of trees, stand structure, and food sources to meet nesting, roosting, and foraging needs of the northern spotted owl.

sustainable harvest: a harvest volume that can be maintained through time without decline.

understory: the vegetative layer consisting of trees and/or shrubs growing under the canopies of larger trees.

universe of LS/OG forest: all mapped LS/OG forests considered in this report.

viable population: a population of adequate size and distribution to maintain its genetic diversity and persist for a century or longer.

watershed: see forest watershed.

watershed and fish options (current, watershed and fish habitat emphasis option): In this report, two options for managing watersheds and fish. The current option implements the standards and guidelines of the existing Forest Plans. The watershed and fish habitat emphasis option promotes protection and enhancement of key watersheds and habitats, for sensitive fish species and stocks.

"west side": west of the Cascade Range.

wetlands: areas inundated by surface water or groundwater frequently enough to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soils for growth and reproduction.

young stands: forest stands not yet mature (generally, less than 50-80 years old; typically 20-40 years old).

TABLES

Table 1. Administrative units on federal lands considered for analysis in this report (partial units are indicated).

Agency	Administrative unit
Forest Service-National Forests	
	Region 6 (Washington and Oregon)
	Deschutes (West of Hwy 97)
	Gifford Pinchot
	Mt, Baker-Snoqualmie
	Mt. Hood
	Okanogan (W, of Chewuch River)
	Olympic
	Rogue River [1]
	Siskiyou [1]
	Siuslaw
	Umpqua
	Wenatchee
	Willamette
	Winema (West of Hwy 97)
	Region 5 (northern California)
	Klamath
	Mendocino
	Modoc (comer only)
	Shasta-Trinity
	Six Rivers
Bureau of Land Management-Districts	
	Oregon
	Coos Bay
	Eugene
	Lakeview
	Medford
	Roseburg
	Salem
	California
	Ukiah

[1] The portions of the Rogue River NF and Siskiyou NF in California re included in the FS Oregon and FS Region 6 totals.

Table 2. Factors used in classifying the ecological significance of LS/OG.

Factor	Characteristics contributing to higher ecological significance
Block size	Larger blocks of forest
Fragmentation	Little or no fragmentation
Location	Location critical in network
Stand attributes	Classic old growth [1]
Age	Age 250-750 years
Productivity	Higher site productivity
Elevation	Lower elevation (relatively rare)
Occurrence of spotted owls	Known/likely occurrence of spotted owls
Occurrence of marbled murrelets	Known/likely occurrence of marbled murrelets
Occurrence of other species	Known/likely occurrence of other late-successional species

[1] As defined in Forest Service publication PNW-447 (see text footnote for citation).

Table 3. Gross area of all lands and federal land in different reserve categories, by agency and state (outside of Wilderness, Oregon Cascades Recreation Area, and National Parks).

Reserve categories	BLM (Or/Cal)	FS R-5 (Cal)	FS R-6 Or	FS R-6 Wash	FS Total	Total
	---------- M acres ----------					
LS/OG1						
All lands	1120	1330	2140	1610	3750	6200
Federal	860	1220	2090	1530	3620	5700
Owl additions[1]						
AII lands	270	240	230	300	530	1040
Federal	200	230	220	270	490	920
LS/OG2						
Overlap with owl additions						
AII lands	0	100	130	280	410	510
Federal	0	100	130	280	410	510
Outside of owl additions						
All lands	280	320	930	290	1220	1820
Federal	250	290	910	290	1200	1740
Total						
All lands	1670	1990	3430	2480	5910	9570
Federal	1310	1840	3350	2370	5720	8870

[1] See "Provision for the Northern Spotted Owl,"

Table 4. Existing acreages in the federal land base (a) and LS/OG forest withdrawn from timber production under different land allocations (b) on nine National Forests in western Washington and western Oregon and five BLM Districts in western Oregon. LS/OG is defined for FS as acres considered "potential old growth" according to Pacific Meridian Resource maps and for BLM as acres over 80 years old.

Category[1]	BLM	FS	Total
	---------- M acres ----------		
(a) Federal land base			
Total land	2260	9700	12060
Total forest	2176	8381	10592
LS/OG forest[2]	1080	3998	5078
(b) LS/OG forest withdrawn, by land allocation			
FP	375	21144	2489
FP + LS/OG1	650	2842	3492
FP + LS/OG1 + owl additions a	680	2943	3622
FP + LS/OG1 + owl additions + LS/OG2	770	3310	4080
FP + LS/OG1 + owl additions + LS/OG2 + LS/OG3	1080	3998	5078

[1] Consult the report's "List of Abbreviations" as necessary.
[2] As of 1988.
[3] See "Provision for the Northern Spotted Owl."
[4] Other information (an undated FS "fact sheet" entitled "Vegetative Mapping for Determination of Old Growth") suggests that this estimate of "potential old growth" withdrawn from timber production by the Forest Plans is high. Rather than the 52.8% withdrawn estimated here (2114/3998), this other information suggests that approximately 46% is withdrawn.

Table 5. Standards and guidelines for the two watershed and fish options.

Option	Description
Current option	Riparian standards and guidelines and best management practices to minimize cumulative effects in watersheds, as defined in current FS and BLM Plans.
Watershed and fish habitat emphasis option	Reserve areas: Wilderness, National Parks, Wild and Scenic Rivers, LS/OG1, and owl additions. Riparian management areas on all FS and BLM lands: (1) Wild, Scenic, and Recreational rivers designated or under study: no-harvest area 1/4 mile on each side of the stream or the width of the 100-year flood plain, whichever is larger, where water quality, fish, or other ecological values are described as part of the stream's outstandingly remarkable features. (2) No-harvest area 1/8 mile on each side of the stream or the width of the 100-year flood plain, whichever is larger, on major streams draining at least 30 square miles. (3) Fish-bearing streams: 300-foot no-harvest area on each side of the stream. (4) Permanently flowing non-fish-bearing streams: 150-foot no-harvest area on each side of the stream. (5) Seasonally flowing or intermittent streams: 50-foot no-harvest area on each side of streams in areas of moderate and high soil instability. No-harvest areas will vary with topographic and on-site conditions, but the horizontal width of such areas, implemented in practice, should reach the objectives expressed as averages here. Key watersheds identified as having high-quality fisheries, water, or ecological values (Appendix D): Augment the Forest Plan standards and guidelines with the 50-11-40 rule and rotations approaching 200 years (management option C as described in "Lands Outside of Reserves," under "Forest Management'). Forest road systems and related road-drainage problems: (1) Reduce and minimize forest road-system mileage: (a) Minimize construction of new roads, and construct no new roads in current roadless areas identified in the Forest Plans. (b) Remove (return to a natural condition) spur roads and other nonessential roads.

Table 5. (continued)

Option	Description
	(2) Conduct a forest road-system analysis by National Forest and BLM District to identify road locations and practices which will reduce impacts to riparian areas of existing and new roads. (3) Road drainage: (a) Increase maintenance of road network during the rainy season. (b) Upgrade culverts to larger sizes on existing and planned roads. (c) Increase frequency of culverts on new and existing roads. Logging slash treatment/prescribed fire: (1) Eliminate hot bums on **steep** grounds. (2) Eliminate burns in riparian management **areas.** Livestock grazing: Include temporary and permanent exclusion from riparian areas to promote the reestablishment of **shrubs,** hardwoods, and fringe wetlands, and maintenance of stream-bank integrity. Riparian and fish-habitat restoration: Establish a **program** that ***will*** ensure long-term stream-habitat stability. Cumulative effects: Conduct an analysis by National Forest and **BLM** District to aid in the timing and location of timber harvest and location of roads and landings.

Table 6, Summarized description of the 14 major alternatives considered.[1]

Alternative No.	Identifier	Description
1	High timber yield	This option, obtained from FS and BLM planning documents, reflects scenarios that emphasize timber production. These scenarios consider spotted owl habitat through the SOHA[2] approach.
2	Forest Plans	This option was compiled from the selected or most likely to be selected plans for National Forests and BLM Districts. SOHAs are included.
3	Forest Plans + modified ISC strategy	In this option, the basic ISC strategy, which uses the HCA approach and specifies 20 or more owl pairs in HCAs spaced 12 or less miles apart, was modified to 15 owl pairs in HCAs spaced 16 miles apart, with no added management constraints on forest land outside of HCAs. SOHAs are dismantled.
4	Forest Plans + ISC strategy	This option combines ISC strategy (see Alternative 3) with application of the 50-11-40 rule for the forest lands between HCAs. SOHAs are dismantled. Forest lands outside of HCAs may be managed under three options: (A) 50-11-40 rule and per-acre retention after final harvest of 6 "green" (live) trees with DBH more than the stand average, 2 "hard" snags greater than 21 inches DBH, and 2 large logs. (B) Same A plus10 percent of lands outside of Wilderness and HCAs should be dominated by stands over 180 years of age, and 10 percent dominated by stands 120-180 years of age; the forest suitable for timber production should be managed via "area control" on rotations of at least 120 years (i.e., at most 1/12 of these acres harvested each decade). (C) Same as except that 10 percent of lands outside of Wilderness and HCAs should be dominated by stands over 180 years of age; the forest suitable for timber production should be managed via area control on rotations of at least 180 years (i.e., at most 1/18 of these acres harvested each decade).
5	Forest Plans + LS/OG1	This option adds LS/OG1 areas (most ecologically significant LS/OG stands, or stands with such potential). Forest lands outside of reserves may be managed under the three options (A, B, C) described in Alternative 4. LS/OG1 substitutes at least partially for HCAs.
6	Forest Plans + LS/OG1 + owl additions	As in Alternative 5, except that areas are added to assure compliance with ISC standards and guidelines.
7	Forest Plans + LS/OG1 + watershed/fish emphasis	As in Alternative 5, except that management requirements for habitat for sensitive fish species and stocks are added.
8	Forest Plans + LS/OG1 + owl additions + watershed/fish emphasis	As in Alternative 6, except that management requirements for sensitive fish species and stock are added.
9	Forest Plans + LS/OG1 + owl additions + managed LS/OG2	As in Alternative 6, except that all LS/OG2 stands available for harvest should be managed as described under Alternative 4, option C.
10	Forest Plans + LS/OG1 + owl additions + managed LS/OG2 + watershed/fish emphasis	As in Alternative 9, except that management requirements for habitat for sensitive fish species and stocks are added.

Table 6. (continued)

Alternative No.	Identifier	Description
11	Forest Plans + LS/OG1 + owl additions + LS/OG2	As in Alternative 6, except that all LS/OG2 stands are reserved from timber harvest.
12	Forest Plans + LS/OG1 + owl additions + LSIOE2 + watershed/fish emphasis	As in Alternative 11, except that management requirements for habitat for sensitive fish species and stocks are added.
13	Forest Plans + LS/OG1 + owl additions + LS/OG2 + LS/OG3	As in Alternative 12, except that all LS/OG3 stands also are reserved from timber harvest.
14	Forest Plans + LS/OG1 + owl additions + LS/OG2 + LS/OG3 + watershed/fish	As in Alternative 13, except that management requirements for habitat for sensitive fish species and stocks emphasis are added.

[1] Consult the report's "List of Abbreviations" as necessary.
[2] Spotted owl habitat areas, or SOHAs, were used to protect the northern spotted owl before the ISC strategy.

Table 7. Risk-analysis scale for ranking the probability of retaining a functional LS/OG forest network; ensuring viable populations of northern spotted owls; and providing habitat on federal land for marbeled murrelet nesting, other LS/OG-associated species, and sensitive fish species and stocks.

Risk rating	Description
VH - VERY HIGH (very reliable)	Denotes a very high likelihood of retaining ecologically functional LS/OG forests and associated species for a century or longer; ensuring habitats and environmental conditions for conserving well-distributed LS/OG species and fish considered to be at risk. Provides broad latitude for natural catastrophes and uncertainties in knowledge.
H - HIGH (reliable)	Denotes a high likelihood of retaining ecologically functional LS/OG forests and associated species for a century or longer; ensuring habitats and environmental conditions for conserving well-distributed LS/OG species and fish considered to be at risk. Provides some latitude for natural catastrophes and uncertainties in knowledge.
MH - MEDIUM HIGH (somewhat reliable)	Denotes a moderately high likelihood of retaining ecologically functional LS/OG forests and associated species for a century or longer; ensuring habitats and environmental conditions for conserving well-distributed LS/OG species and fish considered to be at risk. Provides limited latitude for natural catastrophes and uncertainties in knowledge.
M - MEDIUM (uncertain)	Denotes a roughly 50/50 likelihood of retaining ecologically functional LS/OG forests and associated species for a century or longer; ensuring habitats and environmental conditions for conserving well-distributed LS/OG species and fish considered to be at risk. Provides extremely limited latitude for natural catastrophes and uncertainties in knowledge; catastrophic events are likely to cause local extirpations of LS/OG-associated species. Does not meet the criterion for well-distributed populations.
ML- MEDIUM LOW (somewhat harmful)	Denotes less than a 50/50 likelihood of retaining ecologically functional LS/OG forests and associated species for a century or longer; ensuring habitats and environmental conditions for conserving well-distributed LS/OG species and fish considered to be at risk. Provides almost no latitude for natural catastrophes and uncertainties in knowledge.
L - LOW (harmful)	Denotes a highly unlikely chance of retaining ecological~ functional LS/OG forests and associated species for a century or longer; ensuring habitats and environmental conditions for conserving well-distributed LS/OG species and fish considered to be at risk. Provides no Iatitude for natural catastrophes and uncertainties in knowledge. Local extirpation of LS/OG-associated species or habitats and fish considered to be at risk due to natural catastrophes and uncertainties in knowledge is probable.
VL - VERY LOW (very harmful)	Denotes a very highly unlikely chance of retaining ecologically functional LS/OG forests and associated species for a century or longer; ensuring habitats and environmental conditions for conserving well-distributed LS/OG species and fish considered to be at risk. Provides no latitude for natural catastrophes and uncertainties in knowledge. Local or regional extirpation of LS/OG-associated species or habitats and fish considered to be at risk due to natural catastrophes and uncertainties in knowledge is highly likely.

Table 8. Risk analysis, by alternative and management option, for retaining a functional LS/OG forest network; ensuring viable populations of northern spotted owls; and providing habitat on federal land for marbeled murrelet nesting, other LS/OG-associated species, and sensitive fish species and stocks.[1]

Alternative		Risk rating: probability of				
No.	Identifier	Functional LS/OG network	Viable spotted owl populations	Habitat for Marbled Murrelet nesting	Habitat for other LS/OG species	Habitat sensitive fish species/stocks
1	High timber yield	VL	VL	VL	VL	VL
2	Forest Plans	VL	L	L	VL	VL/L[2]
3	FP + modified ISC	L	ML	L	L	VL./L[2]
4	FP + ISC					
	Option A	ML	H	ML	ML	L
	Option B	ML	H	M	M	L
	Option C	M	VH	M	M	M
5	FP + LS/OG1					
	Option A	M	M	M	M	L
	Option B	M	M	M	M	L
	Option C	MH	MH	MH	MH	M
6	FP + LS/OG1+ owl additions					
	Option A	M	H	M	M	ML
	Option B	M	H	M	M	ML
	Option C	MH	VH	MH	MH	M
7	FP + LS/OG1 + watershed/fish emphasis					
	Option A	M	M	M	M	M
	Option B	MH	M	M	MH	MH
	Option C	H	MH	MH	MH	H
8	FP + LS/OG1 + owl additions + watershed/fish emphasis					
	Option A	M	H	M	MH	MH
	Option B	MH	H	M	MH	MH
	Option C	H	VH	MH	H	H
9	FP + LS/OG1 + owl additions + managed LS/OG2					
	Option A	M	H	M	M	M
	Option B	MH	VH	M	M	M
	Option C	H	VH	MH	MH	M
10	FP + LS/OG1 + owl additions + managed LS/OG2 + watershed/fish emphasis					
	Option A	MH	H	M	MH	MH
	Option B	H	VH	M	MH	H
	Option C	H	VH	MH	H	H

Table 8. (continued)

Alternative		Risk rating: probability of				
No.	Identifier	Functional LS/OG network	Viable spotted owl populations	Habitat for Marbled Murrelet nesting	Habitat for other LS/OG species	Habitat sensitive fish species/stocks
11	FP + LS/OG1 + owl additions + LS/OG2					
	Option A	MH	VH	MH	H	M
	Option B	MH	VH	MH	H	M
	Option C	H	VH	H	H	M
12	FP + LS/OG1 + owl additions + LS/OG2 + watershed/fish emphasis					
	Option A	MH	VH	MH	H	MH
	Option B	H	VH	MH	H	H
	Option C	VH	VH	H	VH	VH
13	FP + LS/OG1 + owl additions + LS/OG2 + LS/OG3					
	Option A	MH	VH	H	H	M
	Option B	H	VH	H	H	M
	Option C	VH	VH	H	VH	M
14	14 FP + LS/OG1 + owl additions + LS/OG2 + LS/G3 + watershed/fish emphasis					
	Option A	H	VH	VH	VH	H
	Option B	VH	VH	VH	VH	H
	Option C	VH	VH	VH	VH	VH

[1] For definitions of the risk-analysis scale (VH, H, MH, M, ML, L, VL), see Table 7. Consult the report's "List Abbreviations" as necessary.
[2] Whether the probability is very low or low depends on watershed and administrative unit.

Table 9. Existing acreages in the federal land base (a) and forest suitable for timber production under different land allocations (b) on the owl forests[1]

Categories	BLM (Or/Cal)	FS				Total
		R-5 (Cal)	R-6			
			Or	Wash	Total	
	---------- M acres ----------					
(a) Federal land base						
Total land	2410	5658	8741	7597	16338	24406
Total forest	2250	4732	7960	5985	13945	20927
Forest tentatively suitable for timber production	1875	2852	5960	3486	9446	14173
(b) Forest suitable for timber production, by land allocation						
FP (Alternative 2)	1620	1725	4538	2569	7107	10452
FP + ISC (Alternative 4)	1080	1471	3747	1579	5326	7877
FP + LS/OG1 (Alternative 5)	1090	1433	3425	1728	5153	7676
FP + LS/OG1 + owl additions (Alternative 6)	996	1360	3221	1396	4617	6973
FP + LS/OG1 + owl additions + LS/OG2 (Alternative 11)	830	1190	2656	1264	3920	5950

[1]Consult the report's "List of Abbreviations" as necessary. Note: One alternative (Alternative 1 : high timber yield) would have a higher percentage of forest suitable for timber production than reported here. Alternative 13 and alternatives including riparian withdrawals for the watershed/fish emphasis option would have lower percentages than reported here. Excludes the Ukiah District of BLM (California), for which we lack data.

Table 10. Historical timber harvest and sales (a) and estimated sustainable harvest levels (b), by alternative management option, agency, and state for the owl forests.

			FS						
				R-6			FS and BLM		
		BLM1 (Or/Cal)	R-5 (Cal)	Or	Wash	Total Owl[2]	Cal	Or	Wash	Total
		----------Millions of board feet/year of net volume----------								
(a) Historical level										
	1980-89 harvest	850	570	2061	970	3031	570	2911	970	4451
	1985-89 harvest	1050	680	2457	1080	3537	680	3507	1080	5267
	1990 sale program	790	390	2012	686	2898	390	2802	886	4078
(b) Estimates from 14 alternatives										
Alternative No.	Identifier									
1	High timber yield	1096	600	2392	1054	3447	600	3489	1054	5143
2	Forest Plans	787	395	1570	639	2209	395	2357	639	3391
3	FP + modified ISC	696	364	1434	558	1992	364	2130	558	3052
4	FP + ISC									
	Option A	390	259	1027	313	1340	259	1417	313	1989
	Option B	305	237	817	286	1103	237	1122	286	1645
	Option C	244	203	658	253	911	203	902	253	1358
5	FP + LS/OG1									
	Option A	350	263	953	348	1301	263	1303	348	1914
	Option B	300	242	748	320	1068	242	1048	320	1609
	Option C	253	212	597	281	878	212	850	281	1343
6	FP + LS/OG1 + owl additions									
	Option A	299	233	858	268	1126	233	1157	268	1658
	Option B	250	212	682	244	926	212	932	244	1388
	Option C	203	170	547	215	762	170	750	215	1130
7	FP + LS/OG1 + watershed/fish emphasis									
	Option A	282	226	737	291	1028	226	1019	291	1536
	Option B	240	210	602	268	870	210	842	268	1320
	Option C	201	195	515	251	761	195	716	251	1162
8	FP + LS/OG1 + owl additions + watershed/fish emphasis									
	Option A	241	201	687	226	893	201	908	226	1335
	Option B	200	164	551	206	757	184	751	206	1141
	Option C	164	152	473	192	665	152	637	192	981

Table 10. (continued)

			FS							
				R-6			FS and BLM			
		BLM1 (Or/Cal)	R-5 (Cal)	Or	Wash	Total Owl[2]	Cal	Or	Wash	Total
		----------Millions of board feet/year of net volume----------								
9	FP + LS/OG1 + owl additions + managed LS/OG2									
	Option A	282	223	777	262	1039	223	1059	262	1544
	Option B	245	187	641	240	881	183	886	240	1309
	Option C	203	170	547	215	762	170	750	215	1130
10	FP + LS/OG1 + owl additions + managed LS/OG2 + watershed/fish emphasis									
	Option A	228	186	623	221	844	186	851	221	1258
	Option B	197	164	523	203	726	164	720	203	1087
	Option C	164	152	473	192	665	152	637	192	981
11	FP + LS/OG1 + owl additions + LS/OG2									
	Option A	265	207	655	239	894	207	920	239	1366
	Option B	200	180	529	217	746	180	729	217	1126
	Option C	168	153	431	192	623	153	599	192	944
12	FP + LS/OG1 + owl additions + LS/OG2 + watershed/ fish emphasis									
	Option A	214	179	518	202	720	179	732	202	1113
	Option B	163	154	435	185	620	154	598	185	937
	Option C	134	131	382	167	549	131	516	167	814
13	FP + LS/OG1 + owl additions + LS/OG2 + LS/OG3									
	Option A	[See text--page 10]								
	Option B									
	Option C									
14	FP +LS/OG1 + owl additions + LS/OG2 + LS/OG3 + watershed/fish emphasis									
	Option A									
	Option B	[See text--page 10]								
	Option C									

[1] We converted all BLM harvest estimates from a 16-foot-iog basis to a 32-foot-log basis to be compatible with the measures used in State Harvest Reports.
[2] To estimate total R-6 harvest, add approximately 850 million board feet to total owl.
[3] Using one year's share of the "318" volume as the sale program for Oregon and Washington.

Table 11. Effects of changes in sustainable harvest level on employment and personal income, by alternative and management option, for two historic harvest periods (1980-89 and 1985-89) (a) and the Forest Plans + ISC strategy (b) as a basis for comparison.

Alternative No.	Identifier	Employment --Thousands-- of jobs				Income -- Millions -- of $/yr			
(a) Two historic harvest periods		1980-89		1985-89		1980-89		1985-89	
		Low	High	Low	High	Low	High	Low	High
1	High timber yield	7	9	-1	-2	235	442	-42	-79
2	Forest Plans	-11	-14	-20	-26	-360	-678	-637	-1200
3	FP + modified ISC	-15	-19	-24	-30	-480	-903	-757	-1425
4	FP + ISC								
	Option A	-26	-33	-35	-45	-830	-1574	-1114	-2096
	Option B	-30	-38	-39	-49	-954	-1795	-1231	-2318
	Option C	-33	-42	-42	-53	-1050	-1980	-1329	-2502
5	FP + LS/OG1								
	Option A	-27	-34	-36	-46	-860	-1620	-1144	-2150
	Option B	-30	-38	-39	-50	-966	-1818	-1243	-2341
	Option C	-33	-42	-42	-54	-1065	-1989	-1334	-2511
6	FP + LS/OG1 +owl additions								
	Option A	-30	-38	-39	-49	-940	-1772	-1219	-2294
	Option B	-33	-42	-42	-53	-1041	-1960	-1318	-2482
	Option C	-36	-45	-45	-57	-1110	-2103	-1395	-2625
7	FP + LS/OG1 + Watershed/fish emphasis								
	Option A	-31	-39	-39	-51	-975	-1830	-1250	-2355
	Option B	-33	-42	-42	-54	-1064	-2003	-1341	-2526
	Option C	-35	-45	-44	-56	-1120	-2123	-1405	-2645
8	FP + LS/OG1+ owl additions + watershed/fish emphasis								
	Option A	-33	-42	-42	-53	-1059	-1994	-1336	-2516
	Option B	-35	-45	-44	-56	-1125	-2118	-1402	-2640
	Option C	-37	-47	-47	-58	-1170	-2209	-1451	-2731
9	FP + LS/OG1 + owl additions + managed LS/OG2								
	Option A	-31	-39	-40	-50	-1068	-2010	-1345	-2533
	Option B	-34	-43	-42	-54	-980	-1846	-1258	-2368
	Option C	-36	-45	-45	-57	-1110	-2103	-1395	-2625

Table 11. (continued)

Alternative No.	Identifier	Employment --Thousands-- of jobs 1980-89 Low	1980-89 High	1985-89 Low	1985-89 High	Income -- Millions -- of $/yr 1980-89 Low	1980-89 High	1985-89 Low	1985-89 High
10	FP + LS/OG1 + owl additions + managed LS/OG2 + watershed/fish emphasis								
	Option A	-34	-43	-43	-54	-1085	-2043	-1363	-2565
	Option B	-35	-45	-45	-57	-1143	-2152	-1421	-2675
	Option C	-37	-47	-47	-58	-1170	-2209	-1451	-2731
11	FP + LS/OG1 + owl additions + LS/OG2								
	Option A	-33	-42	-42	-53	-1040	-1963	-1320	-2485
	Option B	-36	-45	-44	-56	-1130	-2128	-1407	-2650
	Option C	-37	-48	-46	-59	-1190	-2240	-1467	-2762
12	FP + LS/OG1 + owl additions + LS/OG2 + watershed/fish emphasis								
	Option A	-36	-45	-44	-56	-1120	-2115	-1401	-2637
	Option B	-38	-48	-45	-59	-1194	-2248	-1472	-2771
	Option C	-39	-49	-48	-61	-1230	-2324	-1512	-2846
13	FP + LS/OG1 + owl additions + LS/OG2 + LS/OG3								
	Option A								
	Option B				[See text--page12]				
	Option C								
14	FP + LS/OG1 + owl additions + LS/OG2 + LS/OG3 + watershed/fish emphasis								
	Option A								
	Option B				[See text--page 12]				
	Option C								
(b) Forest Plans + ISC		Low		High		Low		High	
1	High timber yield	34		43		1072		2018	
2	Forest Plans	15		19		476		897	
3	FP + modified ISC	11		14		350		671	

Table 11. (continued)

Alternative No.	Identifier	Employment --Thousands-- of jobs Low	Employment --Thousands-- of jobs High	Income -- Millions -- of $/yr Low	Income -- Millions -- of $/yr High
4	FP + ISC				
	Option A	0	0	0	0
	Option B	-4	-5	-116	-220
	Option C	-7	-9	-220	-400
5	FP + LS/OG1				
	Option A	-1	-1	-30	-54
	Option B	-4	-5	-130	-240
	Option C	-7	-9	-220	-420
6	FP + LS/OG1 + owl additions				
	Option A	-4	-5	-110	-211
	Option B	-6	-8	-204	-384
	Option C	-9	-12	-292	-549
7	FP + LS/OG1 + watershed/fish emphasis				
	Option A	-5	-6	-145	-289
	Option B	-7	-9	-229	-428
	Option C	-9	-11	-290	-520
8	FP + LS/OG1 + owl additions + watershed/fish emphasis				
	Option A	-7	-9	-222	-418
	Option B	-9	-12	-288	-542
	Option C	-11	-14	-340	-635
9	FP + LS/OG1 + owl additions + managed LS/OG2				
	Option A	-5	-6	-150	-272
	Option B	-7	-9	-231	-435
	Option C	-9	-12	-292	-549
10	FP + LS/OG1 + owl additions + managed LS/OG2 + watershed/fish emphasis				
	Option A	-8	-10	-248	-467
	Option B	-10	-12	-306	-577
	Option C	-11	-14	-340	-635
11	FP + LS/OG1 + owl additions + LS/OG2				
	Option A	-7	-9	-210	-389
	Option B	-9	-12	-293	-552
	Option C	-11	-15	-360	-666

Table 11. (continued)

Alternative No.	Identifier	Employment --Thousands-- of jobs Low	Employment --Thousands-- of jobs High	Income -- Millions -- of $/yr Low	Income -- Millions -- of $/yr High
12	FP + LS/OG1 + owl additions + LS/OG2 + watershed/fish emphasis				
	Option A	-9	-12	-297	-560
	Option B	-11	-14	-357	-673
	Option C	-13	-16	-400	-750
13	FP + LS/OG1 + owl additions + LS/OG2 + LS/OG3				
	Option A				
	Option B		[See text--page 12]		
	Option C				
14	FP + LS/OG1 + owl additions + LS/OG2 + LS/OG3 watershed/fish emphasis				
	Option A				
	Option B		[See text--page 12]		
	Option C				

Table 12. Possible yearly loss of Douglas-fir/western hemlock LS/OG to harvesting on nine National Forests and five BLM Districts in western Washington and Oregon.

Harvest level, billions of board feet	1000s acres cut/year[1]	Square mi. cut/year[1]	Total LS/OG --- % removed/year ---	Unreserved LS/OG
0.5	9.5	14.8	0.2	0.4
1.0	19.0	29.7	0.4	0.8
1.5	28.5	44.5	0.6	1.2
2.0	38.0	59.4	0.9	1.6
2.5	47.5	74.2	1.1	2.0
3.0	57.0	89.1	1.3	2.4
3.5	66.5	103.9	1.5	2.8
4.0	76.0	118.8	1.7	3.2
4.5	85.5	133.6	1.9	3.6
5.0	95.0	148.4	2.1	4.0

[1] Assuming that 85 percent of the harvest comes from Douglas-fir/western hemlock LS/OG and the volume/acre is 45,000 board feet.

FIGURES

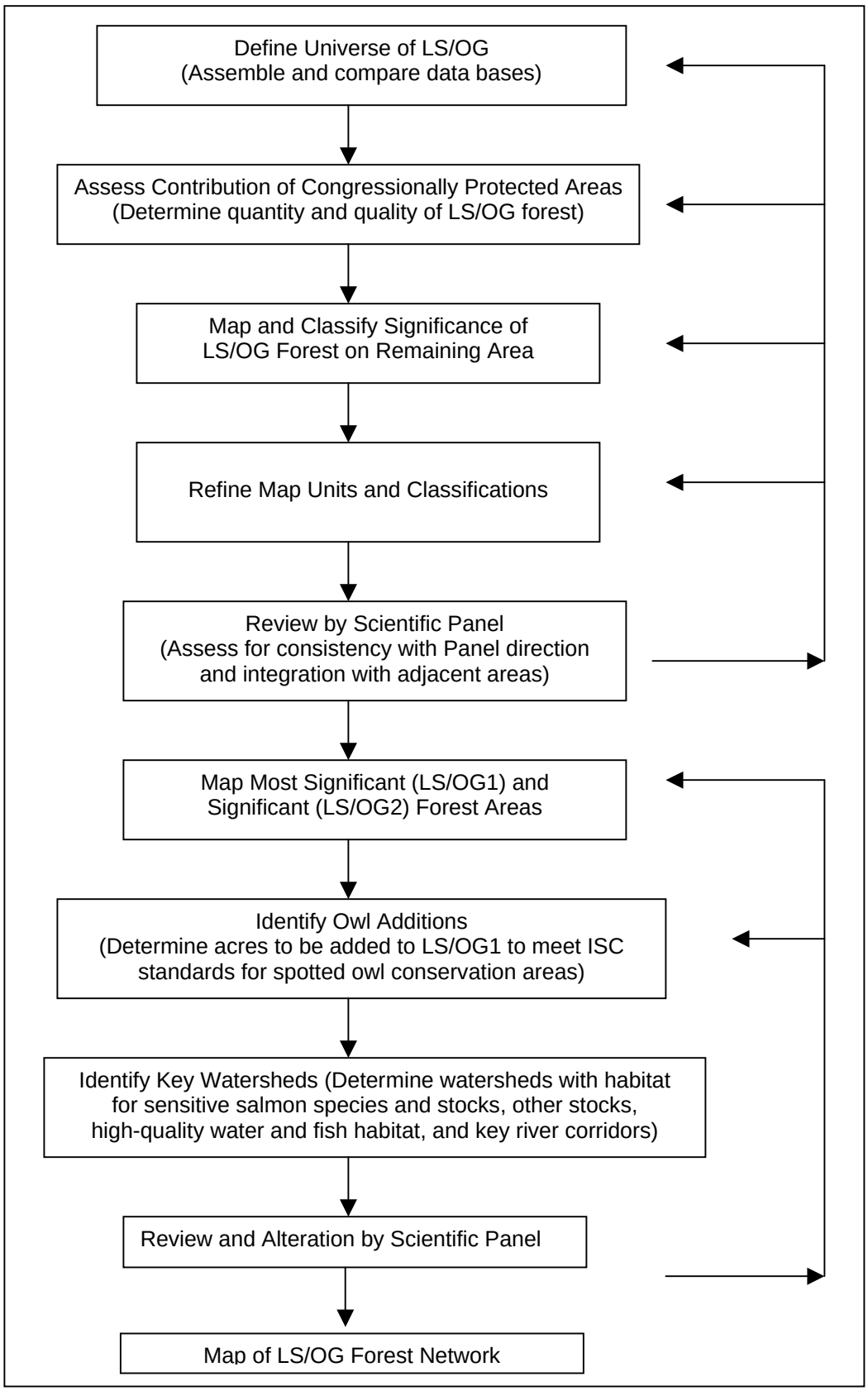


Figure 1. Major steps in mapping ecologically significant LS/OG forest ecosystems. Consult the report's "List of Abbreviations" as necessary.

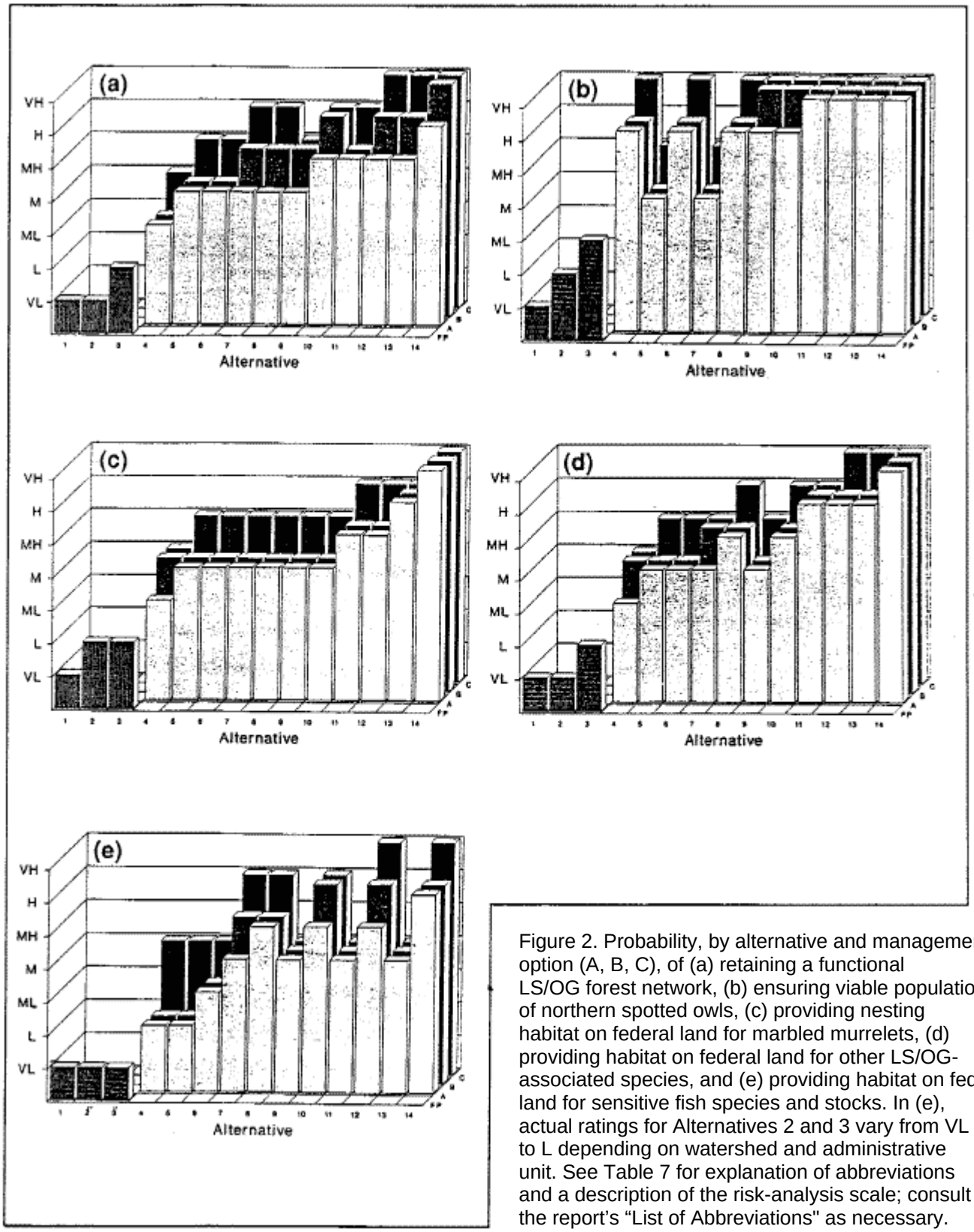


Figure 2. Probability, by alternative and management option (A, B, C), of (a) retaining a functional LS/OG forest network, (b) ensuring viable populations of northern spotted owls, (c) providing nesting habitat on federal land for marbled murrelets, (d) providing habitat on federal land for other LS/OG-associated species, and (e) providing habitat on federal land for sensitive fish species and stocks. In (e), actual ratings for Alternatives 2 and 3 vary from VL to L depending on watershed and administrative unit. See Table 7 for explanation of abbreviations and a description of the risk-analysis scale; consult the report's "List of Abbreviations" as necessary.

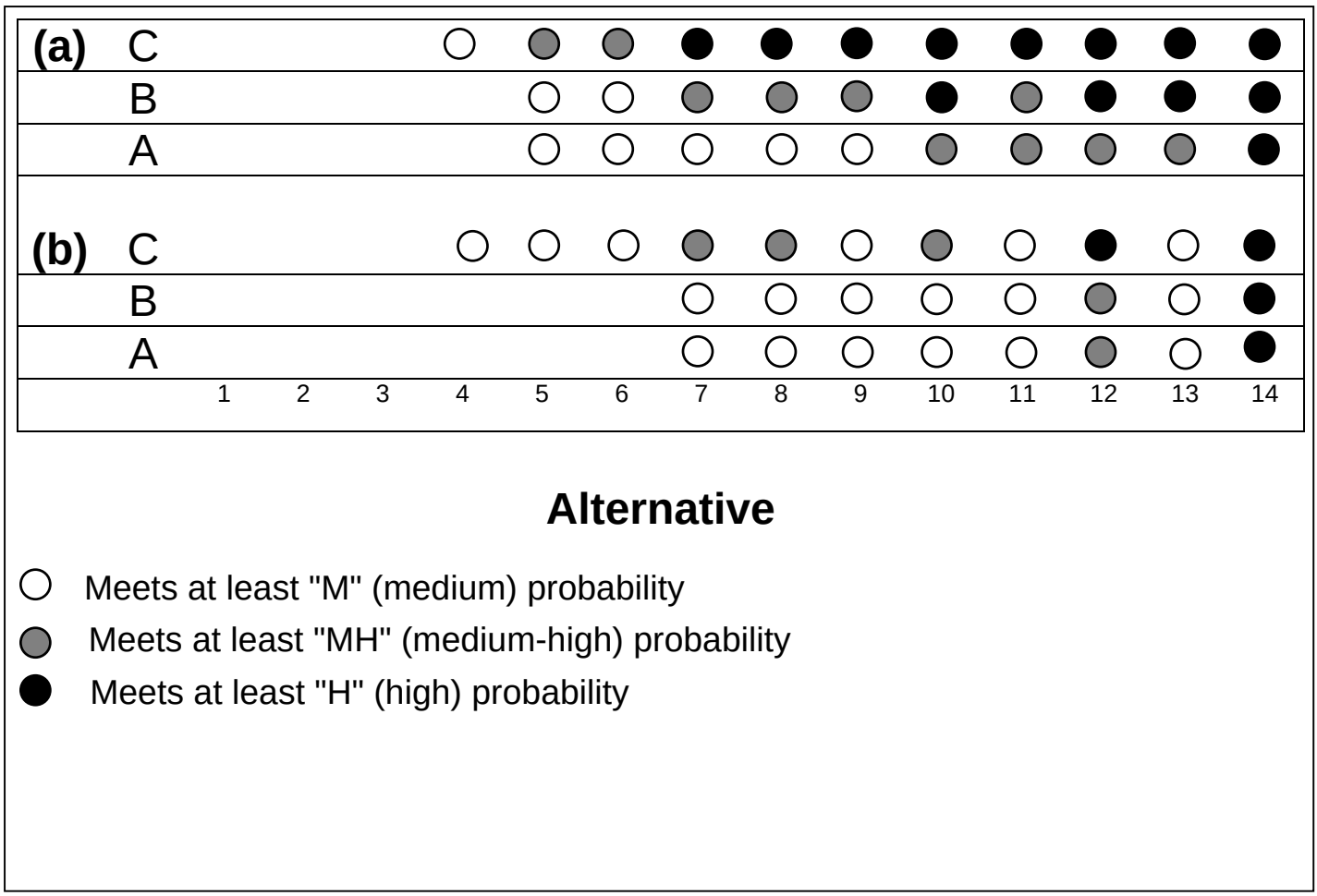


Figure 3. Alternatives, by management option (A, B, C), that have at least a medium probability of (a) retaining a functional LS/OG forest network and (b) ensuring viable populations of northern spotted owls and providing habitat on federal land for marbled murrelet nesting, other LS/OG-associated species, and sensitive fish species and stocks. See Table 7 for explanation of abbreviations and a description of the risk-analysis scale; consult the report's "List of Abbreviations" as necessary.

APPENDIX A: Letter of instructions to the Scientific Panel on Late-Successional Forest Ecosystems from Reps. E. (Kika) de la Garza, Walter B. Jones, Gerry E. Studds, and Harold L. Volkmer

U.S. House of Representatives
Committee on Agriculture
Room 1301, Longworth House Office Building
Washington, DC 20515

May 22, 1991

Dr. Norman Johnson
Department of Forest Resources
Peavy Hall 108
Oregon State University
Corvallis, OR 97331

Dear Dr. Johnson:

As a follow-up to your meeting with Members and staff from the Committee on Agriculture and the Committee on Merchant Marine and Fisheries last week, we are writing to request your further assistance in helping to resolve issues associated with the management and protection of old-growth forests and the northern spotted owl in the Pacific Northwest.

We would like your assistance in helping to identify old-growth forest areas in the region, including affected forests in Northern California. Specifically, we ask that you evaluate different approaches for protecting ecologically-significant old growth and late successional ecosystems, species, and processes, including, but not confined to, spotted owls. These approaches should include the establishment of a regional reserve and changes in existing forest management practices.

For each affected forest and BLM district, we ask that these old-growth areas be identified and mapped as a graded series from most to least important for achieving the stated objectives. In addition, we ask that you develop recommended guidelines for managing unreserved lands associated with alternative configurations of the reserve, and that you quantify the effect that each alternative will have on timber harvest levels in the affected areas. For clarity, we would also request that you state explicitly the assumptions that underlie the alternatives you develop.

While we recognize that this is a considerable undertaking, your knowledge of the region and your expertise in these matters can be extremely valuable to the Committees as we grapple with the policy issues affecting the region. We encourage you to solicit the assistance of others who may be helpful in this

endeavour, including resource personnel from the Forest Service, Fish and Wildlife Service, and the Bureau of Land Management. To facilitate this, we are also writing the heads of each of these agencies to request their cooperation in this regard.

As you know, this complex issue could have a substantial impact on the residents and natural resources of the region. Your willingness to lend further assistance to the Committees in helping to identify alternatives which can aid the Members in deciding the policy questions before us is greatly appreciated.

Best personal regards.

Sincerely,

Walter B. Jones
Chairman
Committee on Merchant Marine,
and Fisheries

E (Kika) de la Garza
Chairman
Committee on Agriculture

Gerry E. Studds
Chairman
Subcommittee on Fisheries and
Wildlife Conservation and the
Environment

Harold L. Volkmer
Chairman
Subcommittee on Forests,
Family Farms, and Energy

cc: D. Cy Jamison
F. Dale Robertson
John Turner

APPENDIX B. Maps detailing LS/OG, owl additions, and key watersheds for the owl forests of Washington, Oregon, and northern California

In a map packet attached to the back cover, you will find for each state a map and three overlays:

Base Map: County lines, National Forests, Wilderness, National Parks, LS/OG1 areas; Oregon Cascades Recreation Areas for Oregon only

Overlay #1: Owl additions (purple)

Overlay #2: LS/OG2 areas (orange)

Overlay #3: Key watersheds (blue)

To register the base map for a state with one or more overlays, we suggest that you first line up the state name at the top of the map and overlays and then line up the state boundary.

NOTE: BLM land that did not overlap with LS/OG1 areas on the base map was too fragmented to show. Also, the LS/OG areas, owl additions, and key watersheds in California for the Rogue River NF and Siskiyou NF are shown on the Oregon base map and overlays.

APPENDIX C: Status of LS/OG forest and other lands on nine National Forests in western Washington and western Oregon and five BLM Districts in western Oregon in existing agency plans and among other land allocations

(a) National Forest (LS/OG forest equivalent to Pacific Meridian Resources "potential old growth")

	Potential old growth			Other forest					Proportion,
	DF/WH [1]	Other species groups	Total	Young conifer	Cut-over	Total forest	Non-forest	Forest + non-forest	LS/OG of total forest
	M acres								
Available for harvest in Forest Plans									
LS/OG1	642	86	728	528	312	1568	--	1568	0.46
Owl additions	75	26	101	131	92	324	--	324	0.31
LS/OG2	311	56	367	274	166	807	--	807	0.45
Other	566	122	688	825	292	1805	--	1805	0.38
Total available	1594	290	1884	1758	862	4504	--	4504	0.42
Withdrawn in Forest Plans[2]									
LS/OG1	711	105	816	445	35	1296	281	1577	0.63
Owl additions	99	62	161	152	14	327	111	438	0.49
LS/OG2	317	88	405	204	17	626	137	763	0.65
Other	559	173	732	799	97	1628	782	2410	0.45
Total withdrawn	1686	428	2114	1600	163	3877	1311	5188	0.54
All National Forest lands									
LS/OG1	1353	191	1544	973	347	2864	281	3145	0.54
Owl additions	174	88	262	283	106	651	111	762	0.40
LS/OG2	628	144	772	478	183	1433	137	1570	0.54
Other	1125	295	1420	1624	389	3433	782	4215	0.41
Total	3280	718	3998	3358	1025	8381	1311	9692	0.48

[1] DF = Douglas-fir
WH -- Western hemlock

[2] For this table only, approximately 500 M acres of withdrawn lands classified as LS/OG1, owl additions, and LS/OG2 should actually be in the "other" category.

(b) BLM Districts (LS/OG forest equivalent to age 81 +)

	Age, years				Proportion, LS/OG of total forest
	121+	81-120	0-80	Total forest	
	M acres				
Available for harvest in District Plans					
LS/OG1 + owl additions	222	82	316	620	0.36
LS/OG2	72	19	57	148	0.48
Other	223	87	490	800	0.28
Total available	517	188	863	1568	0.33
Withdrawn in District Plans					
LS/OG1 + owl additions	125	45	68	238	0.52
LS/OG2	55	15	27	97	0.57
Other	93	42	138	273	0.34
Total withdrawn	273	102	233	608	0.45
All District lands					
LS/OG1 + owl additions	347	127	384	858	0.40
LS/OG2	127	34	84	245	0.39
Other	316	129	628	1073	0.30
Total	790	290	1096	2176	0.36

APPENDIX D: Key watersheds and their associated fish species and stocks

Forest/watershed[1]	Steelhead trout		Salmon					Sea-run cutthroat trout	Resident trout	Bull trout	Other
			Coho	Chinook							
	Sum	Win		Spr	Sum	Fal	Win				
Washington											
Mt. Baker-Snoqualmie NF											
23 White R.	P	P	P	X							
24 M. Fork Snoqualmie R.									P		C2
25 Skykomish R.	P	P		P				P		X	P(8)
27 Deer Cr.	X		P					P			
28 N. Fork Stillaguamish R.	P		P	X							P(8)
26 S. Fork Stillaguamish R.	P		P	X							P(8)
29 Sauk R.	P	P	P	P						X	P(6,8)
30 Suiattle R.	P	P	P	P						X	P(6,8)
31 S. Fork Nooksack R.	P	P	X								P(6)
32 N. Fork Nooksack R.	P	P	X								P(6)
Gifford Pinchot NF											
01 Wind R.	X	X							P		
02 E. Fork Lewis R.		X									
04 Siouxon Cr.									P		C2
06 Lewis R.									P	X	
08 N. Fork Cispus R.									P		C2
10 Clear Fork of Cowlitz R.									P		
07 Upper Cispus Cr.[2]									P		C2
09 Packwood Lake & associated streams									P		
05 White Salmon R.	P		X	P					P	X	
03 Little White Salmon R.	P										C1
Okanogan NF											
20 Twisp R.	X			P	X				P		
21 Early Winters Cr.	X			P					P		
21 Upper Methow R.	X			P					P		
22 Chewach R.[2]	X			P							
Olympic NF											
33 Wynoochie R.	P										
34 Satsop R./ Canyon R.[2]	P		P	X							
35 Skokomish R.		X	P	X					P		P(6), X(8)
36 Duckabush R.		X	P			X					
37 Dosewallips R.											
38 Dungeness R.				X							X(6)

Appendix D. (continued)

Forest/watershed[1]	Steelhead trout		Salmon								
			Coho	Chinook				Sea-run cutthroat trout	Resident trout	Bull trout	Other
	Sum	Win		Spr	Sum	Fal	Win				
Washington (continued)											
39 Elwha R.			X	X							X(6,8) 40
40 Soleduck R.	X	X									P(9)
41 Cook Cr./McCalla Cr.											X(10)
Wenatchee NF											
11 Tieton R.										X	
12 Rattlesnake Cr.	P			P						X	
13 Bumping-American R.				P						X	
14 Cle Elum R.										X	P(9)
15 Ingalis Cr.	X								P	X	
16 Mission Cr.	X								P		
17 Icicle Cr.									P	X	C1
18 Upper Wenatchee R.[3]	X			P						X	P(9)
19 Entiat R.	X			P						X	
Oregon											
Siskiyou NF											
02 Winchuck R. Chetco R.		P	X			X		X			
03 Emily Cr. Rogue R.		P	X								
06 Taylor Cr.			X								
07 Quosatana Cr.	X	P				X		X	P		
08 Shasta Costa Cr. Illinois R.	X	P	X			X		X	P		
05 Grayback Cr.		P	X			P			P		C1
05 Cave Cr.		P				P			P		C1
04 Upper Sucker Cr.		P									C1
01 Upper E. Fork Illinois R.		P	X			P			P		
09 Lawson Cr.		P				X		X	P		
10 Silver Cr.		P				X		X	P		
11 Indigo Cr.		P				X		X	P		
12 Elk R. Sixes R.		P	X			P		X	P		X(6)
13 Dry Cr.			X			P					
14 S. Fork Coquille R.	P	X	X	P		P		X	P		

Appendix D. (continued)

Forest/watershed[1]	Steelhead trout		Salmon					Sea-run cutthroat trout	Resident trout	Bull trout	Other
			Coho	Chinook							
	Sum	Win		Spr	Sum	Fal	Win				
Oregon (continued)											
Umpqua NF											
25 S. Umpqua R. N. Umpqua R.		P	X	X				X			X(7)
26 Calf Cr.	P	P	X	P				X	P		
27 Copeland Cr.	P	P	X	P				X	P		
31 Boulder Cr.	P	P	X	P				X	P		
30 Steamboat Cr.	P	P	X	P				X			
28 Deception Cr./ Wilson Cr.		P									C1
29 N, Umpqua R. Corridor[2]	P	P	X	P		P		X	P		
Rogue River NF											
Applegate R.											
15 Palmer Cr.	P	P	X								
16 Beaver Cr.	P	P	X								
17 Yale Cr.	P	P	X								
18 Little Applegate R.	P		X								
Siuslaw NF											
Lower Umpqua R.											
32 Franklin Cr. Smith R.		P	X					X			
33 Wassen Cr.		P	X					X	P		
34 N. Fork Smith R. Siuslaw R.		P	X			P		X			
35 Sweet Cr.		P	X			P		X			
36 Cummins Cr.		P	P					X			
36 Big Cr.		X	P					X			
36 Rock Cr.		P	P					X			
36 Ten Mile Cr.		X	P					X			
38 Drift Cr.-Alsea R.		P	P	X		P		X	P		
39 Drift Cr.-Siletz R.	X	P	X	X		P		X			
40 Three Rivers		P	P			P		X			
41 Powder Cr.		X	P					X			
41 Niagara Cr.		X	P					X			
42 Limestone Cr.		X	P					X			
42 Boulder Cr.		X	P					X			
42 Tony Cr.		X	P					X			
37 Yachats R.		X	X			X		X			X(6)
Winema NF											
19 Clover Cr.									P		
20 Rainbow Cr.									P		
22 Cherry Cr.										X	
23 Seven Mile Cr.										X	

Appendix D. (continued)

Forest/watershed[1]	Steelhead trout		Salmon					Sea-run cutthroat trout	Resident trout	Bull trout	Other
	Sum	Win	Coho	Chinook Spr	Sum	Fal	Win				
Oregon (continued)											
24 Evening Cr.										X	
21 Pelican Butte									P		C1
Deschutes NF											
53 Odell Cr.											
Upper Deschutes R.									P	X	
54 Lava Lake to Crane Prairie[2]								P	X		
55 Cultus Cr.									P		
58 Tumalo Cr.									P		
59 Squaw Cr.									P		
61 Metolius R.									P	X	
52 Marsh Cr.										X	
Deschutes R.											
56 Dilman Meadows to La Pine Rec. Area[2]									P		
57 Bonhan Falls Camp to Dillon Falls[2]									P		
60 Three Creeks Meadows & Creek[2]									P		
Willamette NF											
43 Fem Cr.-Shady Del											X(7)
44 N. Fork of Middle Fork of Willamette R.									P		
50 Upper N. Fork Santiam R.									P		C1
51 Upper Little N. Fork Santiam R.	P	P		P					P		C1
McKenzie R.											
45 S, Fork McKenzie R.	P			P					P	X	
46 Horse Creek											
47 Lost Cr./Scott Cr.									P	X	
48 Boulder Cr.									P	X	
49 Upper McKenzie R.[4]				P					P	X	
Mt. Hood NF											
63 Collawash R.			X	P							
62 Clackamas R.[2] Corridor	P	P	X	P							
65 Oak Grove Fork Corridor[2]	P	P	X	P							
64 Fish Cr.	P	P	X	P					P		
66 Roaring R.		P	X	P							
68 Salmon R.	P	P	X	P							
69 White R. 5									P		X(5)
70 Fifteen Mile Cr./ Ramsey Cr.	X										

Appendix D. (continued)

Forest/watershed[1]	Steelhead trout		Salmon								
			Coho	Chinook				Sea-run cutthroat trout	Resident trout	Bull trout	Other
	Sum	Win		Spr	Sum	Fal	Win				
Oregon (continued)											
72 W, Fork Hood R.	X		X					X			
67 Eagle Cr.		P	P	P					P		
71 Miller Cr./Five Mile Cr./Eight Mile Cr.		X							P		
California											
Mendicino NF											
01 Thatcher Cr.		P									C1
02 Black Butte R.		P				P	P				C1
03 Middle Fork Eel R.		X									
Shasta-Trinity NF											
04 McCloud R. Trinity R.										X	X(5)
05 S, Fork Trinity R.	X	P		X		P					
06 New River	X	P		X		P					C1
07 N. Fork Trinity R.	X	P		X		P					C1
08 Canyon Cr.	X	P		X		P					C1
Six Rivers NF											
Trinity R.											
10 Horse Linto Cr.	X	P	X			P					
11 "Fish Tang Cr.	X		X								
12 Mill Cr.	X		X								
09 Lower S. Fork Trinity R.	X	P		X		P					
Klamath R.											
13 Red Cap Cr.	X		X			P					
14 Boise Cr.	X		X								
15 Bluff Cr.	X		X			P					
16 Blue Cr.	X		X			P					
17 Smith R.		P	P			P		X	P		
Klamath NF											
18 Salmon R.	X	P		X		P					
19 Wooley Cr. Klamath R.	X			X		P					C1
20 Elk Cr.	X	P				P					
21 Dillon Cr.	X	P				P					
22 Clear Cr.	X	P		X		P					C1
23 Indian Cr.	X	P				P					
24 Beaver Cr.		P				P					

Appendix D. (continued)

Key to appendix abbreviations:

P	Present in streams of watershed
X	Identified as at risk or declining by the Endangered Fish Committee of the American Fisheries Society
C1	High-quality water source
C2	High-value fishery
Sum	Summer race
Win	Winter race
Spr	Spring race
Fal	Fall race
5	Redband trout
6	Chum salmon
7	Oregon chub
8	Pink salmon
9	Sockeye salmon
10	Olympic mud minnow

[1] Numbers reference the watersheds for each state on 112 inch to the mile base maps delivered to the Agriculture Committee.

[2] 1/4 mile no-harvest area on each side of stream.

[3] Includes Wenatchee R., White R., Napeequa R., and Chiwawa R.

[4] Includes Kink Cr., Sweetwater Cr., Anderson Cr., Olallie Cr., Deer Cr. to Fritz Cr. Confluence

[5] Includes Rock Cr., Badger Cr., Tygh Cr., and Jordan Cr.

Common Name	Scientific Name
Chinook salmon	Oncorhynchus tshawystcha
Coho salmon	O. kisutch
Steelhead trout	O. mykiss
Sea-run cutthroat trout	O. clarkii clarkii
Sockeye salmon	O. nerka
Chum salmon	O. keta
Pink salmon	O. gorbuscha
Redband trout	O. mykiss gibbsi
Bull trout	Salyenlinus confluentus
Oregon chub	Oregonichthys crameria
Olympic mudminnow	Novumbra hubbsi

APPENDIX E: Reasons for reducing the Region 6 harvest levels

We reduced the harvest levels in the final Forest Plans for the owl forests in Region 6 by 15 percent for the following reasons:

(1) We were asked by the Committees to report realistic, sustainable harvest levels for the alternatives we considered.

(2) The harvest levels in the Forest Plans represent =upper limits" derived from FORPLAN and other modeling done by the Region 6 National Forests which were anticipated to be further refined during implementation. The recognition of these levels as upper limits is reflected in some "Records of Decision" for the National Forest Plans, such as that for the Rogue River National Forest, which states (page 6): "-I-he average annual ASQ [allowable sale quantity]...of timber under this plan is the upper limit of chargeable wood to be sold from suitable timber land during the first decade of the planning period. It is not an actual proposal for timber sale offerings. The annual timber sale offerings...depend on budget appropriations, multiple-use objectives, and market conditions. "[1][Italics ours.]

(3) The analysis conducted with FORPLAN and related models was able to recognize only a portion of the standards and guidelines for implementing the Forest Plans: (1) the environmental protection requirements that must be met during timber sales, and (2) the provision of outputs other than timber such as big game and scenic quality (the "multiple-use objectives" named above). Forest planning with FORPLAN has been especially deficient" in representing the spatial requirements in these standards and guidelines, such as the dispersion of harvest units across the landscape to meet "adjacency requirements" and watershed objectives, the spatial distribution of cover and forage for big game, and the shaping and distribution of harvest units to meet scenic objectives. With the decade long restriction on harvest in roadless areas, the National Forests have concentrated their harvests outside these areas. Because many roadless areas have been withdrawn from timber production in the Forest Plans, the National Forests must return once again to parts of the Forests that previously have been heavily cut. The spatial feasibility and placement of sales thus become a central consideration, and FORPLAN's deficiency in dealing with such issues can lead to an overestimate of harvest capability. [2]

(4) The National Forests have been instructed by the Chief of the Forest Service that achieving the standards and guidelines must take precedence over achieving the ASQ: "There will continue to be professional challenges to produce timber and other outputs while meeting standards and guidelines. Monitoring and evaluation are essential activities to ensure both that the standards and guidelines have been properly set and that they are being met. There should be no doubt in anyone's mind about which takes precedence if there is a conflict between standards and guidelines and program outputs; we expect every project to be in full compliance with standards and guidelines set forth in Forest plans. "[3] In the Record of Decision for the Rogue River National Forest (page 6), as an example, the Regional Forester recognized this instruction when he said, 'I realize that ASQ volumes have a way of becoming a rigid target. My instructions to the Forest Supervisor are that Forest Standards and Guidelines are not to be violated or compromised to attain the ASQ volume. "[1]

(5) In addition to inconsistencies between the standards and guidelines and the ASQ, overestimates in the harvest level may be come from unrealistic estimates of the timber yield that will result from harvest. Numerous forests have begun to experience difficulty in achieving the volume/acre harvested or finding the acres of mature timber for harvest that were assumed in Forest Plan modeling.

(6) As the National Forests of Region 6 have begun to implement the Forest Plans, numerous experiences have led us and many FS specialists and planners to conclude that it will be difficult--and probably impossible--to achieve the ASQs in the Forest Plans on a sustainable basis while meeting all standards and guidelines, given the condition of these forests. As an example, the Fremont National Forest in late 1990 issued a press release giving 15 reasons why it would be difficult to achieve the ASQ. 4 Many of these reasons involved the inability to achieve simultaneously

the standards and guidelines of the Forest Plan and the ASQ of the Plan. These conclusions may partly come from inadequate representation of the standards and guidelines in forest planning and partly from a difference in interpretation of the standards and guidelines between those who constructed the Plans and those who implement them. Because of the complexity of the problem being addressed and the ever-changing mixture of legal restrictions on National Forest timber harvest, it is difficult to test whether the harvest levels in the Plans can be met given the standards and guidelines that must prevail. We believe that the sustainable ASQ for the National Forests in Region 6 may be 10-20 percent less than the levels stated in the Forest Plans. Thus, for our purposes here, we reduced the ASQs in the Forest Plans for the Region 6 owl forests by 15 percent.

[1]USDA Forest Service. 1990. Final environmental impact statement for the land and resource management plan, Rogue River National Forest.

[2]For more discussion on the inadequacy of FORPLAN in representing spatial relationships, see Johnson, K. N. 1990. Consideration of watersheds in long-term forest planning models: the case of FORPLAN and its use on the National Forests. Presented at the Symposium on New Perspectives on Watershed Management. Univ. of Washington, Seattle. (Available from the author at Department of Forest Resources, Peary Hail, Oregon State University, Corvallis, OR 97331. until the proceedings appear.)

[3]Robertson, F. D. February 23, 1989. Forest plan implementation. Letter to Regional Foresters. 2 p.

[4]Fremont National Forest. November 16, 1990. Fremont National Forest Plan monitoring. 2 p.

APPENDIX F: Memo to K. Norman Johnson from Brian J. Greber, Associate Professor, College of Forestry, Oregon State University, dated July 15, 1991, regarding economic impacts of harvest changes

My recent work has indicated that we can associate a one million board foot change in timber harvest in Oregon with the following economic impacts:

Timber Industry Jobs	5.1 - 5.9 Jobs/MMBF
Other Manufacturing Jobs	1.8 - 4.0 Jobs/MMBF
Non-Manufacturing Jobs	1.9 - 4.6 Jobs/MMBF
Total Jobs	10.7 - 13.6 Jobs/MMBF
Income (Thous. 1988 #'s)	340 - 640 Thous. $'s/MMBF

Some items to note in interpreting these numbers:

(1) (1)The harvest is expressed in terms of volumes as measured by the Scribner log rule---not by processed volumes.

(2) The timber industry jobs include logging, sawmilling, veneer and plywood, and remanufactured wood products; they do not include the forestry services sector (e.g., tree planters), the public agencies, proprietors, or truckers who are not directly employed by a timber industry firm. Thus these are conservative.

(3) The other jobs do not include proprietors, so they too are conservative. If I had to guess at the impact on proprietors, it would be to add as much as 10% to these employment impacts.

(4) The range on timber jobs is related to the severity of the harvest reduction--~mall changes = small impacts, large changes = large impacts. Note that these are marginal changes and hence jobs/MMBF do not equal the historic average employment divided by the historic average harvest.

(5) The range on other jobs is related to the health of the economy--a healthy economy = better employment opportunities --- lower impact multiplier,

(6) Total jobs does not equal the sum over the others in this table because the ends of the ranges did not necessarily correspond to the same simulation.

(7) Income impacts reflect (a) displaced worker income, (b) workers re-employed at lower wages, and (c) potential impacts of "cooling" the labor market through increased supplies of labor. This figure does not include proprietor or corporate income.

APPENDIX G: Characteristics of forests on the east side of the Cascade Range

Human Impacts on Stand Development

Two kinds of human activities have shaped east-side forests since the early 1890s: (1) fire suppression, and (2) partial cutting. Both have had profound impact on the LS/OG forests east of the Cascade Range.

Fire Suppression

East-side forests developed under a natural fire regime of both low-intensity underburns and intense crown fires which created a variety of stand structures and landscape patterns. This fire regime varied geographically with changes in vegetation and ecological processes. Relatively few east-side forest stands are (or ever were) over 400 years old (though some individual trees are older) because of the dry climate and attendant natural fire history. Only on relatively wet sites or in habitats with cold, snowy winters can stands over 400 years old be expected.

Frequent but relatively low-intensity fires kept stand structures open and favored fire-tolerant seral species such as ponderosa pine, western larch, westem white pine, and Douglas-fir. However, fire-control efforts since the early 1890s have significantly altered the natural fire regime. Consequently, the structure and composition in many east-side forests have changed dramatically over the past 80 years (fire control became more effective after 1945)--fire-adapted tree species have been replaced by those more competitive and shade tolerant but less fire tolerant. Thus, thickets of species such as white fir now predominate in the understories of many stands.

Partial Cutting

Many sites have been selectively logged (in many cases, "high graded") several times, especially at lower elevation, as the result of relatively accessible terrain and mixed-species stands. Much of that logging involved the selective removal of the highest valued trees, such as ponderosa pine.

Selective harvest of this large, high-value, fire-tolerant species has accelerated the change in forest structure from relatively open single- or two-storied stands of fire-tolerant species to denser multilayered stands mainly of shade-tolerant species. Recent harvest has continued this focus on the higher valued overstory, often removing it in its entirety. Thus, the lower valued, shade-tolerant white fir now makes up much of the residual stand across large areas.

These shade-tolerant species often have thin bark that makes them susceptible to injury during partial cutting. Such injuries serve as natural avenues for a variety of stem and root diseases that have left many residual stands badly crippled and in a state of decline.

Current Conditions and Future Prospects

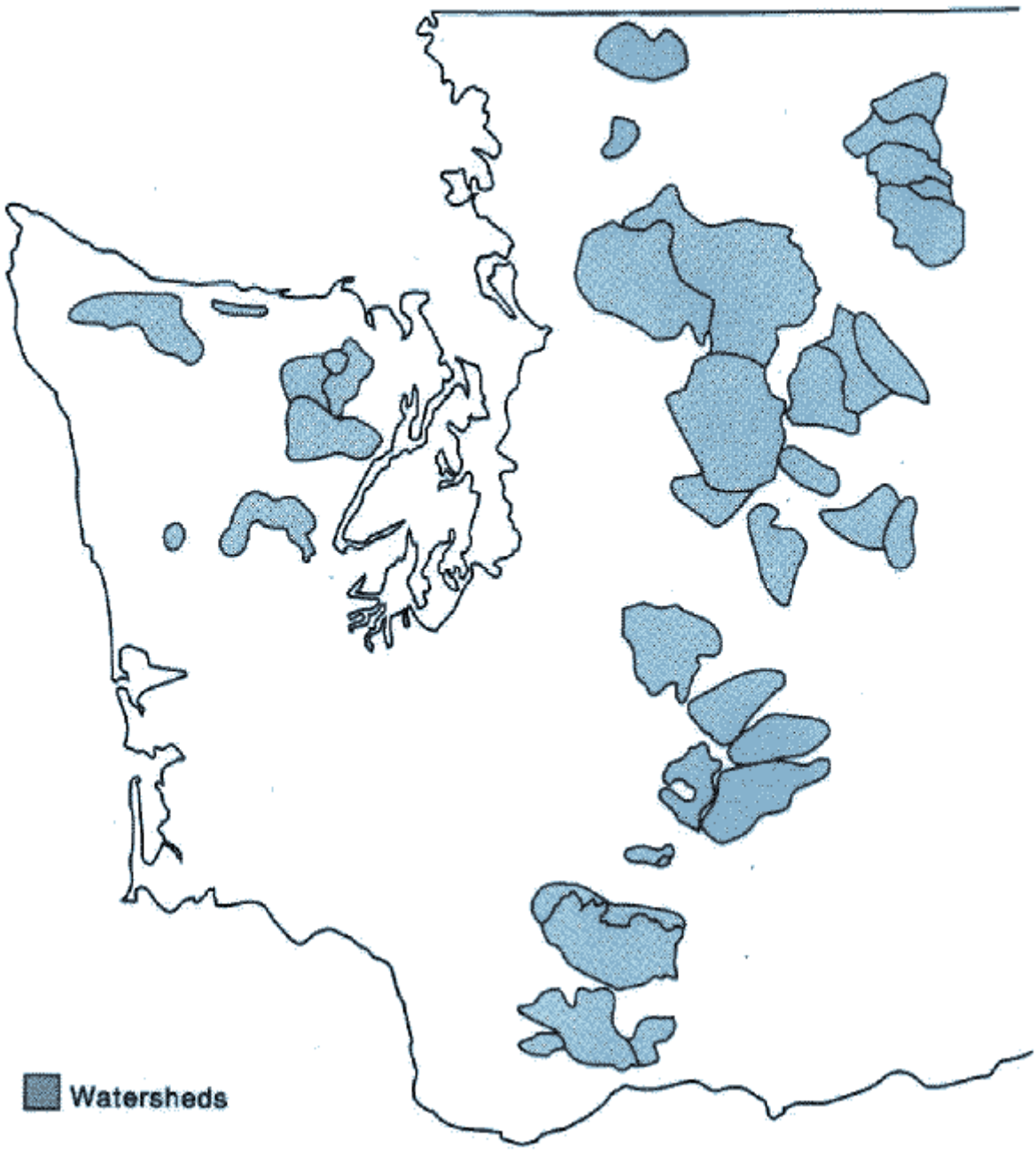
(1) Dense, multilayered stands of shade-tolerant species are much more prone to damage from defoliating-insect outbreaks and various root and stem diseases. Indeed, these forests are now undergoing repeated, ongoing outbreaks of defoliating insects and bark beetles. As a result, the existing forest has been described as "unraveling" over millions of acres. High fuel accumulations resulting from well-intentioned fire control over 50 or so years ensure more intense and destructive fires than would occur naturally. Extensive fires have erupted over the past several years, and very hot fires covering extensive areas are anticipated over the next several years. Because of these changes, activities such as prescribed burning and thinning may be necessary in attempts to restore the natural fire-dependent plant communities and maintain or develop LS/OG characteristics (including biological and structural diversity). Such an effort could involve up to 250,000 acres a year.

(2) Steep environmental gradients result in great diversity of plant communities and more rapid geographic changes in vegetation. Moreover, climate, soils, amounts and seasonal distribution of precipitation, and soil development are highly diverse. Thus, sites and vegetation are frequently more variable per landscape unit on east- than west-side forests.

(3) Ecosystems on the east side are less productive and more fragile (less resilient and resistant to disturbance) than those on the west side of the Cascades because of climate and greater environmental stress. Thus, management activities suitable for west-side forests often do not yield satisfactory results when applied to east-side forests.

(4) Plant communities on the east side have a finer textured mosaic across the landscape than those on the west side of the Cascades because of the more demanding environment. Hence, very different types of vegetation lie in close juxtaposition, each with different ecological requirements.
(5) East-side forests and meadows have a long history of livestock grazing, including significant amounts of abusive grazing in the past that were especially destructive to riparian areas. Riparian areas often remain badly degraded as a result of continued livestock grazing and increased big-game populations. Because species composition of the forest shrub and herb layers before European settlement is often difficult to determine, especially for areas near streams and meadows, restoration of the land to "natural conditions" is problematical.

Washington



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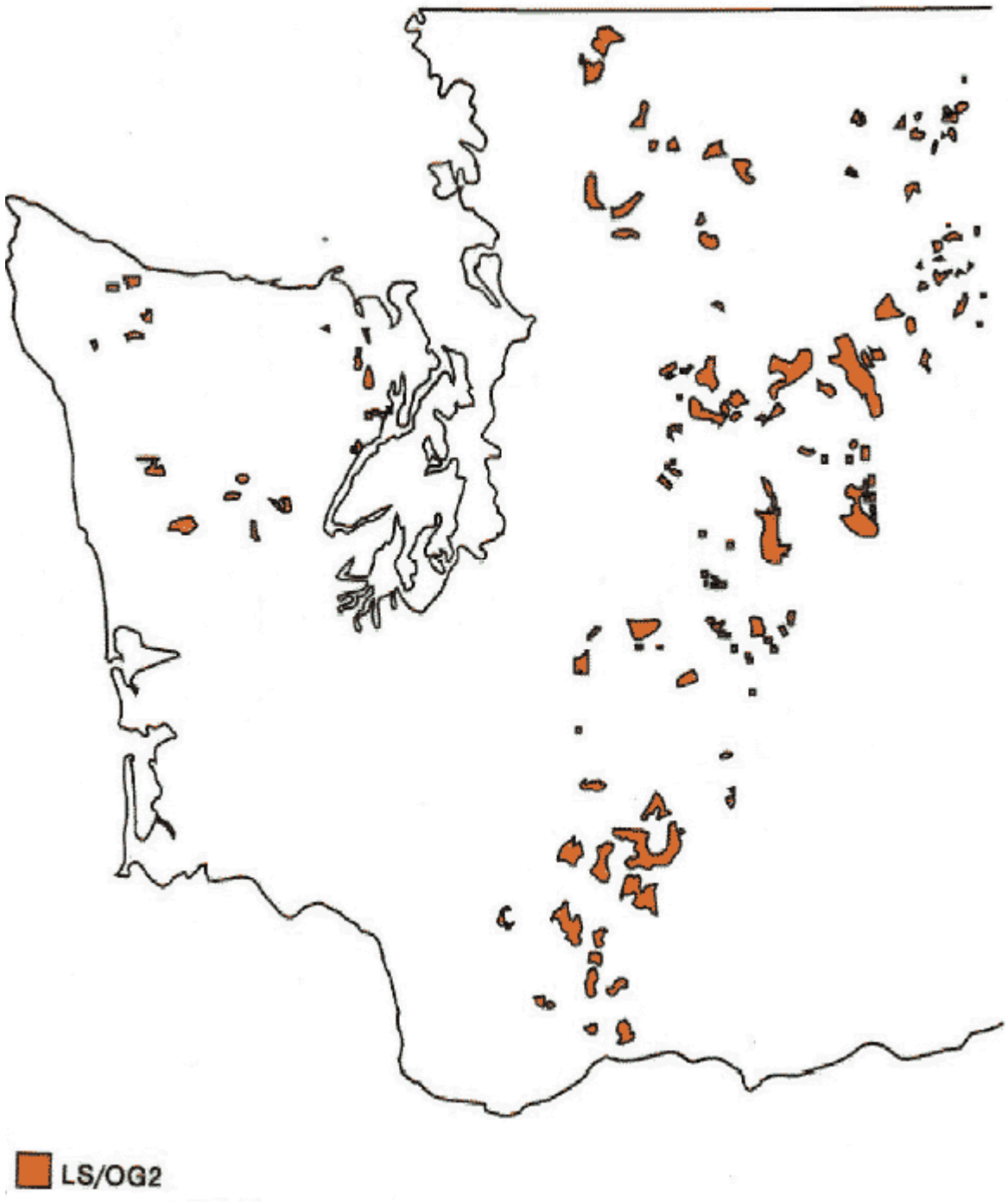

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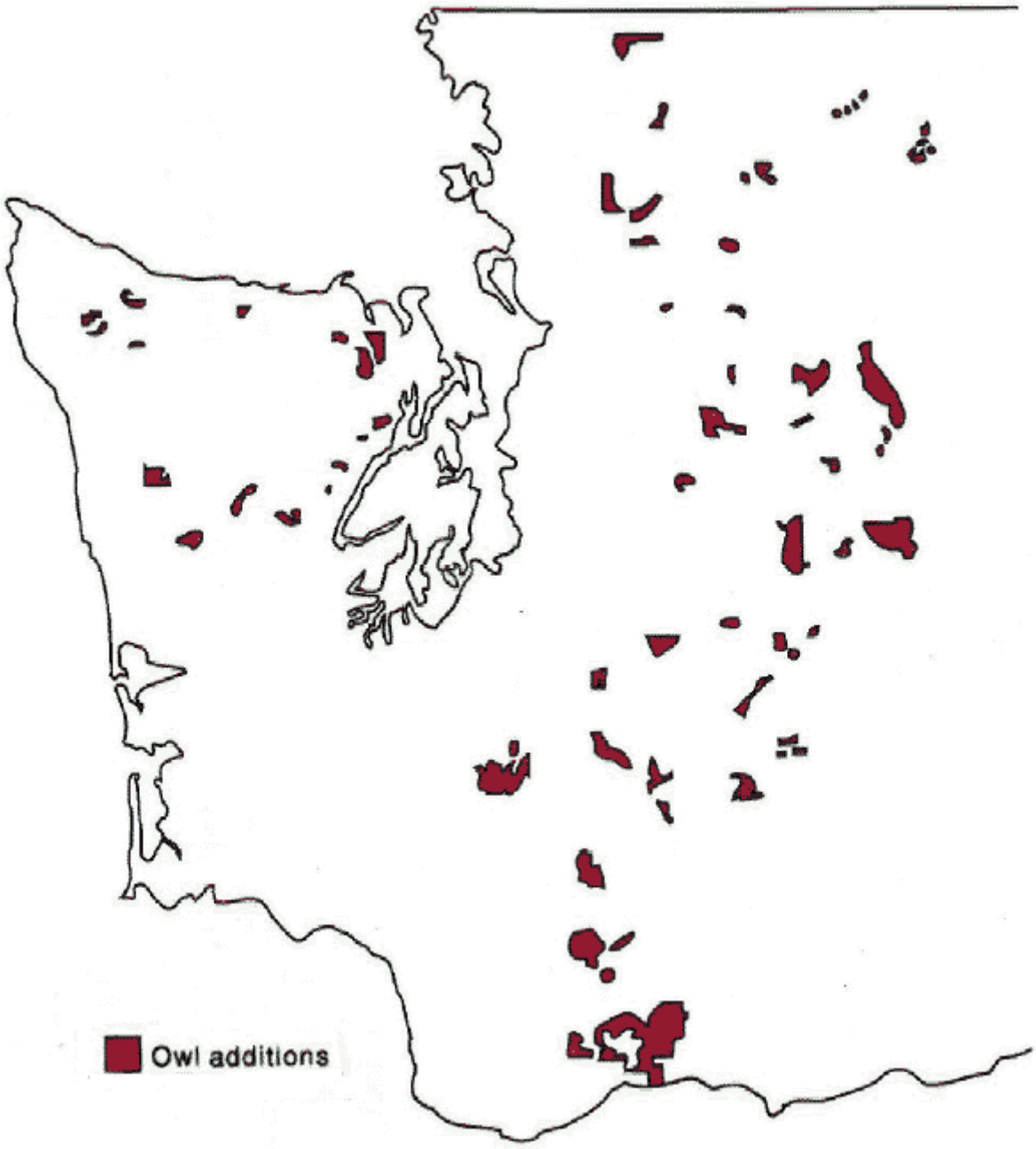

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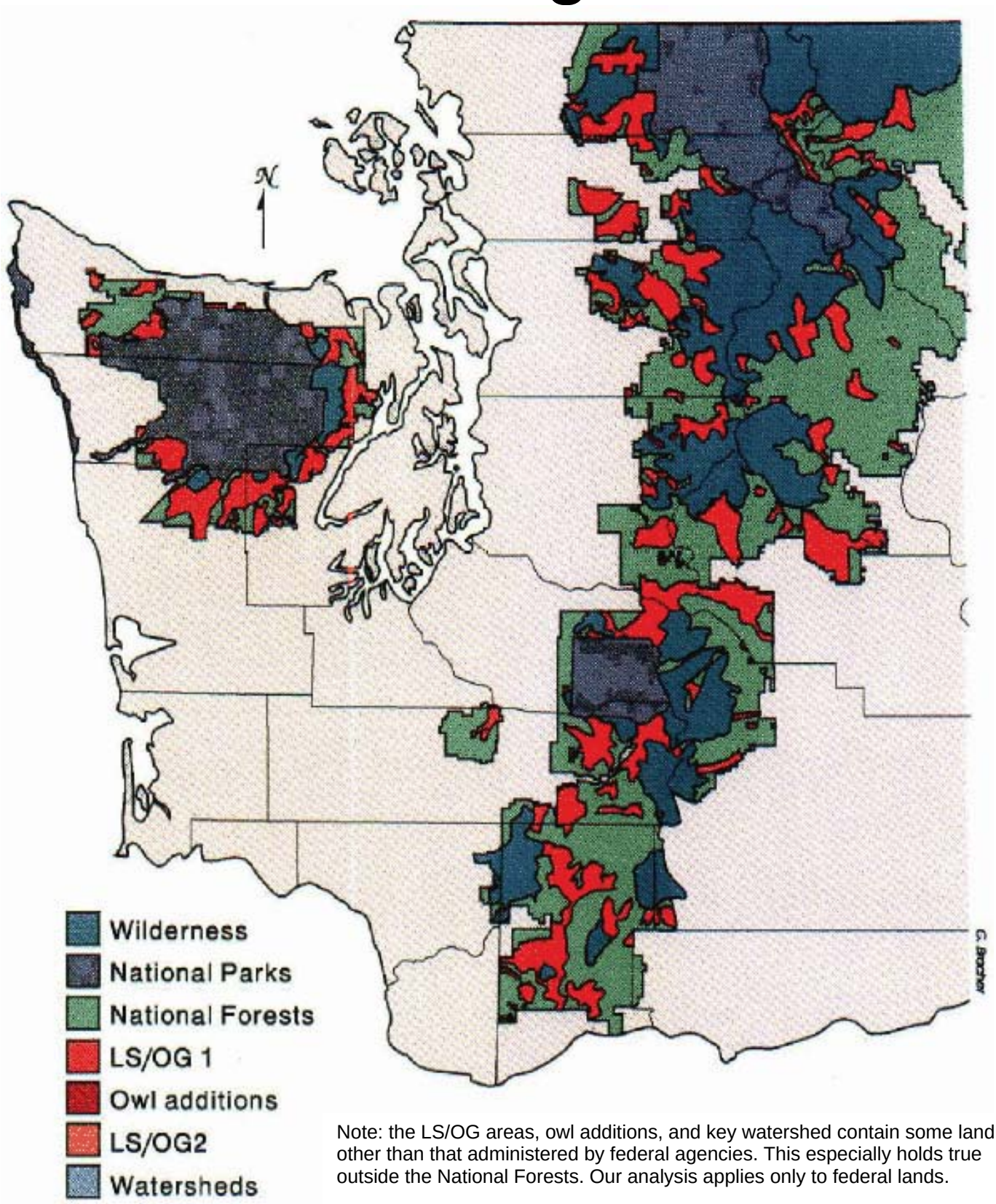
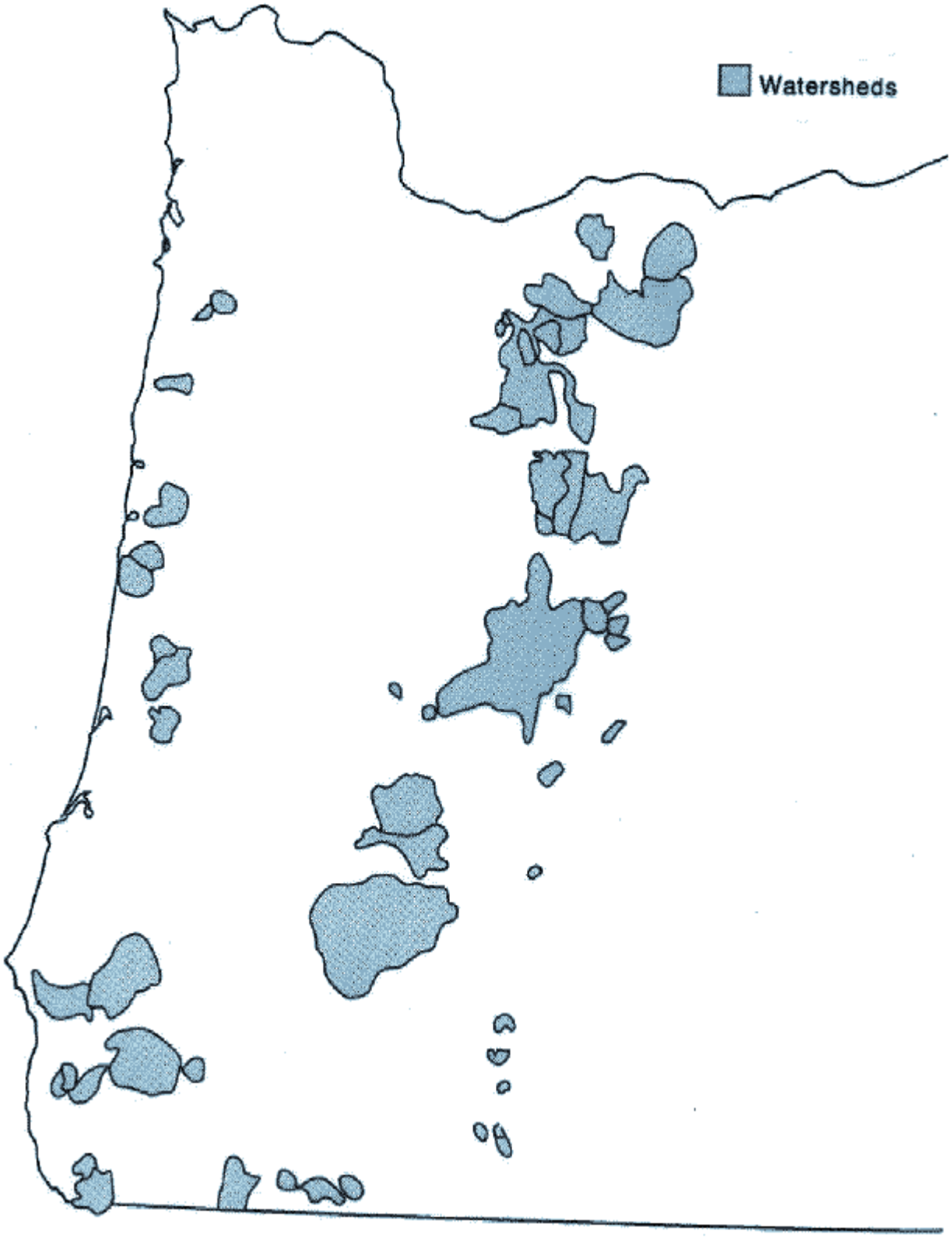


Note: the LS/OG areas, owl additions, and key watershed contain some land other than that administered by federal agencies. This especially holds true outside the National Forests. Our analysis applies only to federal lands.

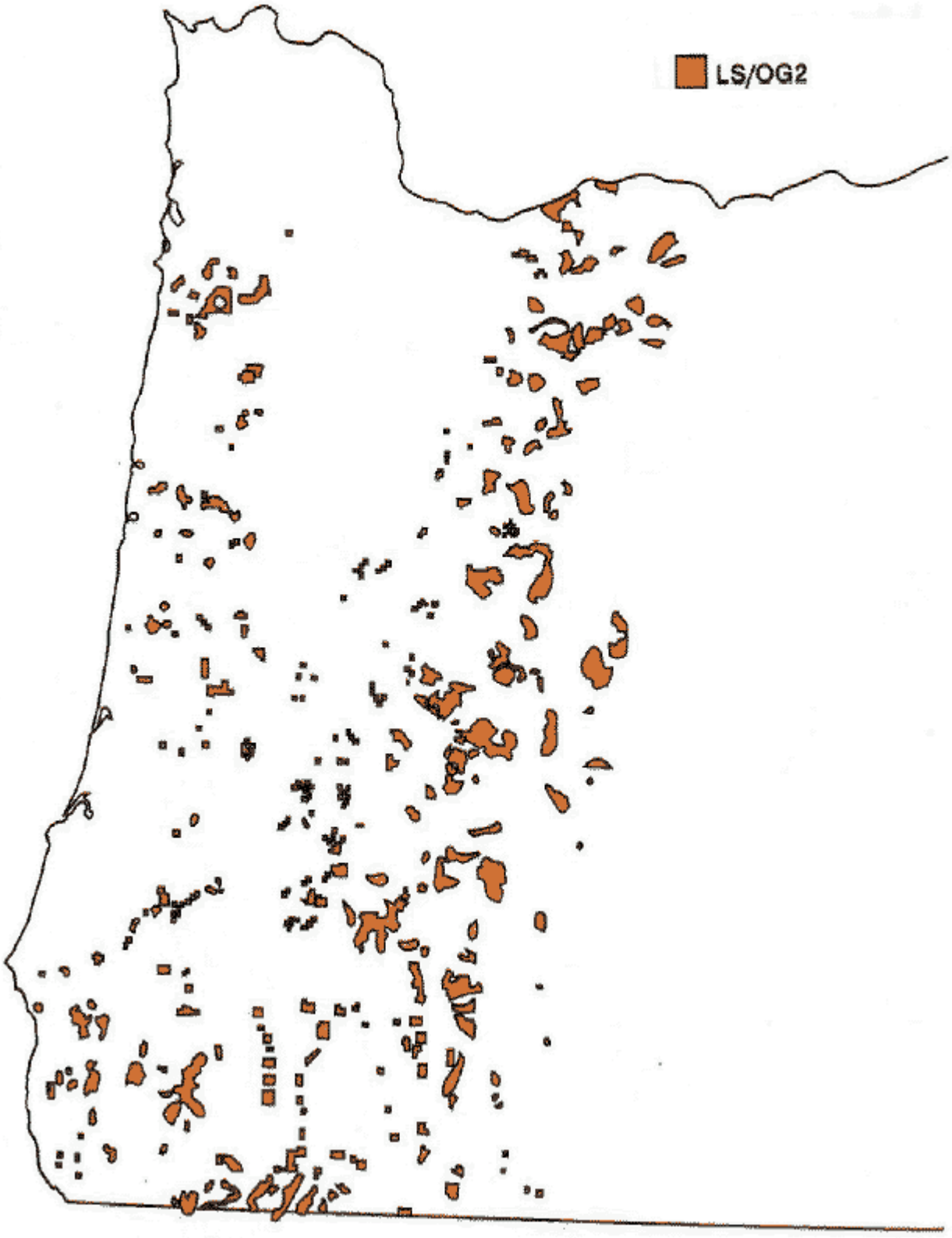
October 8, 1991

Oregon



Oregon

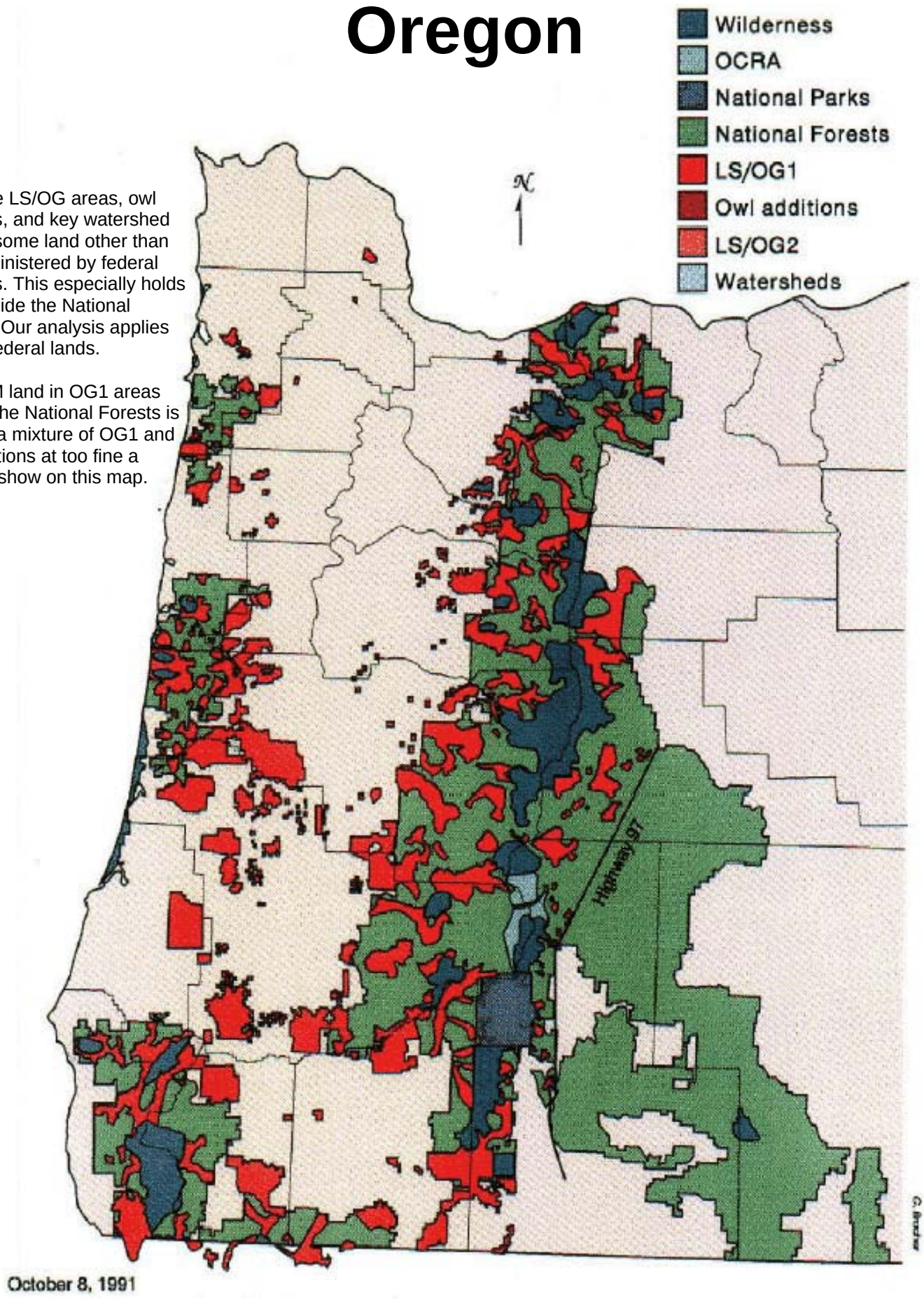
Oregon



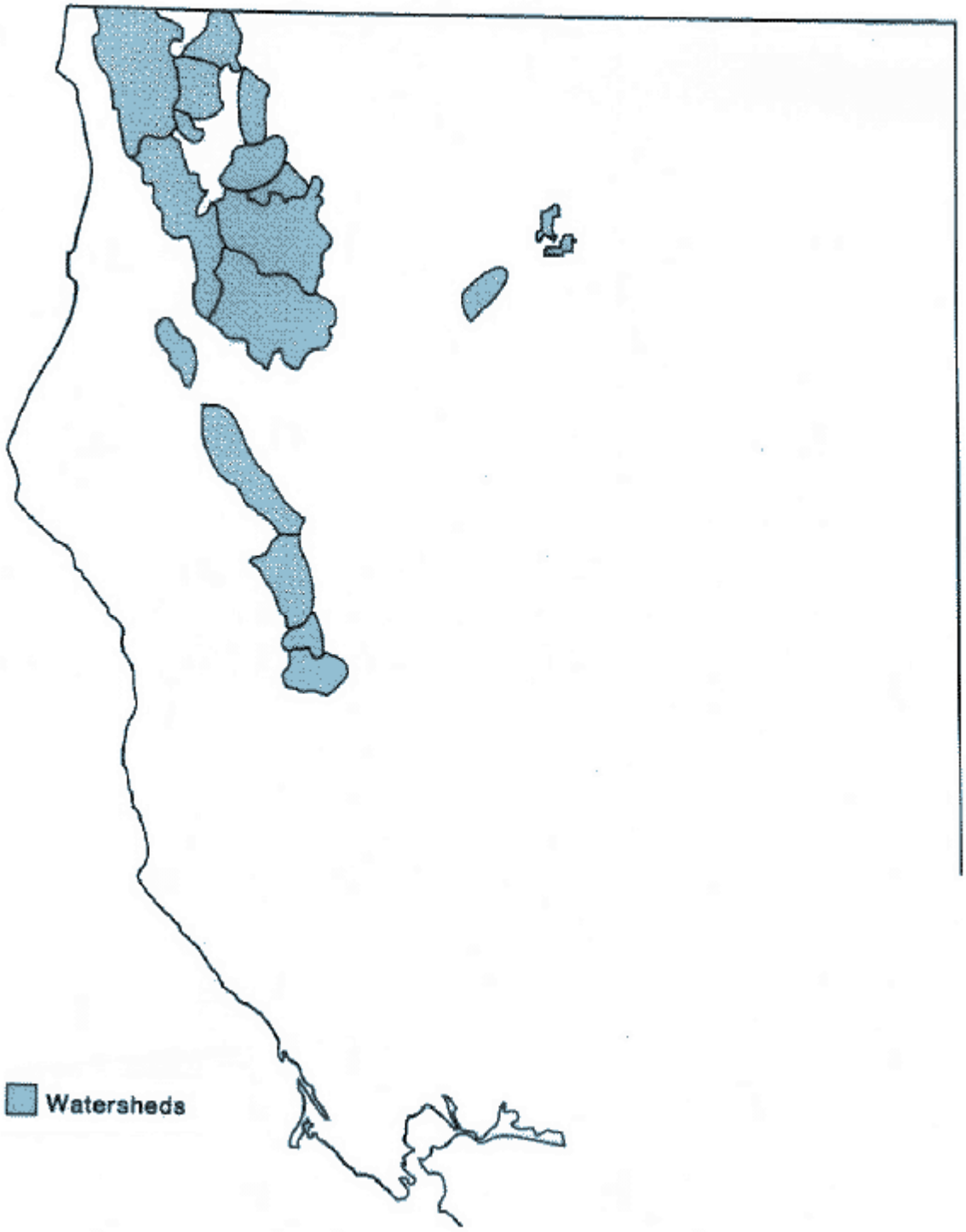
Oregon

Note: the LS/OG areas, owl additions, and key watershed contain some land other than that administered by federal agencies. This especially holds true outside the National Forests. Our analysis applies only to federal lands.

The BLM land in OG1 areas outside the National Forests is actually a mixture of OG1 and owl additions at too fine a scale to show on this map.



California



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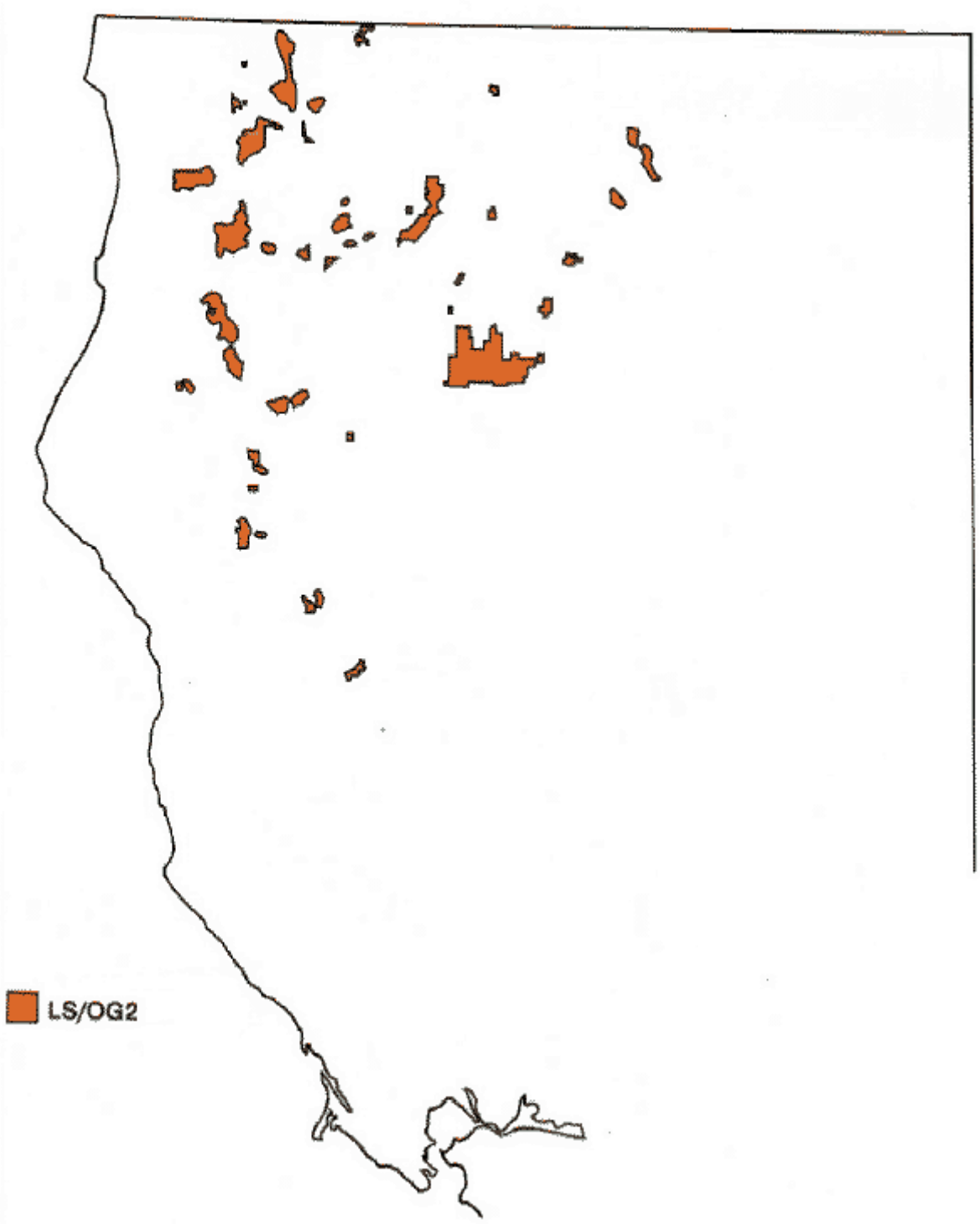

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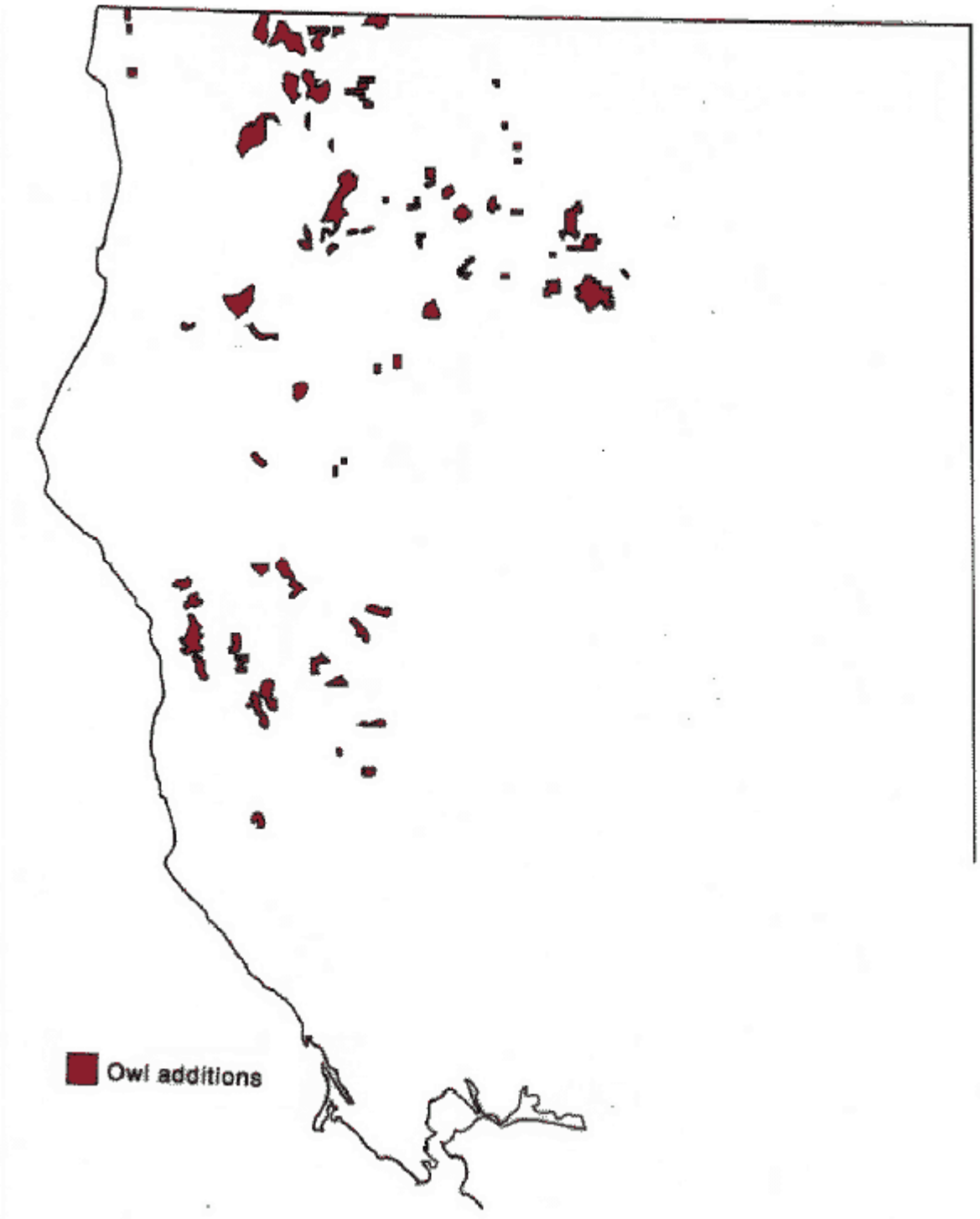
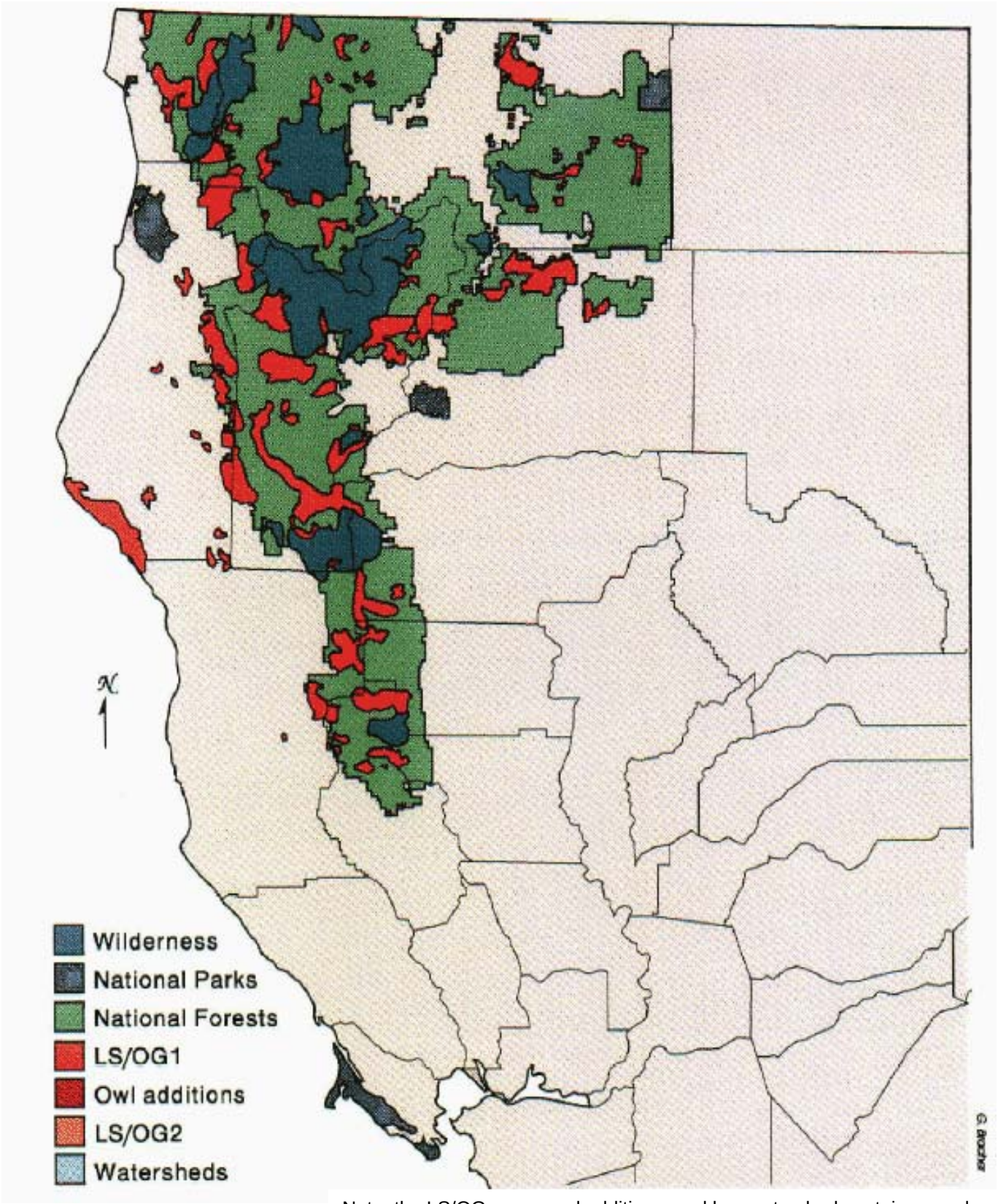


California



October 8, 1991

Note: the LS/OG areas, owl additions, and key watershed contain some land other than that administered by federal agencies. This especially holds true outside the National Forests. Our analysis applies only to federal lands.

The BLM land in OG1 areas outside the National Forests is actually a mixture of OG1 and owl additions at too fine a scale to show on this map.