Northwest Forest Plan –
The First 15 Years (1994 – 2008):
Summary of Key Findings

Technical Editors:
Ray Davis, USDA Forest Service, Pacific Northwest Region
Gary Falxa, USDI Fish and Wildlife Service, Region 8
Elisabeth Grinspoon, USDA Forest Service, Pacific Northwest Region
Gary Harris, USDA Forest Service, Pacific Northwest Region
Steve Lanigan, USDA Forest Service, Pacific Northwest Region
Melinda Moeur, USDA Forest Service, Pacific Northwest Region
Shawne Mohoric, USDA Forest Service, Pacific Northwest Region
Craig Palmer, University of Nevada, Las Vegas

Abstract

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In 1994, the Northwest Forest Plan (NWFP) Record of Decision (ROD) amended 19 national forest and 7 Bureau of Land Management (BLM) resource plans within the range of the northern spotted owl (*Strix occidentalis caurina*). An interagency effectiveness monitoring framework was implemented to meet requirements for tracking status and trend for watershed condition, late and old forests, social and economic conditions, tribal relationships, and population and habitat for marbled murrelets (*Brachyramphus marmoratus*) and northern spotted owls. Monitoring results are evaluated and reported in one- and five-year intervals. This report includes results through year 15 with a focus on the last five years. Monitoring results for the first 10 years are documented in a series of General Technical Reports posted at http://www.reo.gov/monitoring/reports/10yr-report/index.shtml.

Contents

Overview
Late-Successional and Old-Growth Forests
Northern Spotted Owl Populations and Habitats
Populations and Nesting Habitat for the Marbled Murrelet
Watershed Condition
Social and Economic Well-Being
Effectiveness of the Federal-Tribal Relationship

Northwest Forest Plan- The First 15 Years [1994-2008]: Summary of Key Monitoring Findings

Overview

In 1994, the Northwest Forest Plan (NWFP) Record of Decision (ROD) amended 19 national forest and 7 Bureau of Land Management (BLM) resource plans within the range of the northern spotted owl (*Strix occidentalis caurina*). An interagency effectiveness monitoring framework was implemented to meet requirements for tracking status and trend for watershed condition, late successional and old-growth forests, social and economic conditions, tribal relationships, and population and habitat for marbled murrelets (*Brachyramphus marmoratus*) and northern spotted owls. Monitoring results are evaluated and reported in 1- and 5-year intervals.

In the 1980s, controversy intensified over timber harvest in old-growth forests, declining species populations (northern spotted owls, marbled murrelets, Pacific salmon), and the role of federal forests in regional and local economies. The northern spotted owl was listed as a threatened species in 1990, and was followed shortly thereafter by lawsuits over federal timber sales and injunctions on timber harvests within the range of the owl. This turmoil over forest management in the region led to a presidential conference in Portland, Oregon to address the human and environmental needs served by federal forests of the Pacific Northwest and northern California. On July 1, 1993, President Clinton announced his proposed “Forest Plan for a Sustainable Economy and a Sustainable Environment” (Northwest Forest Plan). Over the next year, environmental analysis was completed and a ROD was signed in 1994, legally adopting new management direction. The ROD amended existing management plans for 19 national forests and 7 BLM districts in California, Oregon, and Washington (24 million acres of federal land within the 57-million-acre range of the northern spotted owl). Although this report uses the term “Northwest Forest Plan” out of convenience, it is important to note that we are actually reporting on the monitoring of 26 separate plans.

The NWFP ROD with its published standards and guidelines established the following purposes:

- Take an ecosystem management, scientifically supported approach to forest management.
- Meet the requirements of existing laws and regulations.
- Maintain a healthy forest ecosystem with habitat that will support populations of native species (particularly those associated with late-successional and old-growth forests), including protection for riparian areas and waters.
- Maintain a sustainable supply of timber and other forest products that will help maintain the stability of local and regional economies on a predictable and long-term basis.

To help meet these intentions, the plan direction allocated a network of connected reserves to conserve the species of concern within the existing pattern of land ownership and location of remaining old-growth forests. The reserve network was embedded in a matrix of “working” forests, and was designed to maintain late-successional (mature or old-growth) forests in a well-distributed pattern across federal lands, protect stream habitats, and connect old-growth forests with corridors with old-forest elements while providing a sustainable level of timber harvest (see sidebar for details of land designations).
The planning direction also called for a comprehensive monitoring program to evaluate progress toward meeting desired outcomes. In 1995, a scientifically-based interagency monitoring program was developed.

Currently composed of six modules, monitoring is designed to answer these key questions:

- **Late-successional and old-growth** monitoring characterizes the status and trend of older forests to answer the question: Is the NWFP maintaining or restoring late-successional and old-growth forest ecosystems to desired conditions on federal lands in the plan area?
- **Northern spotted owl** monitoring assesses status and trends in northern spotted owl populations and habitat to answer the questions: Will implementing the NWFP reverse the downward trend in spotted owl populations? Is the NWFP maintaining or restoring owl habitat necessary to support viable owl populations?
- **Marbled murrelet** monitoring assesses status and trends in marbled murrelet populations and nesting habitat to answer the questions: Are the marbled murrelet populations associated with the NWFP area stable, increasing, or decreasing? Is the NWFP maintaining and restoring marbled murrelet nesting habitat?
- **Aquatic and riparian** monitoring characterizes the ecological condition of watersheds and aquatic ecosystems to answer the question: Is the NWFP maintaining or restoring aquatic and riparian ecosystems to desired conditions on federal lands in the plan area?
- **Socioeconomic** monitoring characterizes the social and economic impacts of federal forest management on forest-associated communities to answer the question: What is the status and trend of socioeconomic well-being?
- **Tribal** monitoring addresses conditions, trends, and access to resources protected by treaty or of interest to American Indian tribes, the condition of and access to religious and cultural heritage sites, and the quality of the government-to-government relationship to answer the questions: How well and to what degree is government-to-government consultation being conducted under the NWFP? Have the goals and objectives of the consultation been achieved? Is the consultation occurring because of effects on resources of tribal interest on federal lands?

Implementation monitoring has also been used to determine if the objectives, standards, guidelines and management practices specified in the NWFP are being implemented. In other words, "Did we do what we said we were going to do?" Owing to the high levels of compliance, regional implementation monitoring was discontinued in 2006. However, local land management units continue to conduct and report on implementation monitoring as specified in their land and resource management plans.

Between 2005 and 2008, a series of GTRs was published through Pacific Northwest Research Station documenting results from the first decade of monitoring http://www.reo.gov/monitoring/reports/10yr-report/index.shtml. In 2005, interagency federal executives convened a regional conference to examine new science and monitoring results to determine if changes in management direction or monitoring were needed. Over the years, monitoring protocols and methods have been periodically examined and refined based on new science, technology, and lessons learned.

This report includes key summary results for each monitoring module with a focus on the last 5 years. Each chapter includes methods, key findings and a set of recommendations for monitoring into the future. The recommendations are those of the authors and do not necessarily reflect the views of the federal agencies. More detailed reports for each monitoring module are also being published.

Much has changed since land and resource management plans were amended by the NWFP ROD. A wealth of new science informs ecosystem management. Emerging large-scale issues such as climate change has the potential to affect how federal forests are managed in the future. Monitoring will continue to be an essential tool for implementing adaptive management on federal forests in the Pacific Northwest and charting a course for the future.

<u>Land Use Designations</u> (adapted in the 1994 Northwest Forest Plan)

- **Congressionally reserved areas**. Includes national parks and monuments, wilderness, wild and scenic rivers, national wildlife refuges, Department of Defense lands, and other Congressional designations.
- **Late-successional reserves** (LSRs). Management actions are allowed to benefit late-successional forest characteristics or reduce the risk of catastrophic loss.
- **Managed late-successional areas**. Management actions are allowed to help prevent catastrophic loss to fire, insects, etc. around known spotted owl activity centers in the Washington Eastern Cascades and the California Cascades Provinces.
- **Riparian reserves**. Areas along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas managed for aquatic and riparian values.
- **Matrix**. All remaining lands outside reserves and withdrawn areas. Available for regularly scheduled timber harvests.
- **Adaptive management areas**. Areas designated as places to test new ideas and management approaches. Portions of AMAs are available for regularly scheduled timber harvest.
- **Administratively withdrawn areas**. Lands excluded from scheduled timber harvest (e.g., recreation sites; areas that are visually sensitive, unstable, or have special habitat or sensitive species; or areas where reforestation cannot be ensured.)
- **Key watersheds**. System of watersheds to be managed to provide high-quality habitat for at-risk salmon and steelhead (*Oncorhynchus mykiss*), bull trout (*Salvelinus confluentus*), and resident fish species and important sources of high-quality water.

Chapter 1: Status and Trend of Late-Successional and Old-Growth Forests

Melinda Moeur, Janet L. Ohmann, Robert E. Kennedy, Warren B. Cohen, Matthew J. Gregory, Zhiqiang Yang, Heather M. Roberts, Thomas A. Spies, and Maria Fiorella

Introduction

The goal of the late-successional and old-growth (LSOG) monitoring plan is to evaluate the success of the Northwest Forest Plan (NWFP) in reaching the desired amount and distribution of LSOG on Federal lands (Hemstrom et al. 1998). Objectives include tracking the status and trends of LSOG to answer questions such as: How much older forest is there? Where is it? How much has it changed and from what causes? Is implementation of the Northwest Forest Plan (NWFP) maintaining or restoring older forest ecosystems to desired conditions on federal lands?

The current LSOG monitoring model relies primarily on vegetation structure and composition at both landscape- and stand-scales. It also includes monitoring of processes that cause ecological changes that lead to the loss, development, or maintenance of late-successional and old-growth ecosystems at both spatial and temporal scales. This monitoring model applies most clearly to forest vegetation (Hemstrom et al. 1998). LSOG as defined in this report (see sidebar) does not necessarily equate to habitat for all late-successional species. However, the ecological functionality of LSOG for individual species is also being monitored using much of the same data, especially for northern spotted owl (*Strix occidentalis caurina*) and marbled murrelet (*Brachyramphus marmoratus*), as the following chapters will show.

This summary report briefly describes methods, key findings, new information, and recommendations from the 15-year technical report (Moeur et al. 2011), which contains a more detailed accounting of the monitoring results from the second monitoring cycle. The results from the first monitoring cycle can be found in Moeur et al. (2005).

Methods

We assessed amounts, distributions, and trends of LSOG (fig. 1-1) based on multiple data sources, and using complementary map-based and sample-based analyses. Map-based analyses provide broad-scale information on landscape patterns developed from statistical models, while field-plot-based vegetation inventories provide detailed information on forest characteristics from a probability sample.

Forest Vegetation "Bookend" Maps

A gradient nearest neighbor (GNN) imputation method (Ohmann and Gregory 2002) was used to map detailed attributes of forest composition and structure for all forest land in the NWFP area. These types of maps have been developed in the Pacific Northwest specifically for landscape analysis, land management planning, and broad-scale vegetation mapping across a wide range of forest ecosystems for multiple objectives (Moeur et al. 2009; Ohmann et al. 2007, 2011; Pierce et al. 2009; Spies et al. 2007). In GNN, forest attributes from regional inventory plots are assigned to map pixels where data are missing, on the basis of a modeled relationship between the detailed forest attributes from plots and a combination of spatial predictor variables derived from Landsat satellite imagery, climate variables, topographic variables, and soil parent materials (fig. 1-2).

The vegetation mapping from the NWFP monitoring marks the first application of GNN to two different satellite imagery dates. We called these two map periods "bookends". The GNN "bookend" maps cover the period from 1994 to 2007 in California, and 1996 to 2006 in Washington and Oregon and were used to portray LSOG conditions at the beginning and ending of the monitoring period covered by this report. The primary challenge was to develop multi-date GNN models (and maps) that reflected real forest changes between dates, by minimizing apparent changes caused by various sources of error. To accomplish this, the GNN models used Landsat imagery that had been geometrically rectified and radiometrically normalized through time (i.e. temporally smoothed) using image processing algorithms discussed in the following section.

Maps of forest disturbance

We derived yearly maps of forest disturbance using a new approach to analyze annual Landsat satellite imagery called LandTrendr (Landsat-based detection of Trends in disturbance and recovery). LandTrendr uses data-intensive algorithms to assemble and process imagery (Kennedy et al. 2007, 2010). An annual time series of Landsat imagery were assembled for the NWFP area, geometrically rectified, atmospherically corrected, and radiometrically normalized to reduce much of the year-to-year variability in spectral signal caused by differing atmospheric conditions, sun angles, and phenology. After image preparation, the time series of the normalized burn ratio (NBR) (van Wagtendonk et al. 2004) for each 30-m pixel was extracted, and temporal segmentation algorithms were used to identify periods of both stability and change in each pixel's NBR trajectory (fig. 1-3).

Disturbance maps were then created by evaluating each pixel's NBR segmentation results. Disturbance segments were identified as those experiencing declines in NBR over time, and pre- and post-disturbance percentage of vegetation cover were predicted using a statistical model of cover developed from photointerpreted plots (Cohen et al. 2010). Each pixel in a disturbance patch (at least 2.5 ac or 11 adjacent pixels) was labeled with the magnitude of change (percent) and duration of the disturbance (years). We then used rules related to the duration of the disturbance and alignment with spatial fire databases to assign causes of insect/diseases and wildfire, and then considered the remaining change patches to be from harvest. The latter class is dominated by harvest, but also can contain rare cases of avalanche, landslide, riparian disturbance, and windthrow. Thus, results reported under the "harvest" category must be interpreted with caution.

Inventory Plot Analysis

Plot data used in this report came from five inventory programs: Current Vegetation Survey (CVS) (Max et al. 1996; USDA Forest Service 2001) on National Forest lands in Washington and Oregon, administered by the Forest Service (FS) in Region 6 (CVS-R6); CVS on Bureau of Land Management (BLM) lands in Oregon, administered by Oregon BLM (CVS-BLM); Forest Inventory and Analysis (FIA) periodic inventories on National Forest lands in California, administered by the FS in Region 5 (FIA-R5-periodic) (USDA Forest Service 2000); FIA periodic inventories on nonfederal lands throughout the NWFP area administered by the FS Pacific Northwest Research Station (FIA-PNW-periodic); and the FIA Annual inventory of all land ownerships throughout the NWFP area, administered by PNW (FIA-PNW-annual). See Moeur et al. (2005) for more information about the inventory programs.

We analyzed plot information from successive CVS-R6 and CVS-BLM inventories, and FIA-R5-periodic and FIA-PNW-annual inventories in California, as an independent estimate of trends in LSOG area on National Forest and Oregon BLM lands. We also acquired sample-based estimates of LSOG area for all ownerships from FIA-PNW-Annual plots measured from 2001 to 2008. The FIA-PNW-Annual plots provide a consistent sample of forest condition over all ownerships and land use allocations, but have not yet been remeasured. Only those plots classified as forest-capable were included in the analyses.

Key Findings

Approximately 7.3 million ac, or 33.2 percent of the federal forest-capable area, were classified as LSOG at the baseline. Most of it occurred in Oregon, followed by Washington, and then California. As a percentage of the forest landscape, the eastern provinces (Washington Eastern Cascades, California

Cascades, and Oregon Eastern Cascades) had the least LSOG (<20 percent), the Olympic Peninsula had the most (> 50 percent), and the other provinces ranged from about 25 percent (California Coast Range) to >40 percent (Oregon Western Cascades). The bookend map analysis suggested a slight net loss (-1.9 percent NWFP-wide) to 32.6 percent (7.1 million ac) in 2006/2007 (fig. 1-4).

Trends varied by physiographic province, but in all cases the net changes were small relative to the sources of error and uncertainty. Nevertheless, losses from the bookend maps that coincided with disturbances mapped by LandTrendr amounted to about 217,100 ac, or 3 percent of the baseline federal LSOG. Most of the losses (183,800 ac) were associated with wildfire, including several very large wildfire events (i.e. 2002 Biscuit fire). Approximately 32,100 ac (<0.5 percent) were associated with harvest and about 1,200 ac with insects and disease disturbance. Both LSOG area and losses were proportionately higher in reserved land use allocations than in nonreserved lands, and although reserved lands make up about two-thirds of the federal area, about three-fourths of the total LSOG occurred in reserves, with almost 90 percent of those losses associated with wildfire (fig. 1-5).

Estimates of LSOG area from successive plot inventories showed a very slight increase in percentage (0.1 percent) in Washington, a slight decrease (-1.9 percent) in Oregon, and an overall decrease of 1.2 percent, but the differences were not statistically significant (90 percent confidence level). GNN map estimates were within the plot sampling error for all states.

Over all ownerships, the GNN model-based estimate of current (2006/2007) LSOG area was within the standard error of the FIA Annual sample-based estimates for 2001-2008. However, the GNN estimate was less than FIA for federal lands (fig. 1-6) and greater than FIA for nonfederal lands. At the province level, the GNN estimates of LSOG area on federal lands in 2006/2007 were within the FIA standard error for all but the Washington Western Cascades and Washington Eastern Cascades. At the state level for all ownerships, the GNN estimate was within the FIA standard error for California but not for the other two states (fig. 1-6).

Much of the LSOG loss mapped by the GNN bookends could be verified by the LandTrendr disturbance maps. Whereas, LSOG recruitment is much more difficult to map with the current remote sensing technology, and no independent data were available for map validation. Accordingly, LSOG losses from disturbance were mapped with greater certainty than were the LSOG gains. And while some of the losses apparently were offset by recruitment, we could not say if it was caused by incremental stand growth into the lower end of the LSOG diameter class (i.e. from 19 inches to 20 inches average diameter at breast height), or from disturbances (i.e. thinning or fire) that eliminated smaller-diameter trees thus increasing the average stand diameter without actually increasing the number of large trees in the stand, or whether it was from changes in canopy shadowing. Given the shortness of the monitoring period (10 to 14 years), we would not expect much, if any, increase in the amount of multi-storied stands with many very large trees (i.e. >40 inches). Different LSOG definitions could reveal different trends and we expect the use of a more restrictive definition (i.e., larger average tree size and/or denser canopy) likely would have increased the estimate of LSOG loss and decreased the estimate of LSOG gain. This being said, we summarized the area of federal forests in regeneration (0 to 9.9 in), young (10 to 19.9-in), and late-successional (20+ in) classes and noted that the biggest change in class distributions over the monitoring period was a 3 percent increase in the 10-19.9-inch diameter class (fig. 1-7), representing the potential for future recruitment into the LSOG class as defined in this report.

In summary, the NWFP projected that over a time horizon of 10 decades, LSOG forest could be restored and maintained at desired levels. In this second monitoring cycle, we have refined LSOG trend estimates using a bookend map analysis, improved disturbance maps, and analyses of more complete remeasured plot data. These analyses indicate a NWFP-wide decline in federal LSOG slighlty less than what was anticipated (FEMAT 1993); however, losses in some provinces (e.g. Oregon Klamath) were higher than the projected 2.5 percent decadal rate of loss. Helping to offset these losses is the potential for future recruitment in the next few decades (fig. 1-7). Futhermore, the results support assumptions made in the NWFP that the primary role in maintaining or restoring LSOG and related habitats would fall to federal lands. Specifically, federal lands contain less than half of the total forest land, but the federal share of total LSOG increased from 65 to 67 percent over the monitoring period. Harvesting removed about 13 percent (approximately 491,000 ac) of LSOG on nonfederal lands. Loss of LSOG on federal land due to harvest was less than 0.5 percent (approximately 32,100 ac)..

What's New?

In the 10-year report, we established the basic monitoring protocols founded on the LSOG monitoring plan (Hemstrom et al. 1998). Although the conceptual approach remains the same for this 15-year assessment, there are major differences in the mapping approaches used for the 15-year and 10-year reports. Foremost, the vegetation mapping for NWFP monitoring marks the first application of Gradient Nearest Neighbor imputation (GNN) to multiple imagery dates, allowing us to map "bookends" for the monitoring period. Previously, we had only a baseline map (1994/96), but no 'bookend 2' map and therefore no method for evaluating net change. Secondly, the LandTrendr disturbance mapping provided better temporal resolution (annual time-series instead of every four or five years), and greater sensitivity to partial disturbances such as thinning and low-severity wildfire. Previously, we mapped only stand-replacing disturbances such as regeneration timber harvests or high-severity wildfires. The third, and perhaps most significant, improvement is that these mapping methods were applied consistently across the entire NWFP area. Previously, we had different mapping projects in Region 5 and Region 6, and data incompatibilities limited our confidence in some of the 10-year monitoring results. And finally, regional forest plot inventories are now much more complete than they were for the 10-year report, including the first regionally consistent sample of all land ownerships, and remeasurement data for much of the federal land base. The current approach achieved much greater integration among the map- and plot- based data and analyses, reducing inconsistencies in the results. In light of these differences, direct comparison of updated status and trends results between the 15-year and 10-year assessments is cautioned.

Next Steps and Recommendations

The LandTrendr/GNN protocols were successfully applied to produce the data required for monitoring—not only LSOG, but also habitat for northern spotted owls, marbled murrelets, and potentially many other species. The data also have been used as the vegetation component for watershed condition monitoring. We recommend continuing the ongoing program of research and mapping technology in partnership with the Pacific Northwest Research Station and Oregon State University. This is consistent with an adaptive management framework that integrates the continuum of research and development, map production, technology transfer, and support. It will maintain continuity of mapping operations and ensure the updating of vegetation data on a regular cycle, which is essential for monitoring forest vegetation and species habitat status and trends. We recommend the following:

- Future analyses encompass a holistic view of forest structure and dynamics through application of a more ecological definition of LSOG.
- Revise our estimate of future trends in LSOG using inventory plots, growth and succession models, ecologically-based definitions, and assumptions about forest disturbance regimes.
- Begin exploring the inclusion of LiDAR-derived variables in our vegetation mapping process.

As we concluded in the 10-year report, wildfire still appears to be the most significant cause for LSOG loss in the range of the northern spotted owl (fig. 1-8). Managers planning future policies affecting, late-successional forests, old-growth-dependent species, and watershed conservation strategies will need to consider active land management and the interaction of land use allocations with the potential risk of wildfire, especially in the more fire-prone portions of the northern spotted owls range.

Figure 1-1– Old-growth forests in the Northwest Forest Plan area typically display a multilayered, multispecies canopy dominated by large overstory trees and containing a large amount of coarse woody debris (photo by Rocky Pankratz).

Figure 1-2– Schematic of Gradient Nearest Neighbor (GNN) imputation approach used to develop vegetation maps for the bookend dates (from Ohmann and Gregory 2002)

Figure 1-3– Schematic of LandTrendr change detection approach. Top—A stack of yearly Landsat images is aligned, cleaned, and normalized. Bottom—Statistical algorithms fit straight-line representations (black lines) of cleaned pixel trajectories (colored traces).

Figure 1-4– The current distribution of late-successional and old-growth forest in the Northwest Forest Plan area. Federally administered lands are shown by their reserve status.

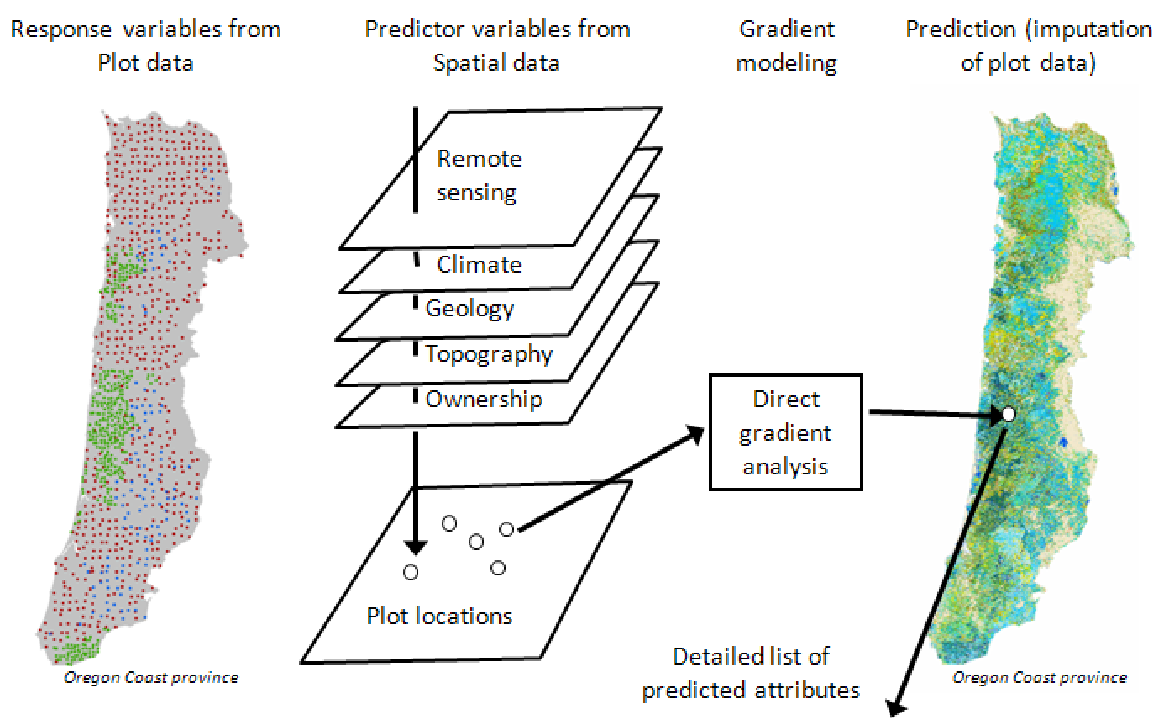
Figure 1-5– Distribution (percentage) of total forested area, late-successional and old-growth (LSOG) forest baseline, and amount of LSOG lost to wildfire on reserved (late-successional reserve, administratively withdrawn, congressionally reserved) and nonreserved (matrix, adaptive management area) federal land use allocations.

Figure 1-6– Amount (percentage and acres) and distribution of late-successional and old-growth forest on federal lands in the Northwest Forest Plan area from bookends map analysis. Red lines are confidence envelopes drawn from the Gradient Nearest Neighbor map quality assessments.

Figure 1-7– Diameter class distribution on federal land in the Northwest Forest Plan area.

Figure 1-8– Biscuit Fire aftermath, Oregon Klamath (photo by Tom Spies).

Figure 1-1



Pixel	ba_PSME (ft²/ac)	CanCov (%)	Snags >20 in (trees/ac)	Old-growth index	QMD (in)	Etc...
1	48	30	11.3	0.17	6.7	...
2	260	97	5.2	0.82	42.1	...

Figure 1-2

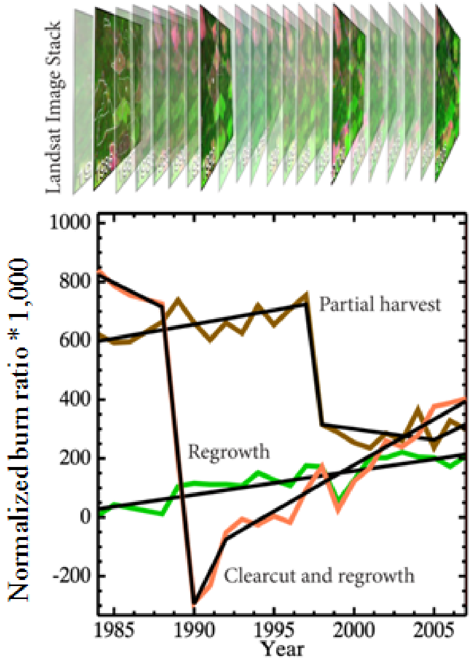

Landsat Image Stack
Normalized burn ratio * 1,000
1000
800
600
400
200
0
-200
1985
1990
1995
2000
2005
Year
Partial harvest
Regrowth
Clearcut and regrowth

Figure 1-3

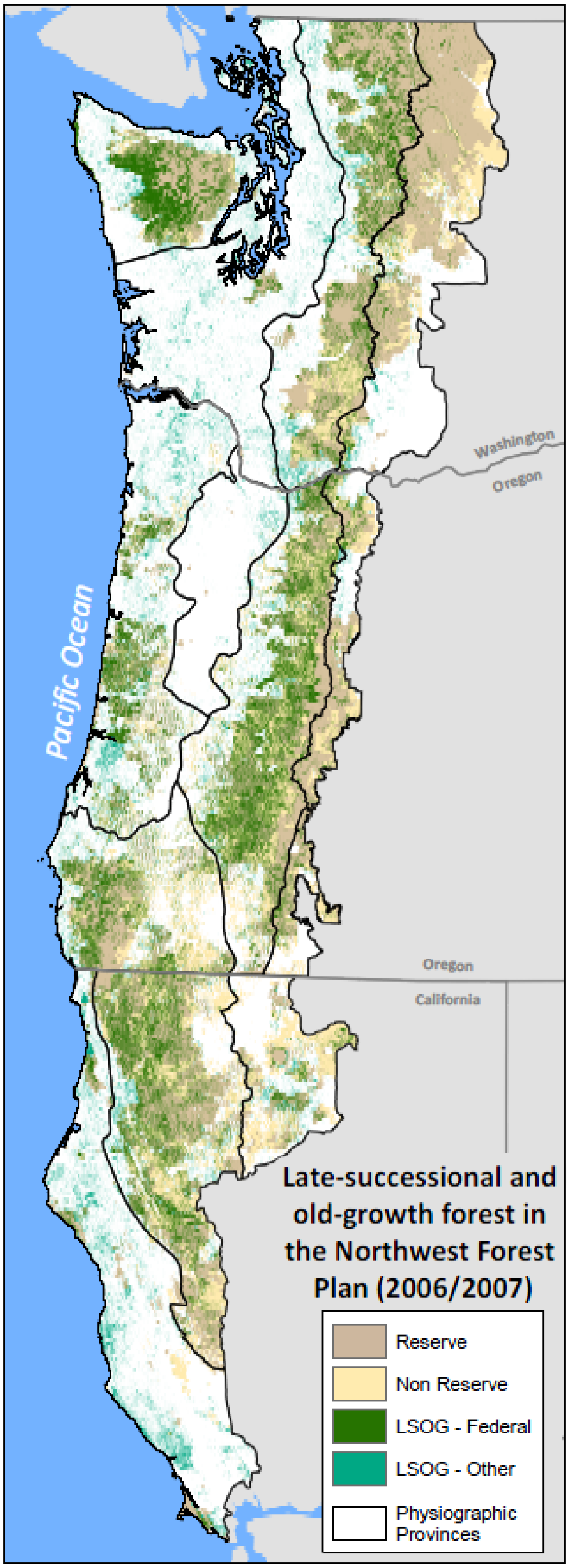

Pacific Ocean
Washington
Oregon
Oregon
California
Late-successional and old-growth forest in the Northwest Forest Plan (2006/2007)
Reserve
Non Reserve
LSOG - Federal
LSOG - Other
Physiographic Provinces

Figure 1-4

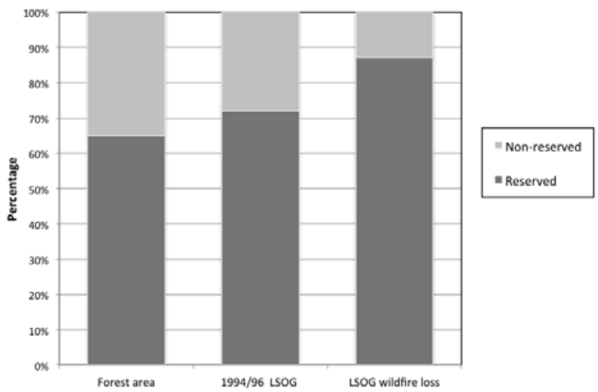


Figure 1-5

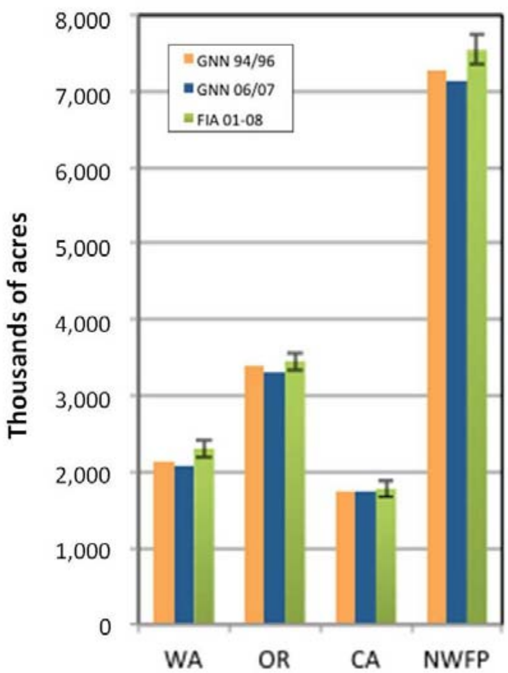


Figure 1-6

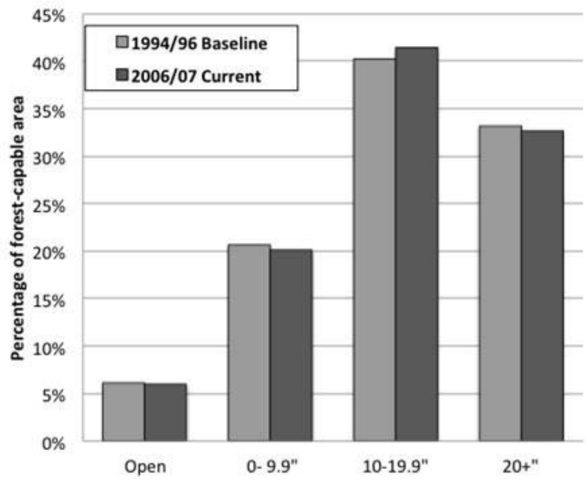


Figure 1-7

Figure 1-8

Sidebar

LSOG definition used in this report

In the 10-yr report, we evaluated three LSOG definitions representing points along a continuum. The definitions used average tree size, canopy layering, canopy closure, and life form as defining attributes. In this report we evaluate only the "medium and large older forest" defined as average diameter of overstory conifers ≥20 inches and conifer canopy cover ≥10 percent, and having either single-storied or multistoried canopies.

Conifer cover [1]	Average tree size [2]	Forest class	LSOG class
< 10%	--	Open	not LSOG
10 to 100%	0 to 19.9 in	Young	not LSOG
10 to 100%	20 + in	LSOG	LSOG

[1] Percentage of area covered by tree crowns, corrected to eliminate overlap.
[2] Quadratic mean diameter of dominant and codominant live conifers.

Chapter 2: Status and Trends of Northern Spotted Owl Populations and Habitats

Raymond J. Davis, Katie M. Dugger, William C. Aney, and Louisa Evers

Introduction

The goal of northern spotted owl (*Strix occidentalis caurina*) monitoring is to evaluate the effectiveness of the Northwest Forest Plan (NWFP) in arresting the downward trends in populations and habitats that were observed prior to its implementation. The NWFP was designed, in part, to maintain and restore habitat conditions necessary to support viable populations of northern spotted owls (fig. 2-1) on federally administered lands throughout the owl's range. Spotted owl monitoring objectives are twofold:

1. Assess changes in population trends and demographic rates of spotted owls on federal lands within the owl's range.
2. Assess changes in the amount and distribution of nesting, roosting, foraging (NRF) and dispersal habitat for spotted owls on federal lands.

This summary report briefly describes methods, key findings, new information, and recommendations from the 15-year technical report (Davis, 2011), which contains a more detailed accounting of the monitoring results from the second monitoring cycle. The results from the first monitoring cycle can be found in Lint et al. (2005).

Population Status and Trend

At its inception, the NWFP's assumption was that northern spotted owl populations would continue to decline for a few decades, gradually lessening and eventually reaching stable, but lower, equilibriums as habitat is maintained and eventually restored in the network of large reserves scattered throughout its range.

Methods

Population monitoring involves annual demographic surveys (fig. 2-2), which provide multiple years of data for producing life history records on territorial spotted owls in eight federal monitoring areas distributed across the owl's range. These eight areas are critical to our ability to infer monitoring results gathered within them to the broader federal landscapes administered under the NWFP that surround them. In addition, data from these study areas have contributed greatly to our understanding of the environmental factors that may affect spotted owl demography rates, including their habitat needs and competition from barred owls (*Strix varia*). Occupancy data from these demographic study areas are also critical for the development of rangewide habitat models for habitat monitoring purposes. Every 5 years the annual monitoring data from these, and additional, areas are pooled and analyzed by a group of experts (fig. 2-3) to determine what the population status and trend is within each study area, and a meta-analysis is done to estimate rangewide population status and trends. Population monitoring since 1994 has produced rangewide estimates of 2.4 to 4.5 percent annual rates of decline (Anthony et al. 2006, Burnham et al. 1996).

Key Findings

The most recent estimate for northern spotted owl population trends on federally administered lands is a 2.8 percent annual rate of decline, which is slightly lower than the 2.9 percent estimated by Forsman et al. (in press), which included two additional nonfederal study areas not managed under the NWFP. The rate of decline is highest in the northern portion of the range (Washington), where populations are estimated to have declined 40 to 60 percent since 1994. Populations remain stationary in the central portion of the owl's range, located in southwestern Oregon (fig. 2-4).

What's New?

Barred owls (fig. 2-5) began moving into the northern portion of the spotted owl's range in the 1970s, progressing southward. We now have multiple years of survey data from the federal demographic study areas that shows an increasing trend in barred owl presence across the entire range (fig. 2-6). Recent studies have shown that barred owls have higher reproductive rates and occur at higher densities than spotted owls. Mounting evidence suggests barred owls and spotted owls are direct competitors for both habitat and prey, and that barred owls may negatively affect spotted owl demography.

For this reason, covariates for presence of barred owls, (and for the first time) percentage cover of suitable owl habitat (fig. 2-7), weather, and climate were included in the analysis of demographic data to explore associations between these factors and observed population trends. Although all had varying degrees of association, the presence of barred owls appeared to have the strongest and most consistent relationship with demographic rates. Another new aspect to the meta-analysis was the estimation of recruitment rates of nonterritorial owls into the territorial population. Low recruitment in conjunction with low survival was associated with population declines. This analysis showed a negative relationship between recruitment rates and the presence of barred owls and a positive relationship with the percentage of suitable owl habitat. Population recruitment was higher on federally owned lands where the amount of suitable owl habitat is generally higher. The latest results do not yet indicate "cause-effect" relationships, but advance our understanding of the interaction between these variables and spotted owl populations.

Habitat Status and Trend

The NWFP assumed that habitat (fig. 2-8) on federally administered lands would not decline faster than the 5 percent per decade predicted in the *Final Supplemental Environmental Impact Statement* (USDA/USDI 1994). Lint et al. (1999) summarized other assumptions that would be looked at under the effectiveness monitoring program, including the assumptions that:

1. Habitat within reserves will improve over time at a rate controlled by successional processes in stands that currently are not habitat. However, this was not expected to produce a substantive change in habitat conditions for several decades.
2. Habitat outside of reserves will generally decline owing to timber harvest and other habitat-altering disturbances.
3. Large stand-replacing stochastic events are expected to occur in some reserves; however, their repetitive design would provide resiliency, and not result in isolation of population segments.

Central to these assumptions is the federal network of reserved land use allocations designed to support groups of reproducing owl pairs across the species range. These reserves include late-successional reserves, adaptive management reserves, congressionally reserved lands, managed late-successional areas, and larger blocks of administratively withdrawn lands. It is also important to monitor habitat on land between these reserves, because owls will disperse through these areas and move from one large reserve to another, maintaining the flow of genetic material needed for healthy populations. These land use allocations include a mix of matrix, adaptive management areas, riparian reserves, small tracts of administratively withdrawn lands, and other small reserved areas such as 100-acre owl cores. Specific habitat monitoring questions include:

1. What proportion of the federal landscape is nesting/roosting and dispersal habitat?
2. What are the trends in the amount and distribution of these habitats on reserved and nonreserved land allocations?
3. What are the primary factors leading to loss and fragmentation of nesting/roosting habitat and dispersal habitat?

Methods

Habitat monitoring is done by analyzing time sequenced maps with geographic information systems (GIS). Having a good baseline habitat map is essential to the effectiveness monitoring program because it provides us a snapshot in time of what conditions were like when the NWFP was implemented. Without maps, we would not be able to answer the question listed above. The first rangewide baseline habitat monitoring maps were developed by Davis and Lint (2005). These maps were replaced by nesting/roosting and dispersal habitat maps created using the GNN vegetation and LandTrendr change-detection data described in chapter 1 and new habitat modeling methods and software called "MaxEnt" (Phillips et al. 2006). These improved habitat maps provide us the first consistently mapped estimation of habitat conditions across the owl's entire range and two periods. The period for our baseline map (our first "bookend") is 1994 in California and 1996 in Oregon and Washington. We analyze changes to habitat between this and our other "bookend," which is for 2007 in California and 2006 in Oregon and Washington.

Key Findings

On federal lands, we observed a net change of <1% of nesting/roosting habitat from the baseline to the end of our analysis period using our bookend models. When error estimates for habitat amounts during the two periods are considered, the net changes are much smaller than the range of uncertainty and for that reason we cannot say that total amount of nesting/roosting habitat has changed significantly over this period. However, net change includes both gains and losses in suitable habitat, and gains of nesting/roosting habitat are difficult to accurately estimate for such a short analysis period and are likely small. If we focus on losses and ignore gains, and count as losses only those acres where bookend losses are also mapped as disturbed by LandTrendr, we estimate the rangewide habitat loss between 1994 through 2007 in California, and 1996 through 2006 in Oregon and Washington at about 3.4 percent (fig. 2-9). This is less than what was anticipated; however, contrary to assumptions, most of the loss occurred within the network of reserved land use allocations, and not within the matrix outside of these reserves (fig. 2-10). In spite of this, the current analysis of habitat within and around the large reserve network validates the assumption that the repetitive design of large reservescan absorb some losses without resulting in isolation of population segments. Of the 12 million acres of nesting/roosting habitat remaining (fig. 2-11), 71 percent occurs on federally administered lands. About 70 percent of this is in reserved land use allocations (not including riparian reserves). Over half of the habitat remaining (both reserved and nonreserved) occurs in the central (geographic core) portions of the owl's range, within the Klamath Mountain provinces of Oregon and California (27 percent) and the western Cascades of Oregon (26 percent). Not enough time has passed for us to accurately detect or estimate significant recruitment of nesting/roosting habitat; however, increases were observed in "marginal" (younger) forests indicating that future recruitment of nesting/roosting habitat will occur as anticipated, within the next few decades.

Using spotted owl dispersal data, we were able to map dispersal-capable landscapes across the entire range of the owl (fig. 2-12), for both periods. This map indicates that although there have been losses and gains in dispersal habitat, the network of large reserves appears to be fairly well connected, with the exception of the northern portion of the eastern Cascades of Washington and also within the southern tip of the range, where some large reserves occur in landscapes with poor dispersal conditions, including the Marin County population. Although we were not able to detect recruitment of nesting/roosting habitat, we did detect an increased amount of dispersal habitat, as defined by conifer forests that exceed 11 inches diameter at breast height and 40-percent canopy closure. Although forest succession accounts for some of this habitat recruitment, especially in the more productive tree-growing portions of the range (e.g., Oregon Coast Range), partial disturbance of nesting/roosting habitat also accounts for some of it. Losses of dispersal habitat, primarily resulting from wildfires were exceeded by recruitment rates, resulting in a net increase of about 5.2 percent, rangewide. However, given the distribution of this habitat, we noted a 1-percent decrease in dispersal-capable landscapes within the owl's range.

Wildfire remains the leading cause of nesting/roosting habitat loss. Rangewide losses from wildfire have not exceeded what was anticipated (2.5 percent per decade), but some physiographic provinces have incurred losses up to 10 percent. About 3.6 million acres of nesting/roosting habitat remain in landscapes that are naturally prone to large wildfires (fig. 2-13). Most (85 percent) occurs within the "core" of the owl's range–the Klamath Mountains and the western Cascades of Oregon. Not all habitat burned will result in habitat loss. Monitoring data show that wildfires in the east Cascades resulted in 62-percent habitat loss within their perimeters, whereas losses average 30 percent in the western Cascades of Oregon (fig. 2-13).

What's New?

Recent improvements in remotely sensed vegetation and change-detection mapping has resulted in better habitat maps that replaced the baseline versions produced in the 10-year report (Davis and Lint 2005). Progress in habitat "niche" modeling methods and software has improved our ability to map not only the habitats for spotted owls, but also "suitable habitat" for large wildfires (fig. 2-14). At present, wildfire appears to be the main disturbance agent on spotted owl habitat. Yet, wildfire is a natural ecological process under which spotted owls have evolved. The overlap of owl habitat and wildfire suitability[1] maps may provide new insights into how this natural disturbance fits within the owl's range.

Next Steps and Recommendations

First, there is very little research documenting the effect of wildfire on spotted owls and spotted owl demography. In light of losses of nesting/roosting habitat to wildfires as high as 10 percent in some provinces, we need to understand how fire severity, spatial patterns of wildfire, and fuel reduction management treatments might affect owl habitat use, prey populations, and owl demography. We recommend increased research and monitoring on this subject to better inform managers on how to manage habitat in fire-prone areas.

Second, we recommend pursuing further evaluations of the potential competitive effects that barred owls and other environmental factors may be having on spotted owls. Along these lines, we recommend cooperating with the US Fish and Wildlife Service on Recovery Action 29 (barred owl removal experiment) under the Final Recovery Plan for the Northern Spotted Owl (USDI 2008). In addition, the use of fixed- effects models in the next demographic analyses should be deemphasized and replaced with random- effects models that incorporate both covariates and temporal variation.

[1] Wildfire suitability is a function of environmental conditions that reflect suitability (from low to high) for large wildfire occurrence.

In addition, the inclusion of new or improved covariates, such as the new habitat and change-detection data, is recommended for future demographic analyses. Particularly, data on annual variation in prey abundance may be important, and we recommend implementing a study on one or more of the demographic study areas in the near future.

Given the new habitat modeling software capabilities and our use of forest tree species and climate variables in our habitat and wildfire suitability models, during the next monitoring cycle we recommend exploring climate change scenarios and how they might affect future habitat and wildfire suitability.

Finally, we recommend that we continue to seek and develop methods for improving vegetation mapping that use GNN and LandTrendr data. This may include the use of LiDAR to improve our ability to monitor forest succession in its later stages and habitats that are used for nesting and roosting. We also recommend that the "baseline" habitat map for the 20-year monitoring cycle be refined using 1994 imagery for the entire range, instead of using different years as was done for this reporting cycle.

Figure 2-1–Northern spotted owl adult with three fledglings (photo by Stan Sovern).

Figure 2-2–Field crews conduct demographic surveys within federal monitoring study areas each year to collect life history data on spotted owls (photo by Allan Branscomb).

Figure 2-3–Participants in the fifth demographic meta-analysis workshop conducted in January 2009 (photo by Peter Carlson).

Figure 2-4–Estimates of mean annual rate of population change (λ), with 95-percent confidence intervals for nine demographic study areas that contain federal lands in Washington, Oregon, and California (data from Forsman et al., in press).

Figure 2-5–Barred owl presence continues to increase across the spotted owl's range (photo by Peter Carlson).

Figure 2-6–Trends in barred owl presence in Washington, Oregon, and California from demographic study area survey data.

Figure 2-7–Trends in suitable owl habitat within demographic study areas in Washington and Oregon from monitoring data (Davis and Lint 2005).

Figure 2-8–Adult northern spotted owl in nesting/roosting habitat (photo by Kristian Skybak)

Figure 2-9–Estimated nesting/roosting habitat rangewide losses broken down by causes for loss on federally administered lands.

Figure 2-10–Estimated trends in nesting/roosting habitat on federal lands within each physiographic province.

Figure 2-11–Rangewide map of northern spotted owl nesting and roosting habitat in 2006/07, showing the frames of reference used to evaluate the proportion of the landscape covered by suitable owl habitat from the last meta-analysis on federal lands.

Figure 2-12–Rangewide map of dispersal-capable landscapes, showing areas where conditions have remained the same or changed between 1994/96 and 2006/07.

Figure 2-13–Average percentage of nesting/roosting habitat lost within the perimeters of recent large wildfires.

Figure 2-14–Rangewide map of wildfire suitability based on abiotic variables such as climate and topography.

Figure 2-1

Figure 2-2

Figure 2-3

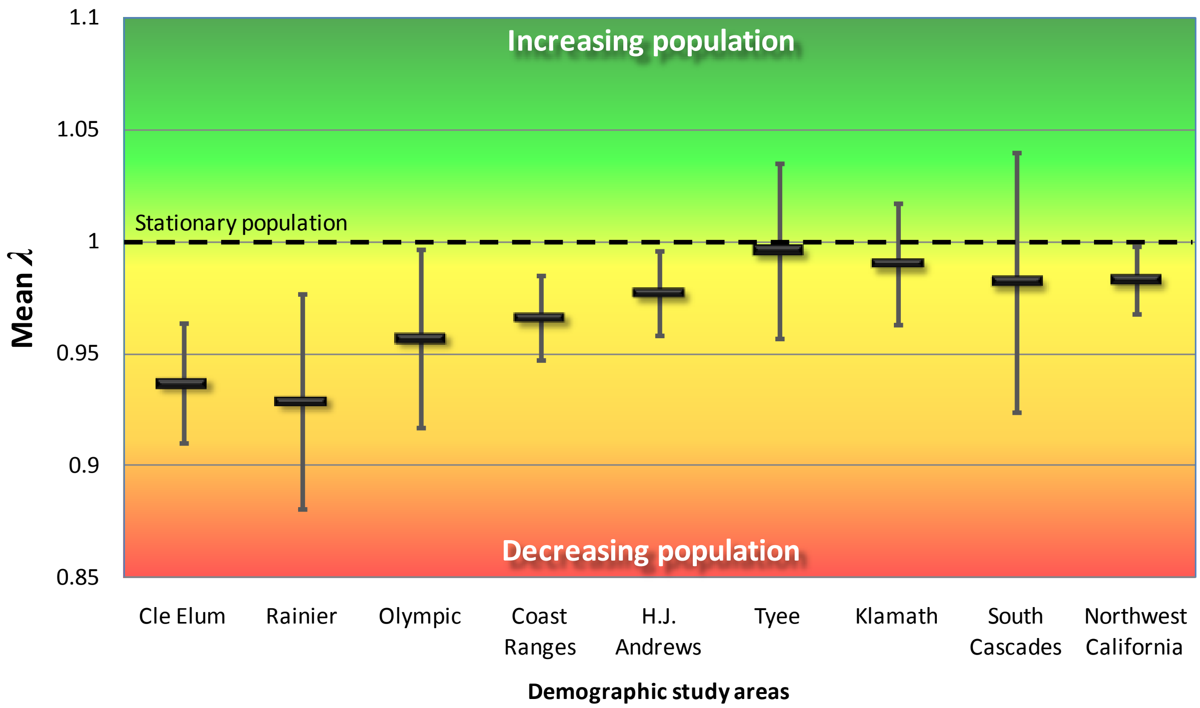
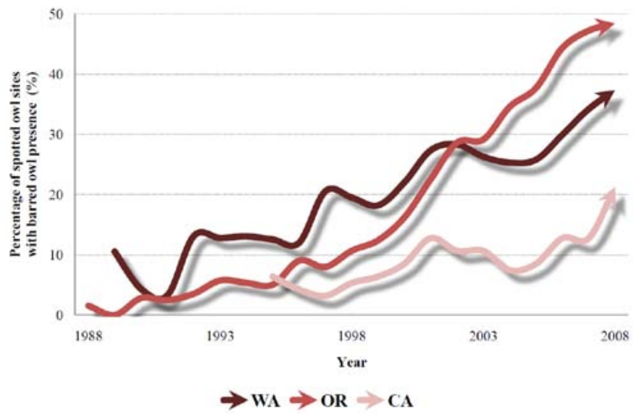


Figure 2-4

Figure 2-5



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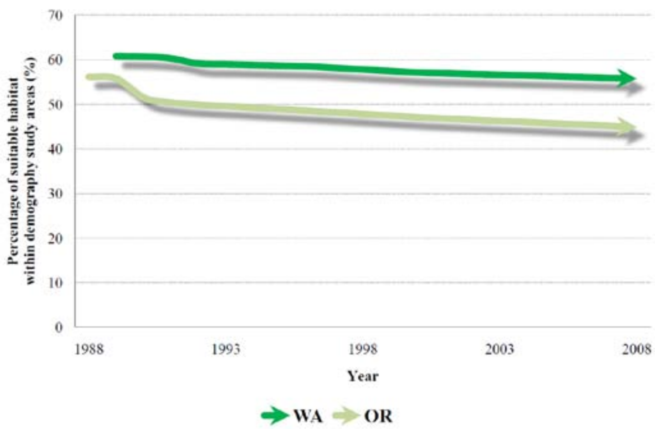

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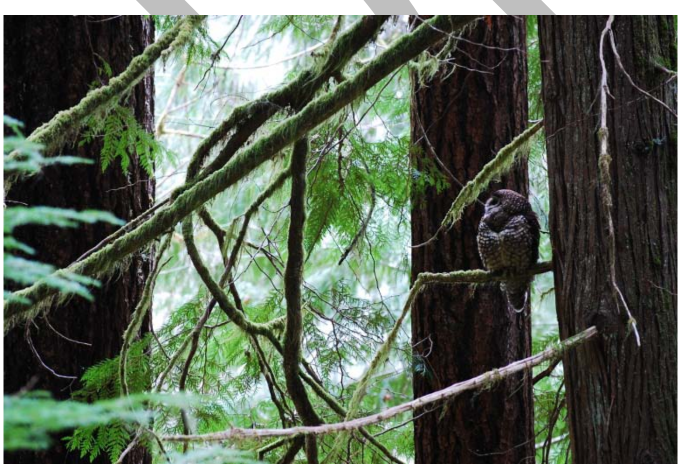

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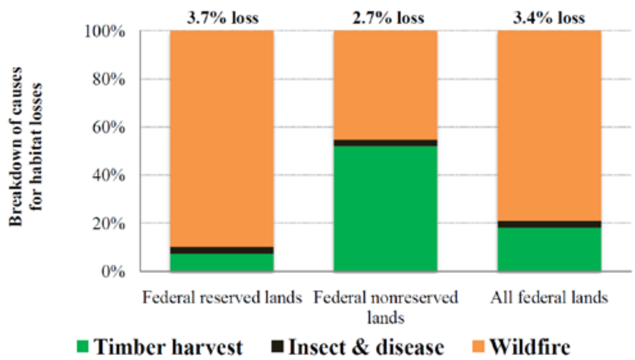

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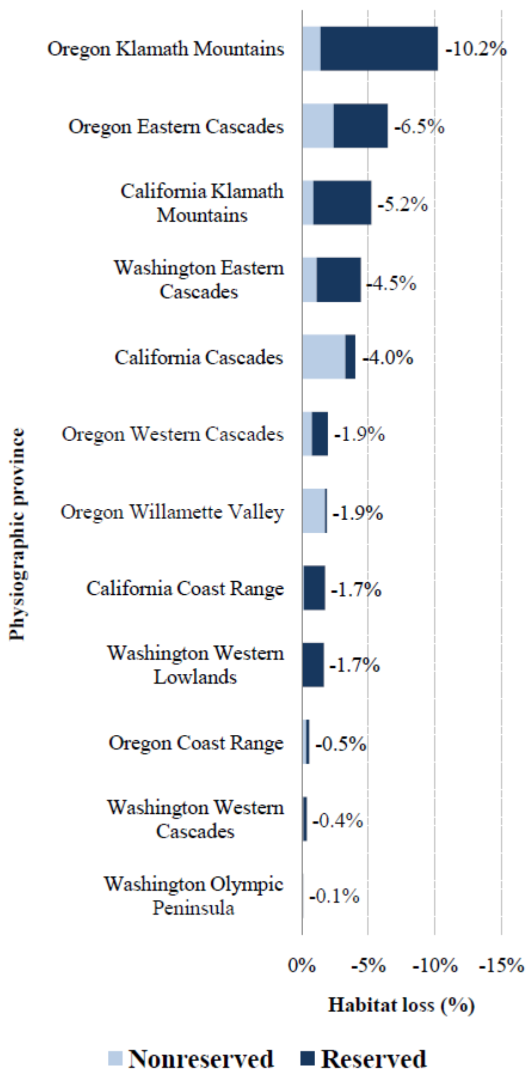

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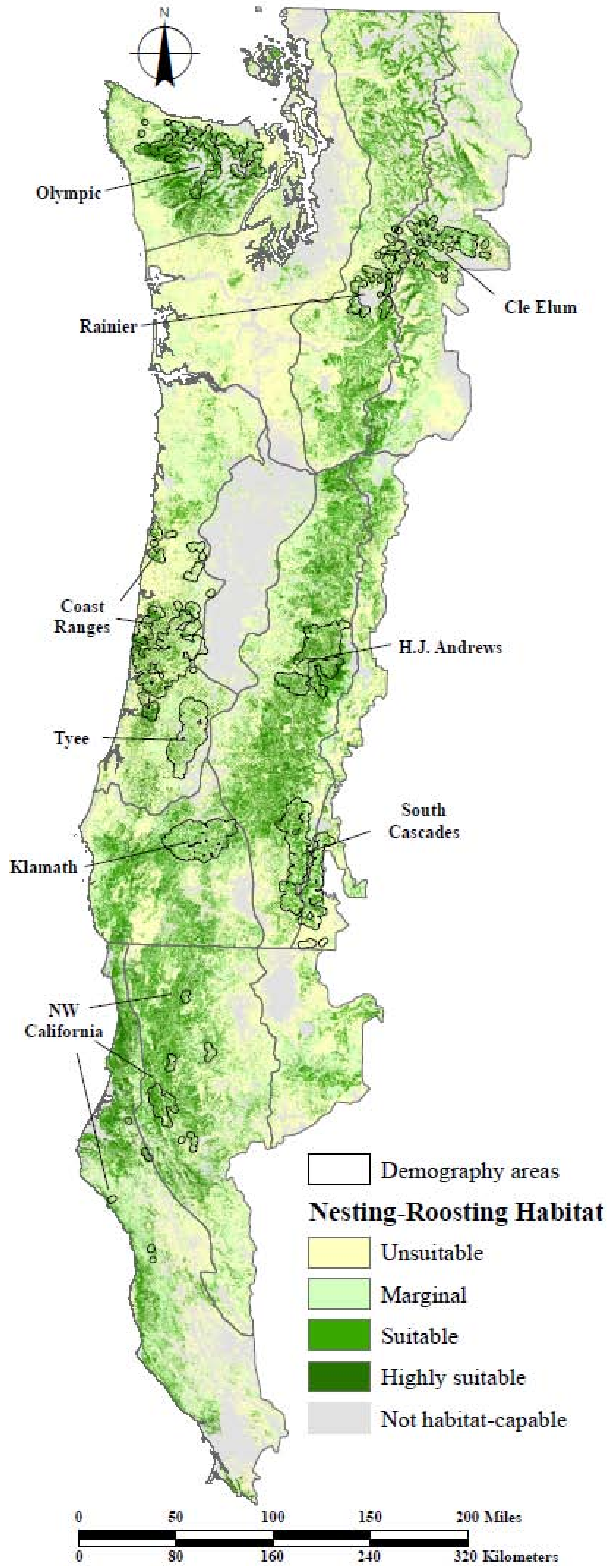

N
Olympic
Rainier
Cle Elum
Coast Ranges
H.J. Andrews
Tyee
South Cascades
Klamath
NW California
Demography areas
Nesting-Roosting Habitat
Unsuitable
Marginal
Suitable
Highly suitable
Not habitat-capable
0
50
100
150
200 Miles
0
80
160
240
320 Kilometers

Figure 2-11

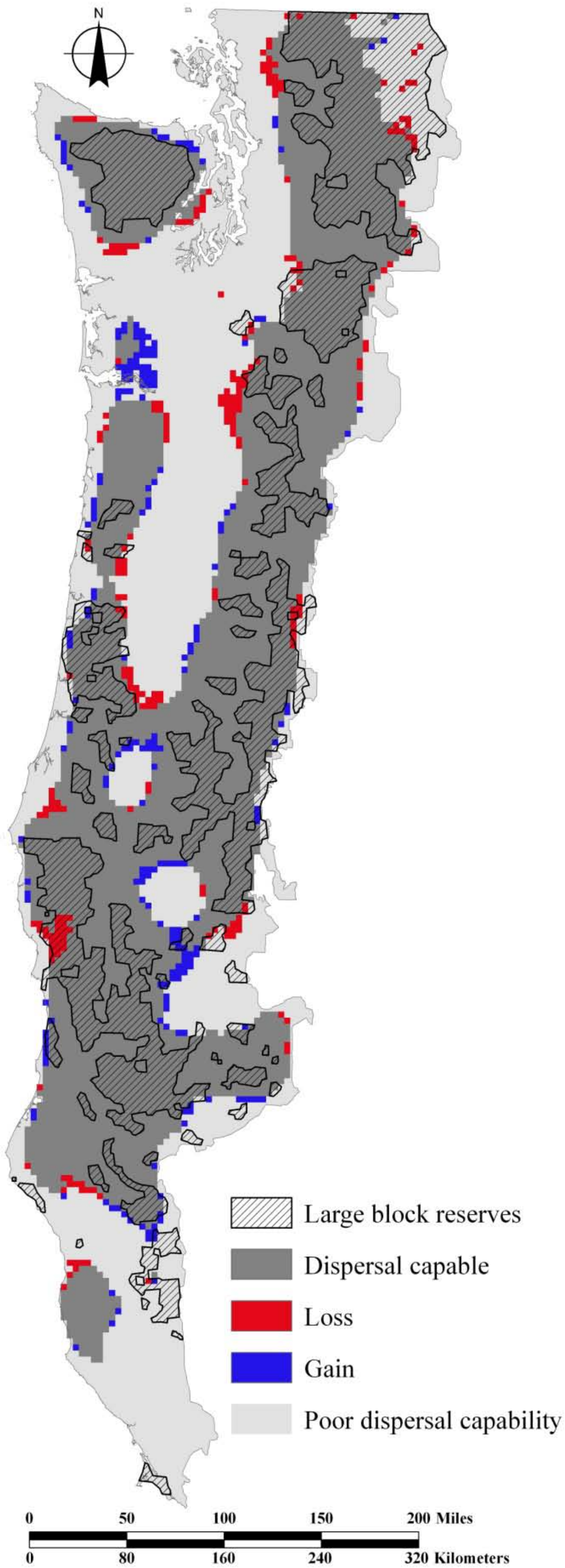
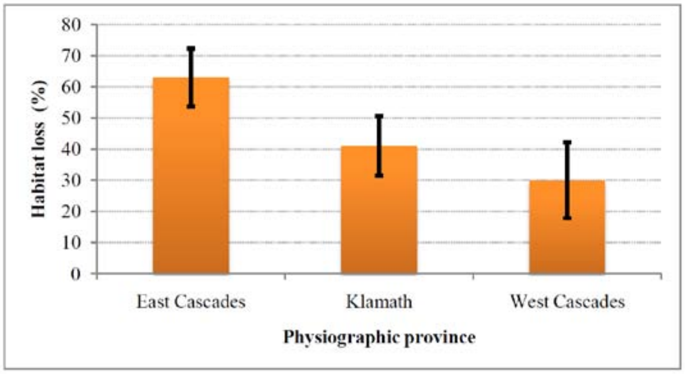

N
Large block reserves
Dispersal capable
Loss
Gain
Poor dispersal capability
0
50
100
150
200 Miles
0
80
160
240
320 Kilometers

Figure 2-12



Habitat loss (%)
80
70
60
50
40
30
20
10
0
East Cascades
Klamath
West Cascades
Physiographic province

Figure 2-13

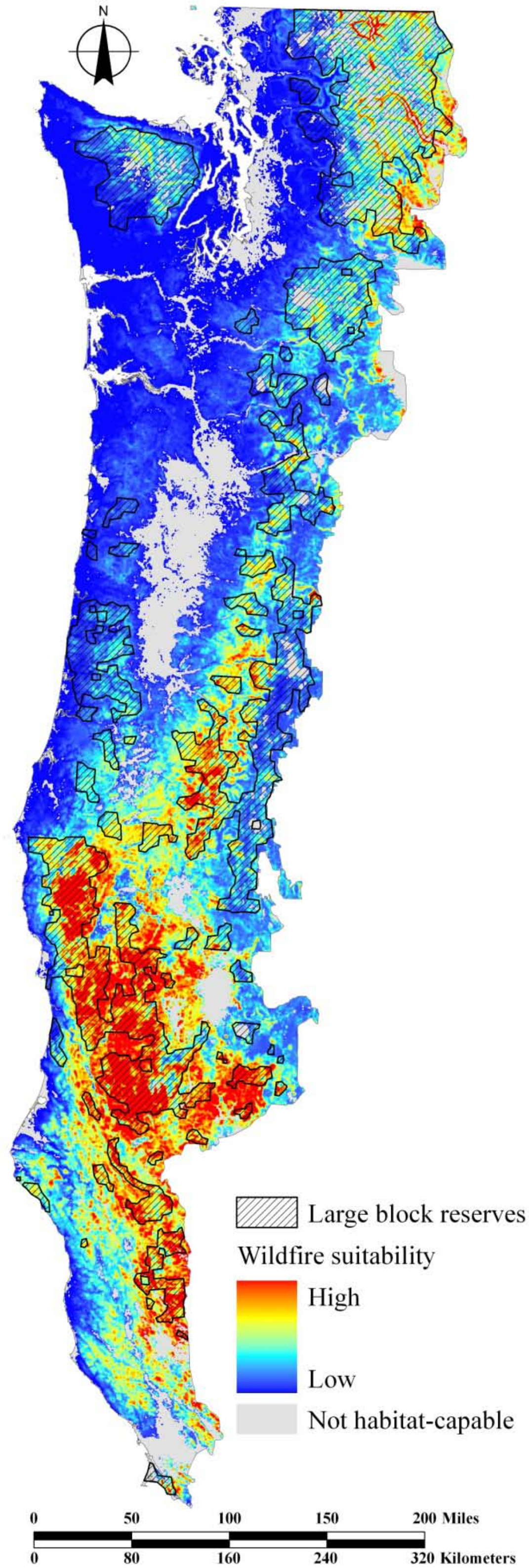

N
Large block reserves
Wildfire suitability
High
Low
Not habitat-capable
0
50
100
150
200 Miles
0
80
160
240
320 Kilometers

Figure 2-14

Chapter 3: Status and Trends of Populations and Nesting Habitat for the Marbled Murrelet

Gary A. Falxa, Martin G. Raphael, Sherri L. Miller, Jim Baldwin, Thomas D. Bloxton, Jr., Katie M. Dugger, Beth M. Galleher, Monique M. Lance, Deanna Lynch, S. Kim Nelson, Scott F. Pearson, C. John Ralph, Craig S. Strong, and Richard D. Young

Introduction

The marbled murrelet (*Brachyramphus marmoratus*) is a small seabird that forages in coastal marine waters, and nests predominantly in coastal old-growth forests, where it lays a single egg on large branches or other suitable natural platforms in large coniferous trees. The murrelet forages primarily in the near-shore marine waters (within 2 to 5 miles of shore), but can fly as far as 50 miles inland to nest sites. Owing mostly to timber harvesting prior to 1994, only a small percentage of original late-successional and old-growth forests remain within the murrelet's range south of Canada, and conserving remaining nesting habitat is key to managing for the murrelet's survival and recovery (USFWS 1997). Conservation of nesting habitat to support stable or increasing populations of the murrelet is a key objective of the Northwest Forest Plan (NWFP).

Ongoing marbled murrelet habitat monitoring addresses the key question of the status and trends of marbled murrelet populations and nesting habitat in the NWFP area. This information will help assess if the current NWFP management direction is contributing to the recovery of this federally listed species by maintaining and restoring murrelet nesting habitat and populations on federal lands.

Here, we summarize key findings of two recent technical assessments that address in detail the status and trends of murrelet populations (Miller et al. 2010) and nesting habitat (Raphael et al. 2010) during the first 15 years of the plan. These reports are the second in the series of NWFP monitoring reports from the Marbled Murrelet Effectiveness Monitoring module (Madsen et al. 1999). The first monitoring report for murrelets (Huff et al. 2006) introduced the monitoring program, reviewed marbled murrelet biology, and presented results from monitoring of murrelet populations and nesting habitat during the first 10 years of the plan, through 2003.

Status and Trends of the Murrelet Population

One primary objective of the effectiveness monitoring program for murrelets is to monitor changes in murrelet abundance throughout the NWFP area, by using a unified and scientifically valid sampling design. This represents the first and only such program for monitoring the murrelet population in the NWFP area.

Methods

Population monitoring is based on breeding-season estimates of the at-sea murrelet population for the coastal waters adjacent to the NWFP area, in Washington, Oregon, and northern California. Since 2000, a team of cooperating scientists has conducted surveys in those waters using a unified sampling design and standardized survey methods published in Raphael et al. (2007). Marbled murrelets were counted by two observers on boats navigated to follow transect lines determined by a randomized sampling procedure. Those data were used to generate annual population estimates for each of five zones (fig. 3-1; based on conservation zones identified in Marbled Murrelet Recovery Plan [USFWS 1997]), and for all five zones combined. Survey effort was substantial, with about 150 to 200 surveys conducted each year along approximately 3,500 to 4,000 miles of transect. To test for trends in population size, we applied linear regression to the annual estimates from the 2001 to 2009 monitoring period, at the single-zone and NWFP-area scales. The 2000 estimates from Washington were not used because departures from survey protocol in that year may have biased data.

Key Findings

For the NWFP area as a whole, the murrelet population declined by an estimated 3.9 percent per year (95 percent confidence interval [CI]: -2.6 to -5.1 percent) between 2001 and 2009, which totals to an estimated 27-percent population decline over the entire 9-year period (fig. 3-2, table 3-1). The rate of decline was greatest in Washington, where the decline was an estimated 7 percent per year for conservation zone 1, which includes Puget Sound and the Strait of Juan de Fuca. Although a significant decline at the zone scale was detected only in zone 1, the estimated rates of change suggest a pattern of decreasing rates of decline from northern to southern zones (table 3-1). However, trend analyses for zones 2 through 4 are preliminary due to low statistical power; about 14 to 23 years of sampling would be needed to test for a 3-percent average annual decline with a high level of statistical power.

Annual population estimates at the NWFP-area (all-zone) scale ranged from a high of about 23,700 in 2002 (95 percent CI: 18,300 to 29,000) to a low of about 17,400 in 2007 (95 percent CI: 12,800 to 21,900). The most recent population estimate, for 2009, is 17,800 birds (95 percent CI: 14,200 to 21,300).

At the conservation zone scale, murrelets are distributed fairly widely, except in conservation zone 5 (fig. 3-1), where both nesting habitat and murrelets are scarce. Zones 1 and 3 (northern Washington and north and central Oregon) had the highest population estimates, whereas zone 5 population estimates never exceeded 300 birds (fig. 3-1). Murrelet density ranged greatly, from about 0.38 murrelets per square mile in zone 5 to about 10 murrelets per square mile in zones 3 and 4.

Status and Trend of Murrelet Nesting Habitat

The primary habitat monitoring objectives for murrelets include mapping nesting habitat at the start of the NWFP and estimating habitat change over time. New for the 15-year assessment was an improved base vegetation map and use of a new modeling platform to estimate the amount and distribution of potential nesting habitat.

Methods

We based our habitat estimates on habitat suitability models which used the updated vegetation mapping from GNN (Gradient Nearest Neighbor; Ohmann and Gregory 2002) described in Chapter 1. We used a recent modeling tool, Maxent habitat suitability software (Phillips and Dudík 2008) to estimate the amount and distribution of potential murrelet nesting habitat during two periods: (1) baseline (1994 for California, 1996 for Oregon and Washington) and (2) 2006 (Oregon and Washington) or 2007 (California) to estimate change since the baseline. As input to the model, we used maps of the distribution of various environmental characteristics, including GNN vegetation data and climate and topographic conditions at the 30-meter pixel scale. We trained the Maxent model by using environmental conditions at known murrelet nest locations and sites classified as occupied by audiovisual surveys. Model output is a map of habitat suitability, which we summarized into four classes ranging from low (class 1) to high (class 4) suitability (fig. 3-1), based on relative likelihood of murrelet presence. We used the higher two of these (classes 3 and 4) to denote potential higher suitability nesting habitat. For habitat analyses we considered federal lands only, nonfederal lands only, and all ownerships. The latter category parallels our monitoring of population status and trend, which encompasses murrelets associated with all lands within the NWFP area.

We used two methods to assess change in the amount and distribution of higher suitability nesting habitat: The “bookend” approach used the Maxent model to estimate habitat suitability in two periods, the baseline year and in 2006/2007; by comparing mapped habitat suitability for the two periods, we estimated net change as the balance between losses and gains of higher suitability habitat during the analysis period. This method cannot identify causes of habitat losses. Our second approach used forest disturbance data provided by LandTrendr (Landsat-based detection of trends in disturbance and recovery, described in Chapter 1) to refine the estimates of habitat loss as determined by the bookend approach. Using LandTrendr data allowed us to identify likely causes of habitat loss, focusing on areas where bookend losses were also mapped as disturbed by LandTrendr. This second approach did not provide information on potential habitat gains.

New vegetation data and Maxent models provided more powerful and consistent results across the monitoring area than those available from the 10-year report (Huff and others 2006). The new baseline maps and estimates replace those from Huff and others (2006).

Key Findings

For the baseline year, we estimated about 3.8 million acres of potential higher suitability murrelet nesting habitat on all ownerships, of which most (64 percent, 2.4 million acres) was on federal lands, mostly (89 percent, 2.2 million acres) in reserve use allocations (fig. 3-1 and 3-3). For both federal and nonfederal lands, most of the higher-suitability habitat is located in Washington and Oregon, where 21 percent of forest lands were higher suitability, compared to only 4 percent in California. California, where most coastal forests are in nonfederal ownership, accounts for only 1.4 percent (35,000 acres) of the NWFP-wide higher suitability habitat on federal lands (fig. 3-3). For all ownerships, more area was in the two lower suitability classes (fig. 3-4). Habitat fragmentation (as indicated by the amount of forest edge in higher suitability habitat) was less on federal lands than nonfederal, but was relatively high on all lands, reflecting the land’s intensive harvest history.

Over all ownerships, we observed a net loss of 7.1 percent of higher suitability nesting habitat from the baseline to the end of our analysis period using our bookend models. When error estimates for habitat amounts during the two periods are considered, the losses fall with the range of uncertainty and for that reason we cannot say that total amount of habitat has changed significantly over this period. However, net change includes both gains and losses in suitable habitat, and gains of murrelet nesting habitat are difficult to accurately estimate for such a short analysis period and are likely small. If we focus on losses and ignore gains, and count as losses only those acres where bookend losses are also mapped as disturbed by LandTrendr, we estimate a total loss of 12.9 percent of higher suitability habitat from the baseline period, across all ownerships.

The all-ownership results were strongly influenced by losses on nonfederal lands, and losses were markedly less for federal lands than for nonfederal lands. Higher suitability murrelet nesting habitat declined by about 3 percent (77,000 acres) on federal lands, compared to 12.9 percent for all ownerships, if we focus on losses as described above (fig. 3-5). About two-thirds of the loss on federal lands was due to wildland fire in Oregon, mostly in the 2002 Biscuit Fire, and the remaining one-third due primarily to timber harvest in Oregon and Washington. Using the same LandTrendr-informed approach, loss on nonfederal lands amounted to about 30 percent of the baseline. Harvest in Oregon and Washington accounted for 94 percent of losses on nonfederal lands.

Habitat loss from fire or harvest is rapid, but development of stands with old-growth characteristics necessary for murrelets is expected to take at least 100 to 200 years after harvest or other stand-replacing events (USFWS 1997). As a result, it will take many years before younger stands resulting from clearcut harvest in the past century will develop into murrelet habitat. Due to the slow rate of habitat development combined with the error associated with the available methods, we cannot reliably estimate nesting habitat gains during the short analysis period. However, if management for late-successional and old-growth forest continues, projections show substantial increases on western federal lands of forest exceeding 150 years age by 2050 (Mills and Zhou 2003). With time and management, much of the nearly 2 million acres of NWFP federal reserve-allocation lands in lower suitability condition is likely to develop into higher suitability potential murrelet nesting habitat. Over the long run, this could balance losses from reserve lands from fire and other causes.

Conclusions and Synthesis

Declining murrelet population trends and habitat losses underscore the need to minimize the loss of suitable habitat, especially in the relatively near term (next 40 to 50 years at least), until regrowing forests develop the structure needed for marbled murrelet nesting. The observed population decline, about 4 percent per year at the NWFP-area scale, was not unexpected, as population demographic models have predicted murrelet populations to be declining south of Canada in the range of 3 to 7 percent per year (McShane and others 2004, USFWS 1997).

Whereas harvest was the principal cause of higher suitability nesting habitat loss on nonfederal lands, the losses on federal lands were largely the result of fire and other nonharvest causes. Although fire is not a dominant process in the coastal forests where murrelets nest, sporadic fires have destroyed large areas of habitat, such as the Biscuit Fire of 2002 and the Tillamook Burn fires of the early-mid 1900s. Over the longer term, climate change may result in drier climate, higher tree mortality, and more frequent wildfires in coastal forests (Littell et al. 2009, van Mantgen et al. 2009, Westerling et al. 2006).

An objective of the murrelet effectiveness monitoring plan is to examine relationships between murrelet populations and nesting habitat condition in the NWFP area, to investigate whether trends in nesting habitat might eventually be used as a surrogate for murrelet population trends. An initial exploratory analysis we conducted suggests a positive relationship between a zone's population size and the amount of potential higher suitability nesting habitat. Although nesting habitat is believed to limit murrelet population size, other factors such as food availability and quality (Becker and Beissinger 2006; Norris et al. 2007) or low nesting success owing to predation (Peery et al. 2004) may also influence murrelet populations and trends. A critical information need is to better understand the factor(s) limiting the murrelet population (as discussed in Raphael 2006).

In light of the observed population declines and habitat losses, continued management of federal NWFP lands to conserve existing potential nesting habitat and to promote development of new nesting habitat is essential. It is not clear what other actions could be taken on federal lands to help reverse the population decline. Management to reduce risk of losses to fire would be important if done so that the management action has minimal impact to nesting habitat. The possible causes of observed population decline will require further study, and likely involve several interacting factors. Timber harvest of higher suitability habitat on nonfederal lands is one factor that may contribute to these declines.

Next Steps and Recommendations

Our long-term monitoring has provided initial results on population trends and established a baseline for potential nesting habitat from which to measure future changes in addition to providing insights into recent habitat changes. While we continue population and habitat monitoring, a next step will be to develop models to explore the relationships between nesting habitat conditions and murrelet distribution and trends at sea. These analyses will consider the relative influence of marine factors related to food availability and quality, and of terrestrial factors (e.g., nesting habitat limitations and nest predation) on murrelet distribution and trends at sea. Forest Service scientists from the Pacific Northwest Research Station will lead this effort.

Recommendations for future monitoring include:

- Identify and develop data sources on murrelet prey availability and abundance and other marine factors that are likely to affect murrelet survival and reproduction. These could become part of the murrelet monitoring database, and be used in evaluating the relative influence of terrestrial and marine factors on population trends.
- Continue work to refine the baseline habitat map and the IMAP/GNN and LandTrendr vegetation mapping techniques.
- To better understand new habitat development, (1) explore methods to assess the process and time scales for murrelet nesting habitat development in younger forests, and (2) synthesize existing data on methods for managing younger forests to accelerate the development of new murrelet nesting habitat and other older forests.
- Continue the at-sea population monitoring to (1) achieve statistical power in testing for trends at the individual zone scale, and (2) to assess whether observed trends continue in the future. These are the best data available to assess species recovery and the effectiveness of the NWFP.
- Consider monitoring murrelet reproductive rates to improve understanding of factors limiting murrelet populations in the NWFP area. This is part of the effectiveness monitoring plan for murrelets (Madsen et al. 1999) but has not been implemented to date owing to logistic and funding constraints. Based on work by team members and others, this could likely be incorporated into the at-sea monitoring protocol, rather than instituting a new program.

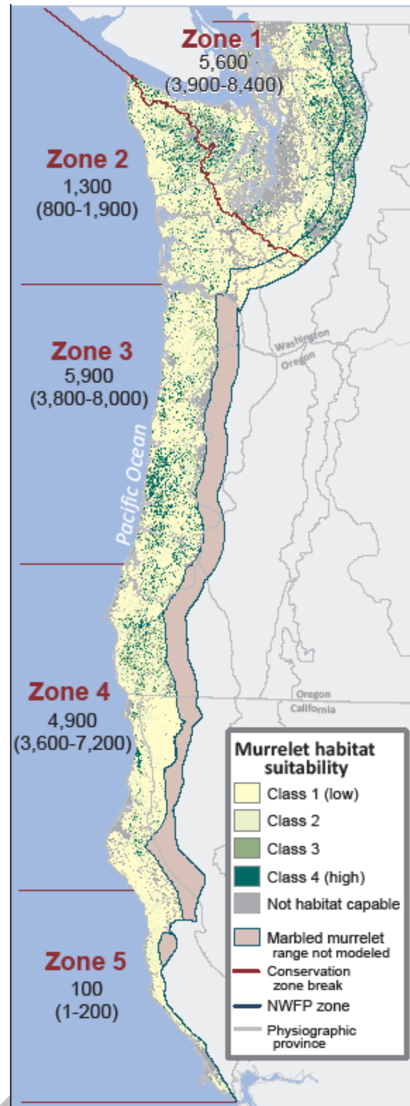


Figure 3-1-Distribution of potential marbled murrelet nesting habitat based on suitability classes for the baseline period. On the left are the five conservation zones in the Northwest Forest Plan area, with the most recent population estimate for each zone (and 95 percent confidence intervals).

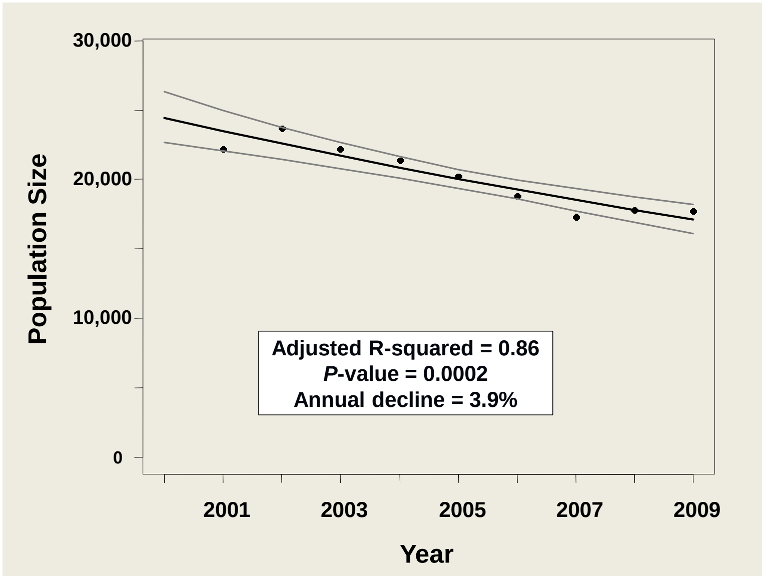


Figure 3-2-Results of trend analyses for the Northwest Forest Plan area (all zones combined), 2001-2009. Graph displays fitted regression line through the annual population estimates for the period of analysis with associated 95 percent confidence limits.

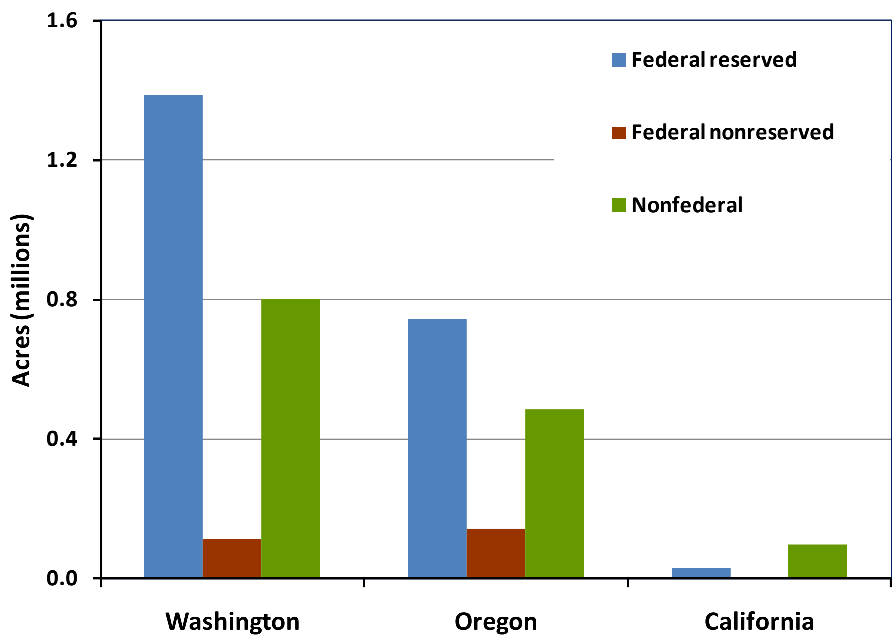


Figure 3-3-Amount of baseline higher suitability potential nesting habitat (sum of suitability classes 3 and 4) by ownership and state.

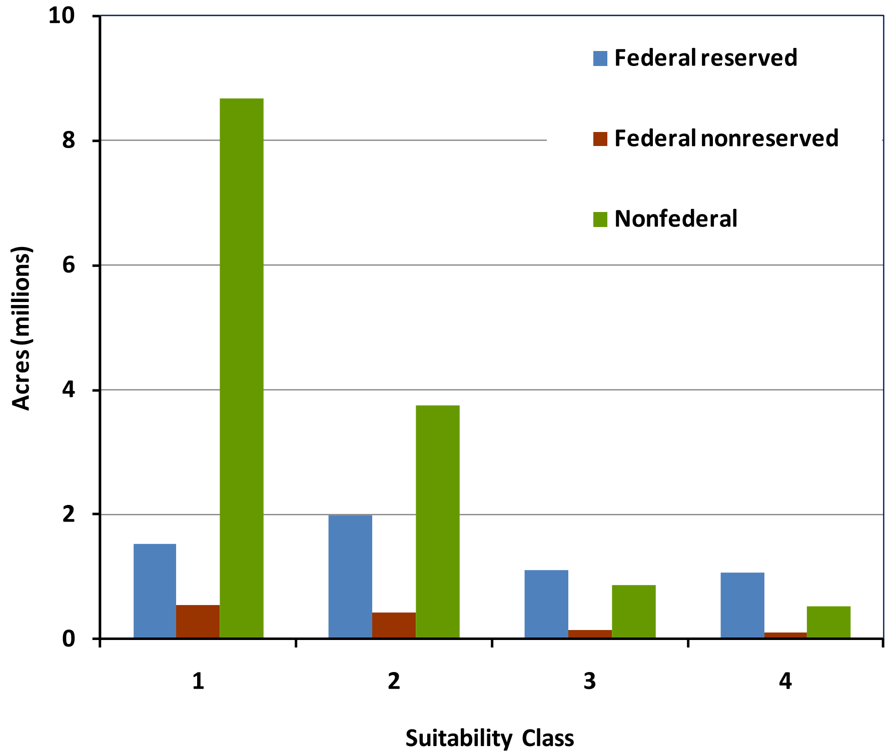


Figure 3-4-Amounts of baseline habitat by habitat suitability class, ownership, and land use type over all lands in the murrelet range.

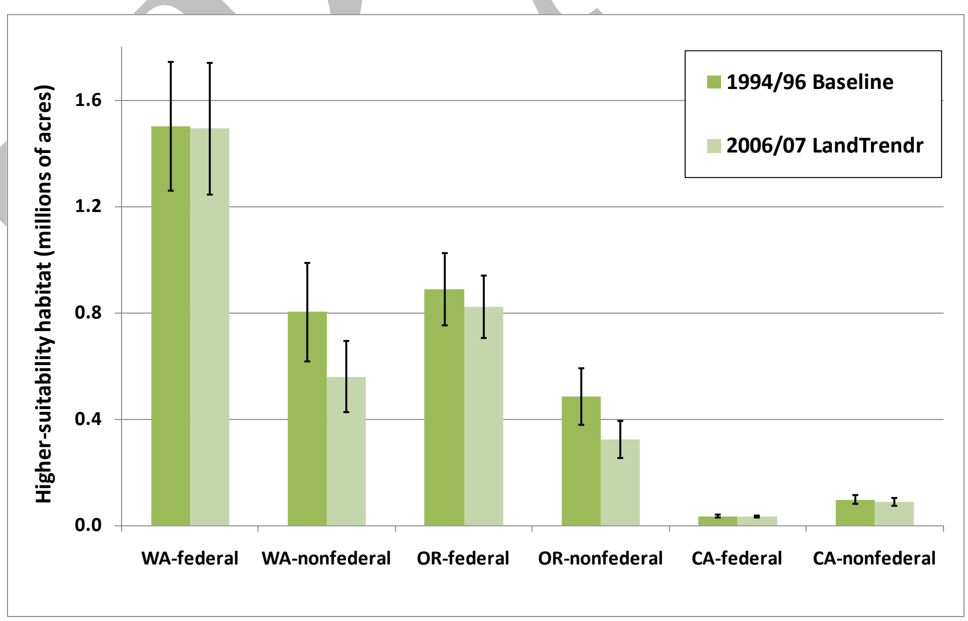


Figure 3-5-Area of higher suitability federal and nonfederal potential murrelet nesting habitat for the baseline period (1994/1996) and at the end of the analysis period (2006/2007) with 95 percent confidence intervals.

Table 3-1-Estimates of average annual rate of population change, with 95 percent confidence intervals and *P*-value for trend analysis.

Zone	Annual rate of change (percent) Estimate	Std. err.	95% conf. limits Lower	Upper	*P*-value
All zones	-3.9	0.5	-5.1	-2.6	<0.001
1	-7.0	2.0	-11.7	-2.1	0.01
2	-4.8	3.5	-12.7	3.8	0.22
3	-2.9	1.8	-7.1	1.4	0.15
4	-0.2	1.4	-3.5	3.3	0.90
5	-0.5	9.3	-21.7	26.3	0.96

Std. err. = Standard error

[a] **Based on 2001-2009 population estimates (all zones and zones 1 and 2) and 2000-2009 data (other analyses)**

Chapter 4 - Status and Trend of Watershed Condition

Steve Lanigan, Sean Gordon, Peter Eldred, Mark Isley, Steve Wilcox, Chris Moyer, and Heidi Andersen

Introduction

The watershed monitoring module (also known as the Aquatic and Riparian Effectiveness Monitoring Program or AREMP) collects data to determine if the Northwest Forest Plan's (NWFP) aquatic conservation strategy is achieving the goals of maintaining and restoring the condition of watersheds (Reeves et al. 2004)

Methods

The NWFP area being evaluated includes lands managed by USDA Forest Service (FS), USDI Bureau of Land Management (BLM), and USDI National Park Service (NPS). Only the federal portion of watersheds was included when determining watershed condition status and trend because federal agency land managers have no say in how nonfederal lands are managed. Land ownership in the Willamette/Puget Trough is predominantly private, so this province was not included in our analysis.

We used two data sets to evaluate stream and watershed condition for each aquatic province within the NWFP area (fig. 4-1):

- A stream evaluation was based on inchannel data (e.g., substrate [fig. 4-2], pieces of large wood [fig. 4-3], water temperature, pool frequency [fig. 4-4], and macroinvertebrates [fig. 4-5]) we sampled from 2002 to 2009 (193 watersheds) as part of a repeating sample design. We just completed our first round of sampling, so only current condition was calculated for this data set.
- A watershed-wide evaluation for 1,379 6^{th}-field watersheds was based on mapped data e.g., road density (fig. 4-6) based on FS and BLM geographic information system road layers, and vegetation data (fig. 4-7), e.g., tree canopy cover, derived from satellite imagery (Moeur et al. 2010). Watershed-wide condition scores were calculated for 1994 and 2008, and the difference in these scores was used to represent trend.

Experts from six aquatic provinces decided which indicators to use and how to evaluate and combine them into an overall stream and watershed condition score. We used decision-support modeling software to calculate the index scores for each watershed to a standardized range between -1 ("poor") and +1 ("good").

What is New This Time?

The biggest change from our 10-year assessment (Gallo et al. 2005), where we determined watershed condition for 250 watersheds, is that we evaluated watershed condition on lands managed by the FS, BLM, and NPS lands for every 6^{th}-field watershed with at least 25 percent federal lands along perennial streams, a total of 1,379 watersheds.

We also refined existing aquatic province models based on input from unit specialists and researchers. This included adding metrics for landslide risk, macroinvertebrates, and amphibians. We also used recent Pacfic Northwest Research Station findings to refine our assessment of upslope vegetation based on the probability of rain-on-snow events (Grant et al. 2008)

Key Findings
Results are presented for (1) monitoring questions that evaluate the success of the NWFP aquatic conservation strategy, (2) a comparison of watershed condition for different land use allocations and between key and nonkey watersheds, and (3) contributors to watershed condition (see Lanigan et al. 2010).

What is the status of inchannel conditions?
Grouping scores for the 193 subwatersheds with inchannel data into categories, shows that relatively few fell into the low (10 percent) and very low (1 percent) categories (fig. 4-8). The majority of inchannel attribute scores fell into the moderate (35 percent) and high (41 percent) ranges, with relatively few (12 percent) in the very high category. For low-scoring subwatersheds, water temperature was often the most influential factor. In many of the provincial evaluation models, a poor water temperature score carried more weight than other attributes because it was only measured once for each subwatershed (at the lowest point), in contrast to the other attributes, which were averaged over 6 to 8 sites. Aquatic invertebrate and wood scores also appeared influential in producing the low scores. Fig. 4-9 shows the spatial distribution of inchannel scores. Low scores are found only in the southern half of the NWFP area, with over 70 percent found in the Klamath-Siskiyou-Franciscan Province. Water temperature and macroinvertebrates were again the lowest scoring factors.

What is the status of upslope and riparian conditions?
Overall condition scores of the 1,379 watersheds are clustered in the center of the distribution and skewed slightly positive (fig. 4-10). Most fell into the low (21 percent), moderate (27 percent) high (26 percent), and very high (22 percent) categories; relatively few watersheds scored in the very low (4 percent) category

The spatial distribution of watershed scores shows some noticeable patterns (fig. 4-11). High scores are found in the central Olympic Peninsula (Olympic National Park), the north central Cascades, the Oregon Coast Range, and scattered pockets along the Klamath-Siskiyou mountain range (mostly corresponding to designated wilderness areas). Low condition scores can be seen in the southern Olympic region, eastern Klamath-Siskiyou, and along the eastern and western flanks of the Cascade Range in Oregon and Washington. These low-scoring areas are generally closer to existing development and lower in elevation and slope, making them historically more accessible to roading and timber harvest.

What is the trend of watershed condition?
The majority of watersheds had a positive change in condition scores (fig. 4-12). Of those with larger positive changes, most were driven by both improvements in road (decommissioning) and vegetation (natural growth) scores. The greatest negative score changes were caused by the Biscuit Fire and other fires along the eastern side of the Cascades (fig. 4-13). Half of the fire-impacted watersheds were in Congressional reserves, 35 percent in late-successional reserves, and 15 percent in matrix (lands identified for timber production).

Looking more closely at the distribution of changes, 8 percent of the watersheds showed no change in score (dot on fig. 4-12). In some cases this "no change" value was the result of no changes in any of the underlying attributes, but in other cases an increase in one or more attributes was cancelled out by declines in others (generally these increases/decreases were quite small). By far the largest trend category was score increases between 0 and 0.1 (55 percent). This trend was largely due to small increases in vegetation scores from natural tree growth moving acres out of early seral classes and into late seral classes. The second largest trend category was a minor decrease between 0 and -0.1 (18 percent) in watershed condition score. Since there has been little road building on federal lands, this trend was again due to vegetation but in this case losses in average tree diameter or canopy cover.

Comparison of Land Use Allocations, and Key vs. Nonkey Watersheds

Watershed condition was most positive for congressionally reserved lands, followed by late-successional reserves (LSR), and then matrix lands (fig. 4-14). Condition changed very little between 1994 and 2008 for any land use allocation (LUA). Scores ranged from -1.0 (poor) to +1.0 (good).

Key watersheds were in better condition than nonkey watersheds in both 1994 and 2008 (fig. 4-15). There was little difference in the amount of change that occurred between these years. Key watersheds provide high-quality habitat or refugia for aquatic- and riparian-dependent species or would be able to after restoration.

Contributors to Watershed Condition

Over 3,400 miles of road were decommissioned between 1994 and 2008. On average, road density (miles of road per square mile of watershed [mi/mi^{2})] in key watersheds was reduced twice as much as in nonkey watersheds. However, the change in road density for most watersheds (75 percent) was less than 0.1 mi/mi^2 (fig. 4-16). Only 5 percent had reductions > 0.5 mi/mi^2,which would be likely to change watershed condition scores.

On a per-watershed basis, pre-plan (prior to 1994) vegetation losses were primarily due to harvest on matrix (timber production) lands (fig. 4-17). In contrast, the greatest post-plan losses have been mainly due to fire and mostly on congressionally reserved lands and late-successional reserves (LSR).

Did the NWFP succeed in maintaining and improving watershed condition from 1994 to 2008? Examining the trend data suggests the answer is yes. The trend was clearly positive with 69 percent of watersheds trending up versus 23 percent showing declines.

Next Steps and Recommendations

Additional research and analysis

Culvert fish passage data, when they become available, should be incorporated into our watershed condition models to reflect how much fish habitat is presently blocked by culverts, and how much fish habitat has been opened up owing to culvert replacements or removal.

Model results indicate relationships between mapped data and inchannel data are currently not very strong. More investigation is needed for the following:

- Are there other attributes we could be using that would result in a stronger relationship?
- How do we take into account the time needed for management actions to be reflected in stream channels?

Further work is needed to describe the benefits and harm that fires cause to watershed condition.

Management review

A management review is underway in 2011 to determine if changes are needed after 10 years of implemention. Questions to be addressed include:

- What are relevant management questions today?
- Is the current effort still needed to answer the questions of status and trend? Should it be adjusted?
- What are new technologies that help answer management questions (e.g., satellite imagery and LiDAR)? Can these be used in lieu of instream sampling?
- The watershed condition monitoring program uses a fairly sophisticated decision-support tool; is it a good fit?
- What are AREMPs strengths? weaknesses?
- What can findings from AREMP be used for besides NWFP monitoring?

Figure. 4-1-Aquatic provinces used to assess watershed condition in the Northwest Forest Plan (NWFP) area.

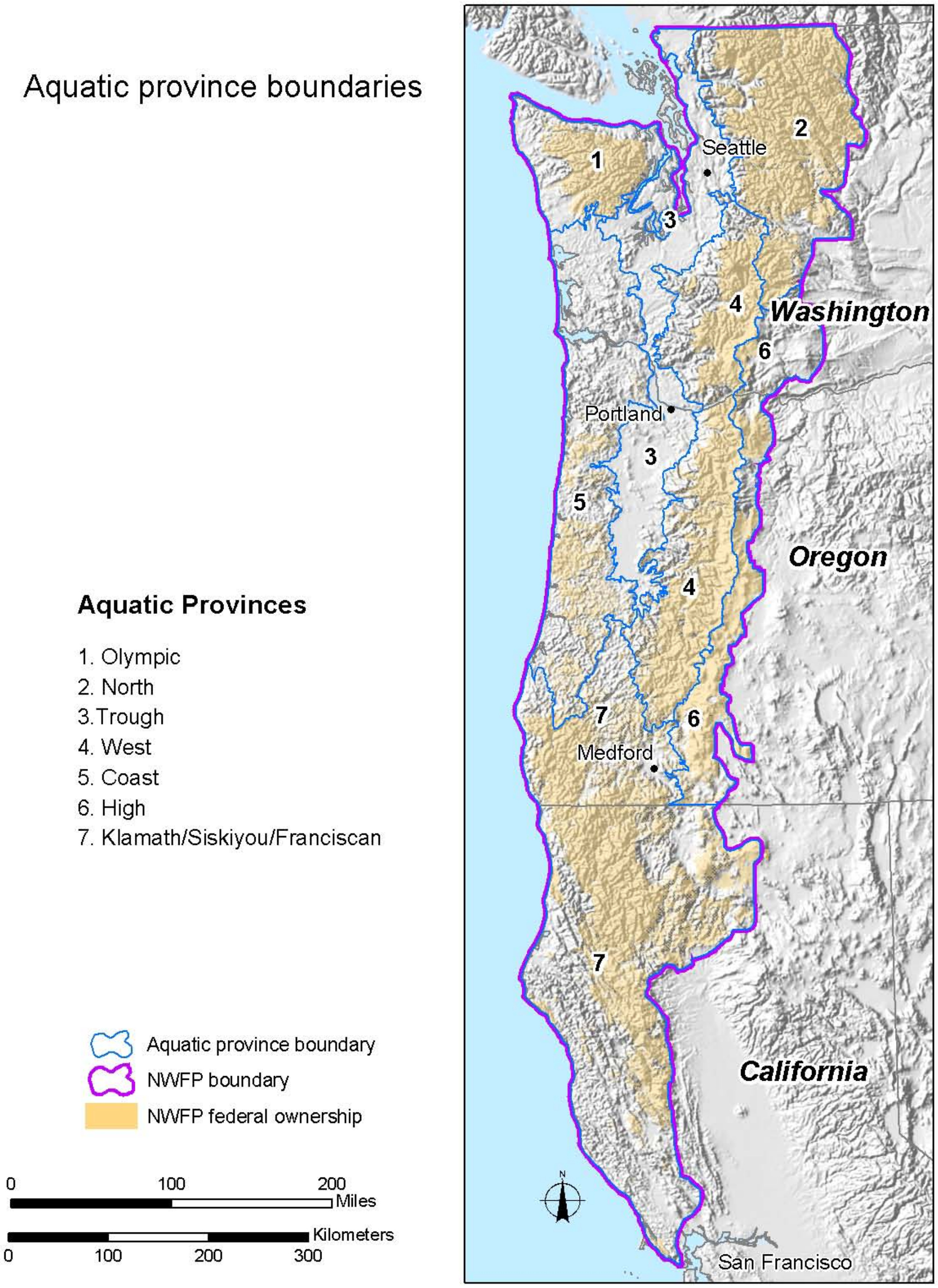


Figure 4-2-Fine sediment was measured at pool tail crests. (Steve Lanigan photo)

Figure 4-3-Large pieces of wood in the stream channel were counted throughout each sampled stream area. (Steve Lanigan Photo)

Figure 4-4-Pool depth and surface area were measured throughout the length of sampled stream areas. (Jared Blake photo)

Figure 4-5-Macroinvertebrates were collected to determine a biotic metric for use in the watershed condition decision-support model. (Steve Lanigan photo)

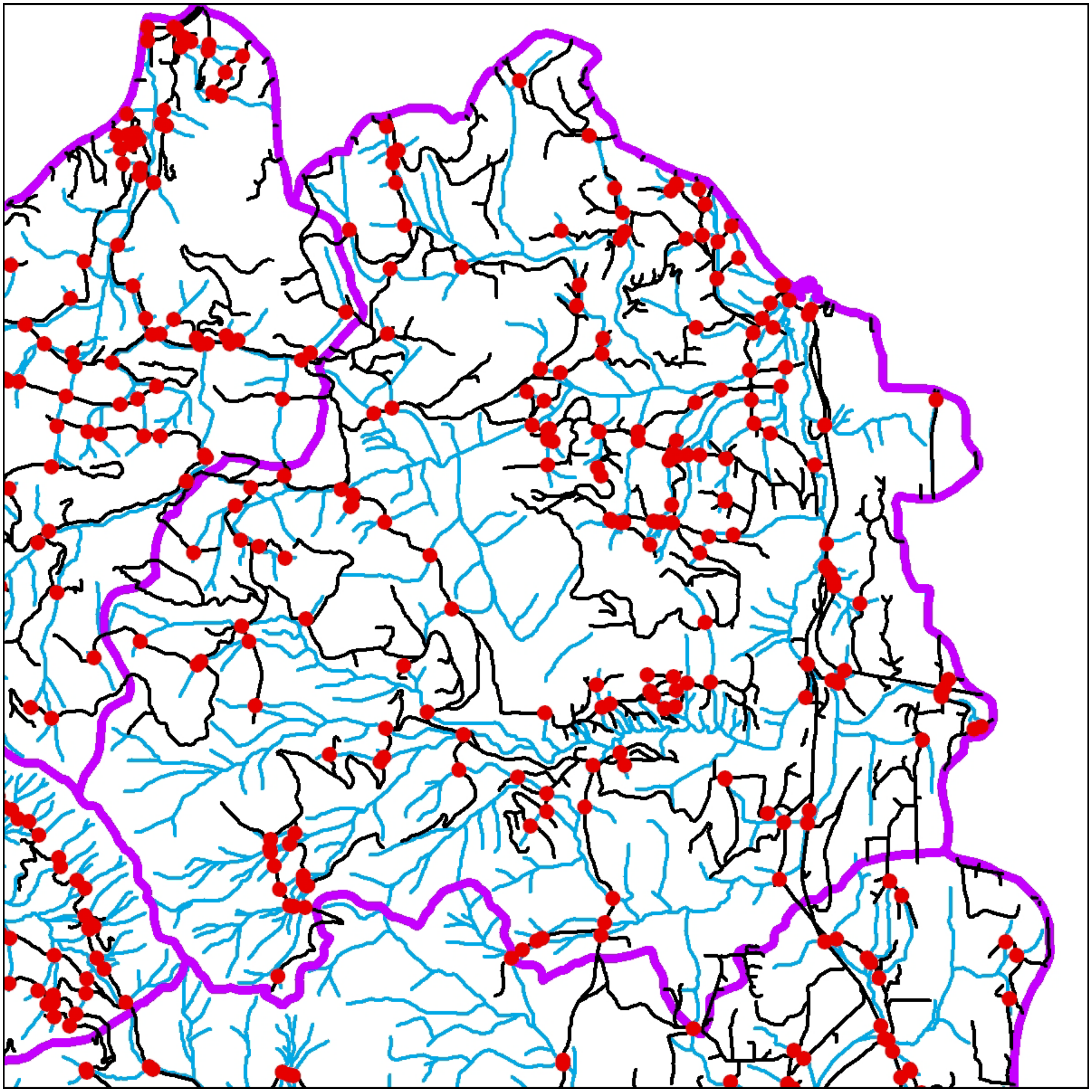


Figure 4-6-Road data (black lines) were a combination of Forest Service road layers and the Bureau of Land Management's (BLM) ground transportation layer. The stream layer (blue lines) was from the BLM 1:24,000 stream geodatabase. The red dots show road stream crossings.

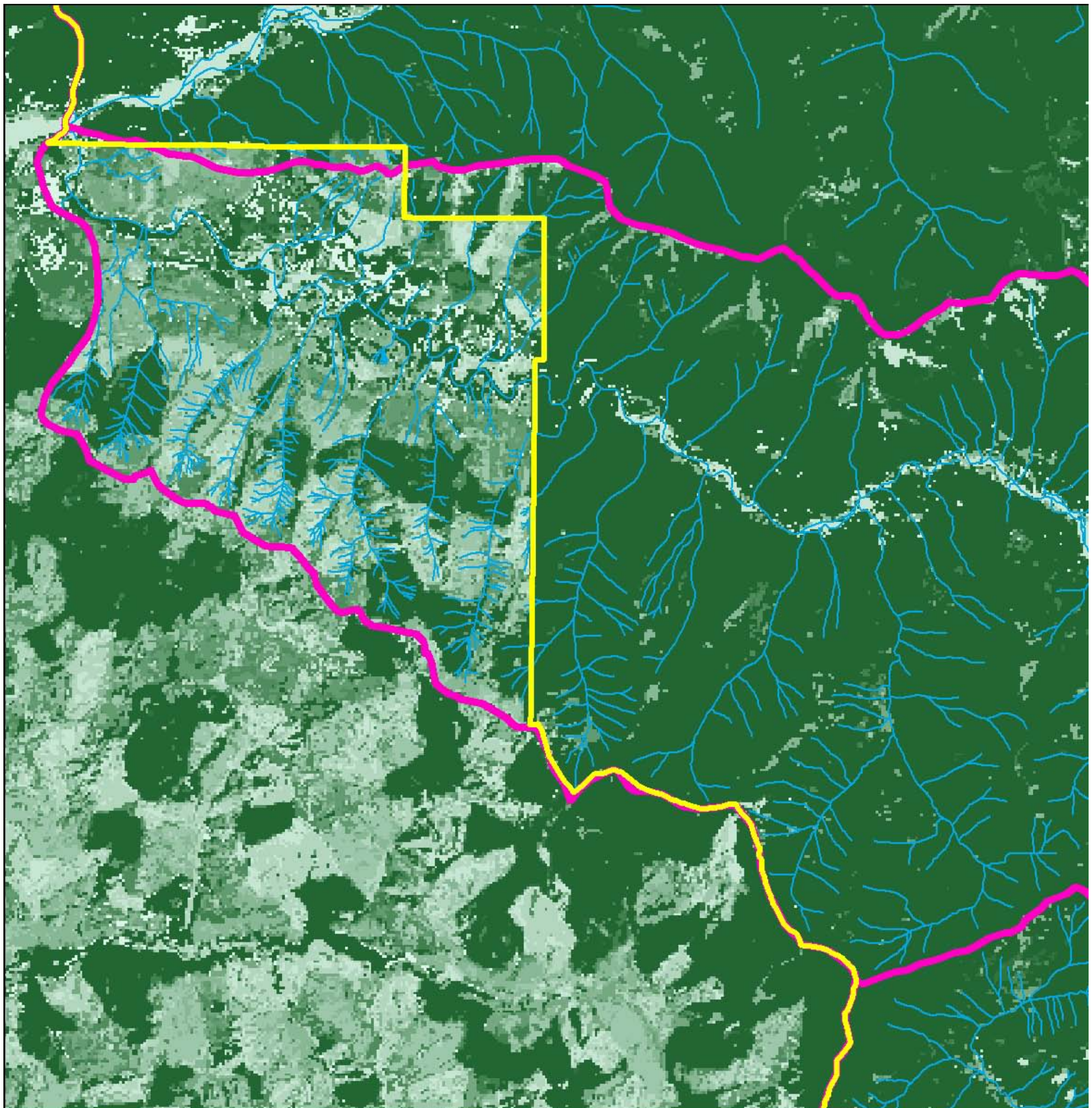


Figure 4-7-Vegetation metrics were determined by using satellite imagery data. The lighter areas to the left of the federal lands boundary (yellow line) show recent harvest activity on nonfederal lands.

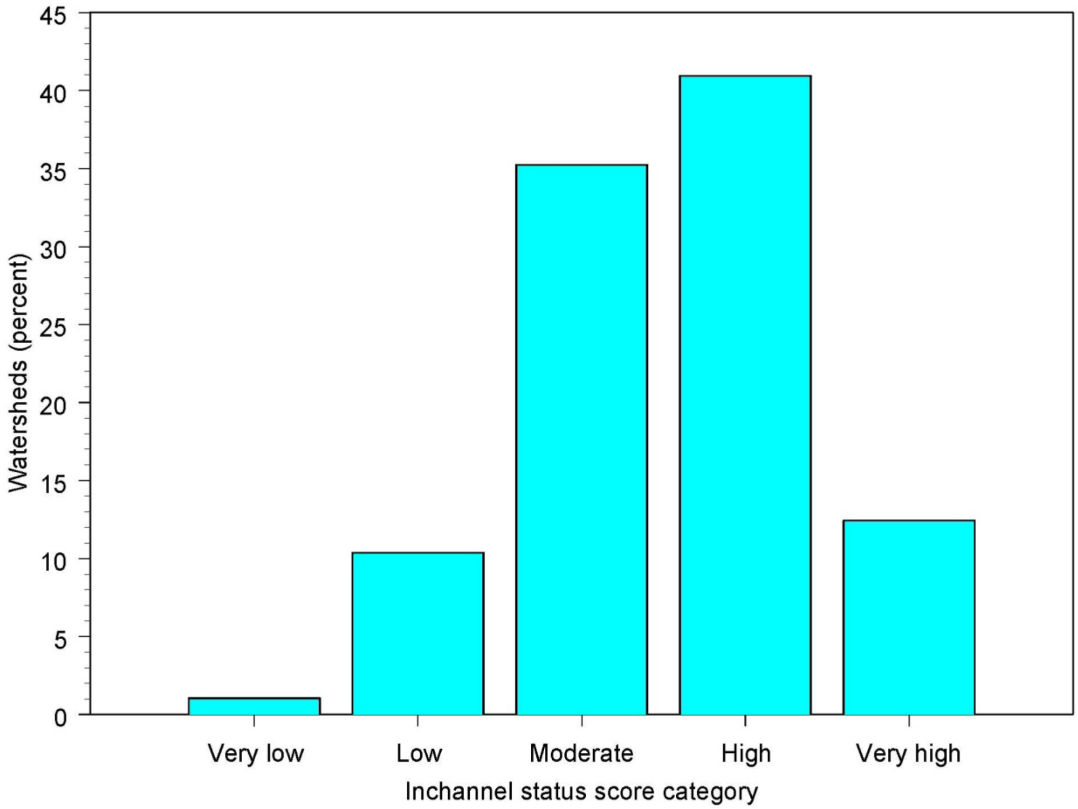


Figure 4-8-Inchannel condition scores by status category for the 193 randomly selected watersheds that were sampled, as of 2009, for inchannel attributes.

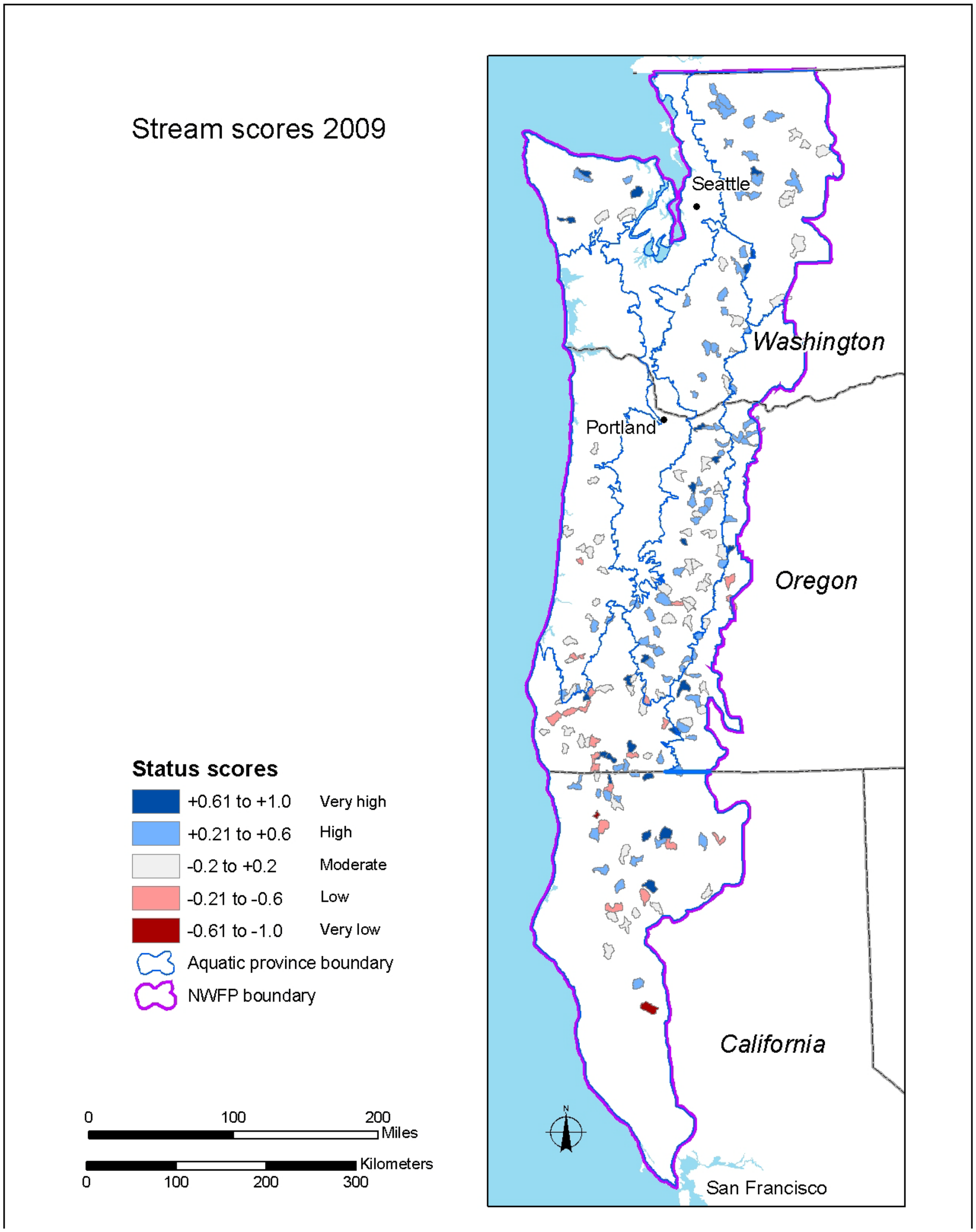


Figure 4-9-Inchannel condition scores for the 193 randomly selected watersheds that were sampled, as of 2009, for inchannel attributes. NWFP = Northwest Forest Plan.

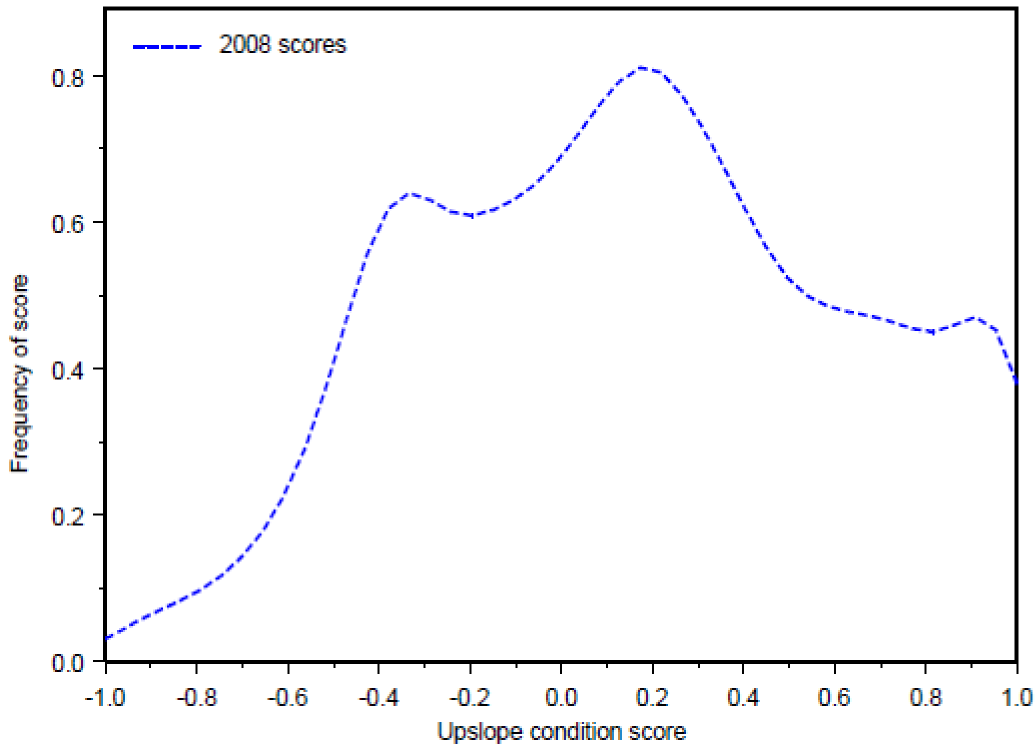


Figure 4-10. Watershed condition scores (based on road and vegetation data for 1,379 watersheds) in the Northwest Forest Plan area by status category in 2008. This curve shows the data in a continuous manner, rather than by data bins (i.e., histograms).

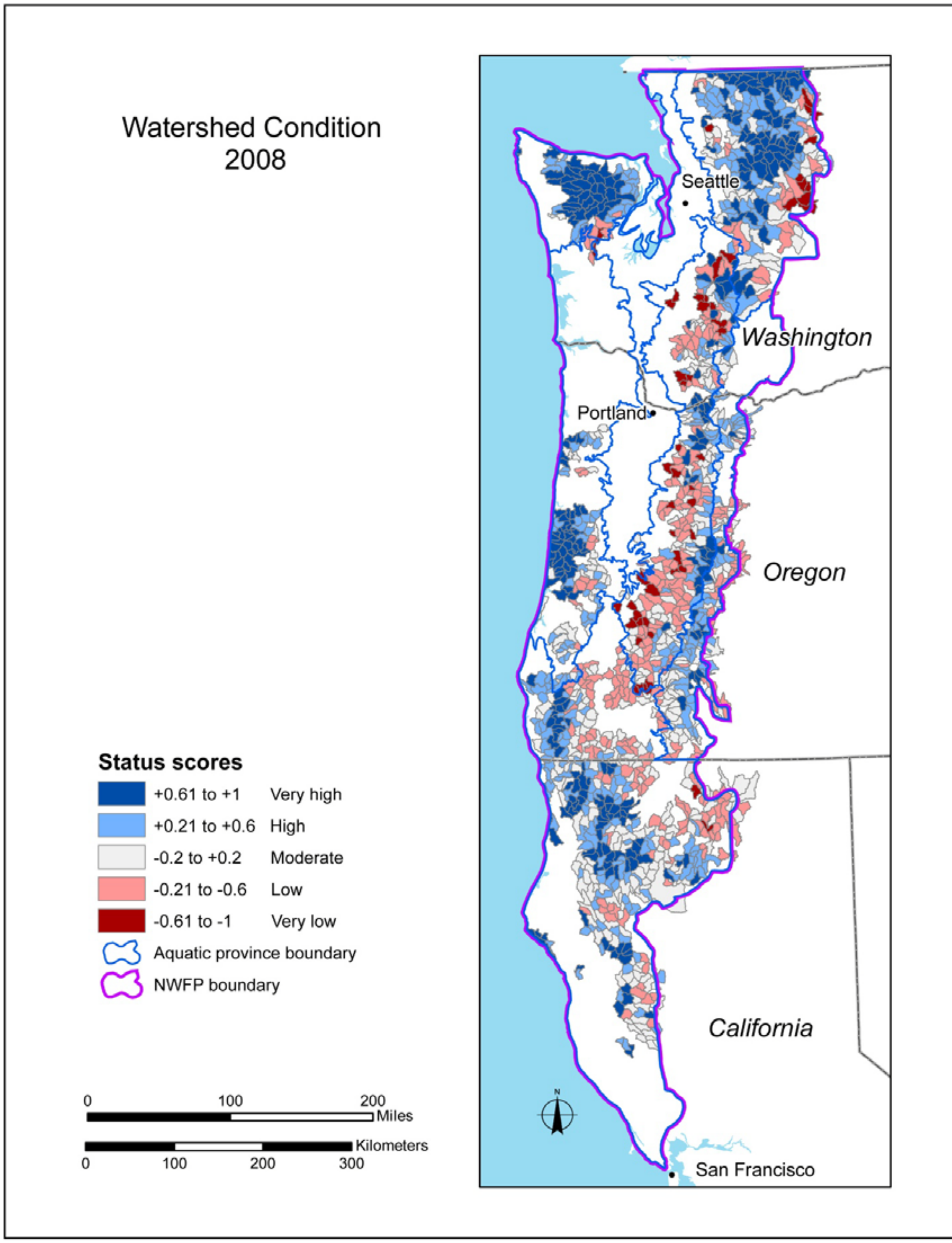


Figure 4-11-Watershed condition scores in 2008, as determined from geographic information system and remote sensing data. NWFP = Northwest Forest Plan

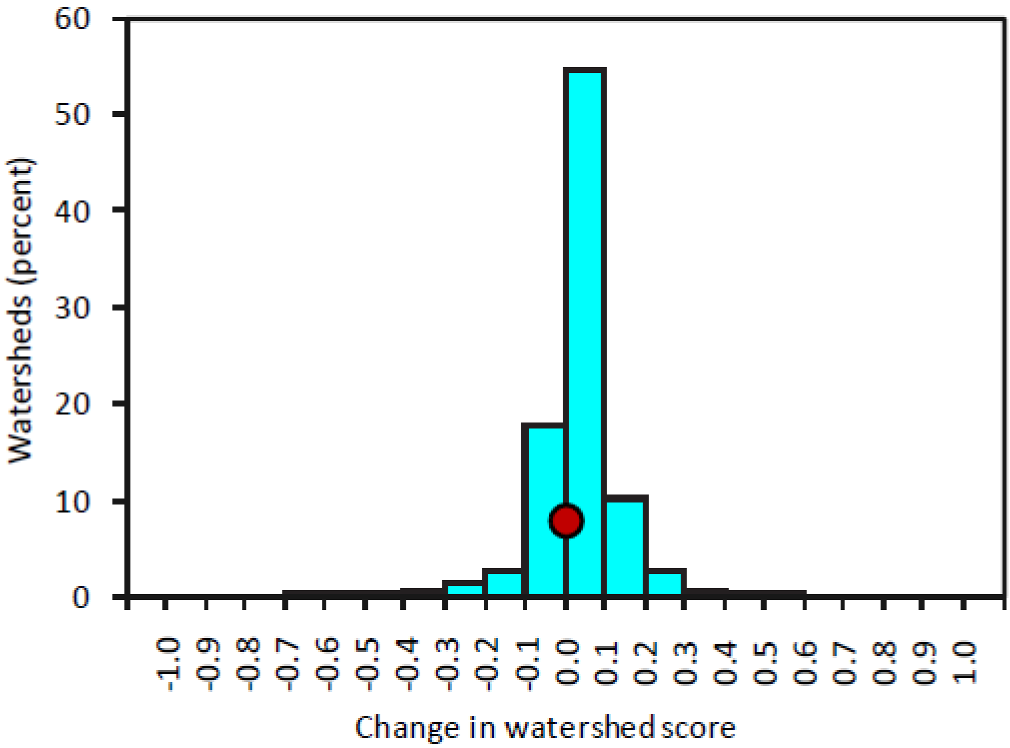


Figure 4-12-Distribution of changes in watershed condition scores between 1994 and 2008 (the red dot indicates 112 watersheds had no change).

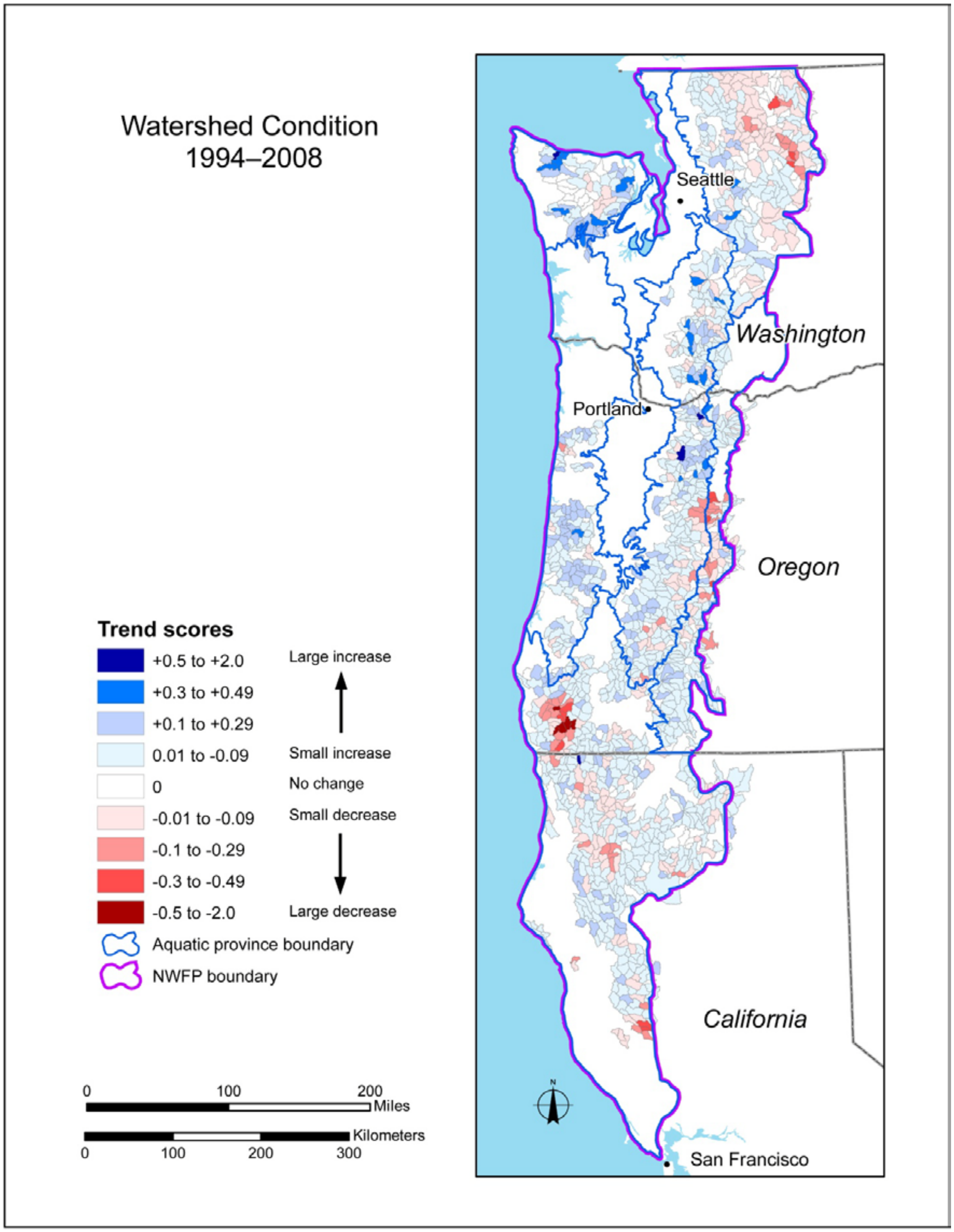


Figure 4-13-Watershed condition trend scores (1994 to 2008), as determined from geographic information system data and remote sensing data. NWFP = Northwest Forest Plan

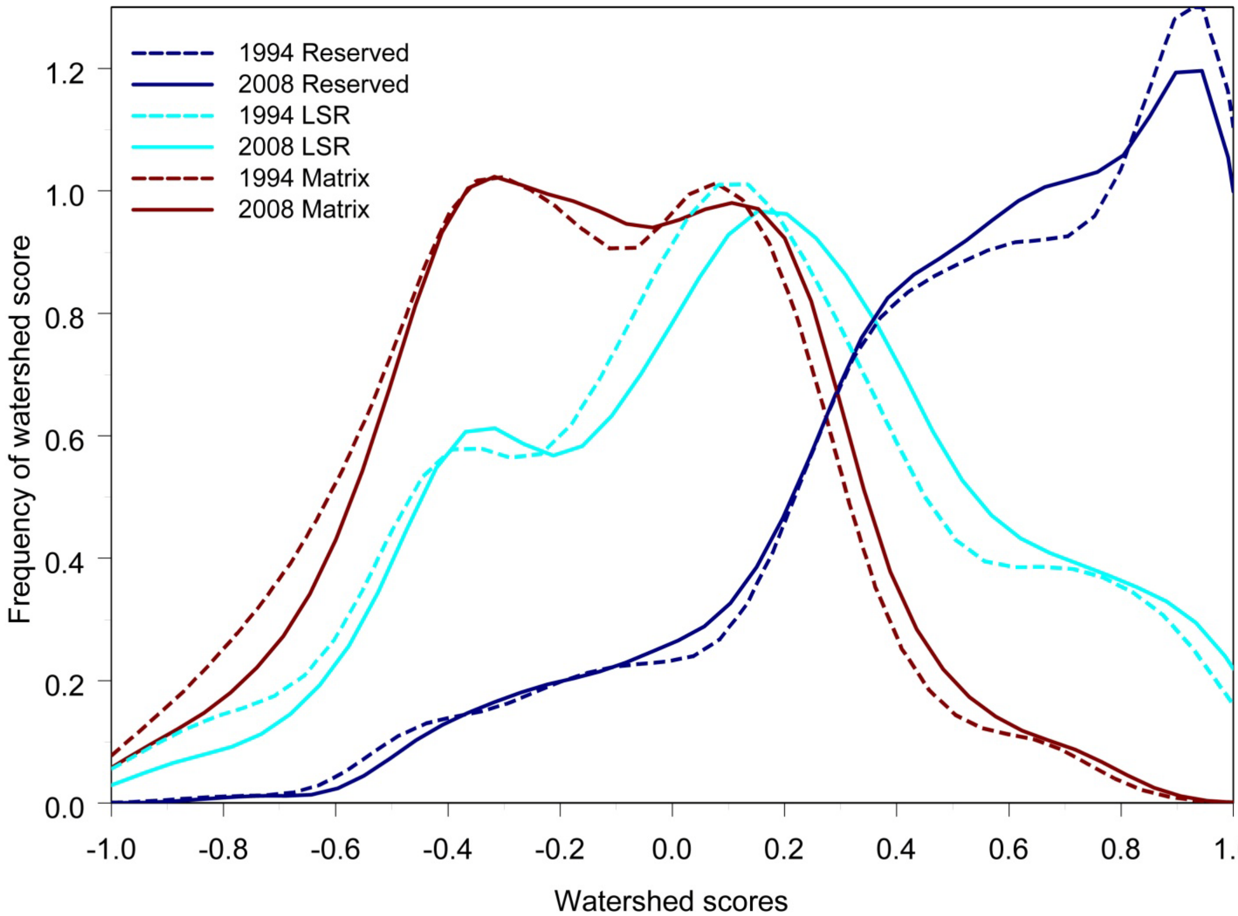


Figure 4-14Frequency of 1994 and 2008 watershed condition scores for congressionally reserved (reserved), late-successional reserves (LSR), and matrix lands. These curves show the data in a continuous manner, rather than by data bins (i.e., histograms).

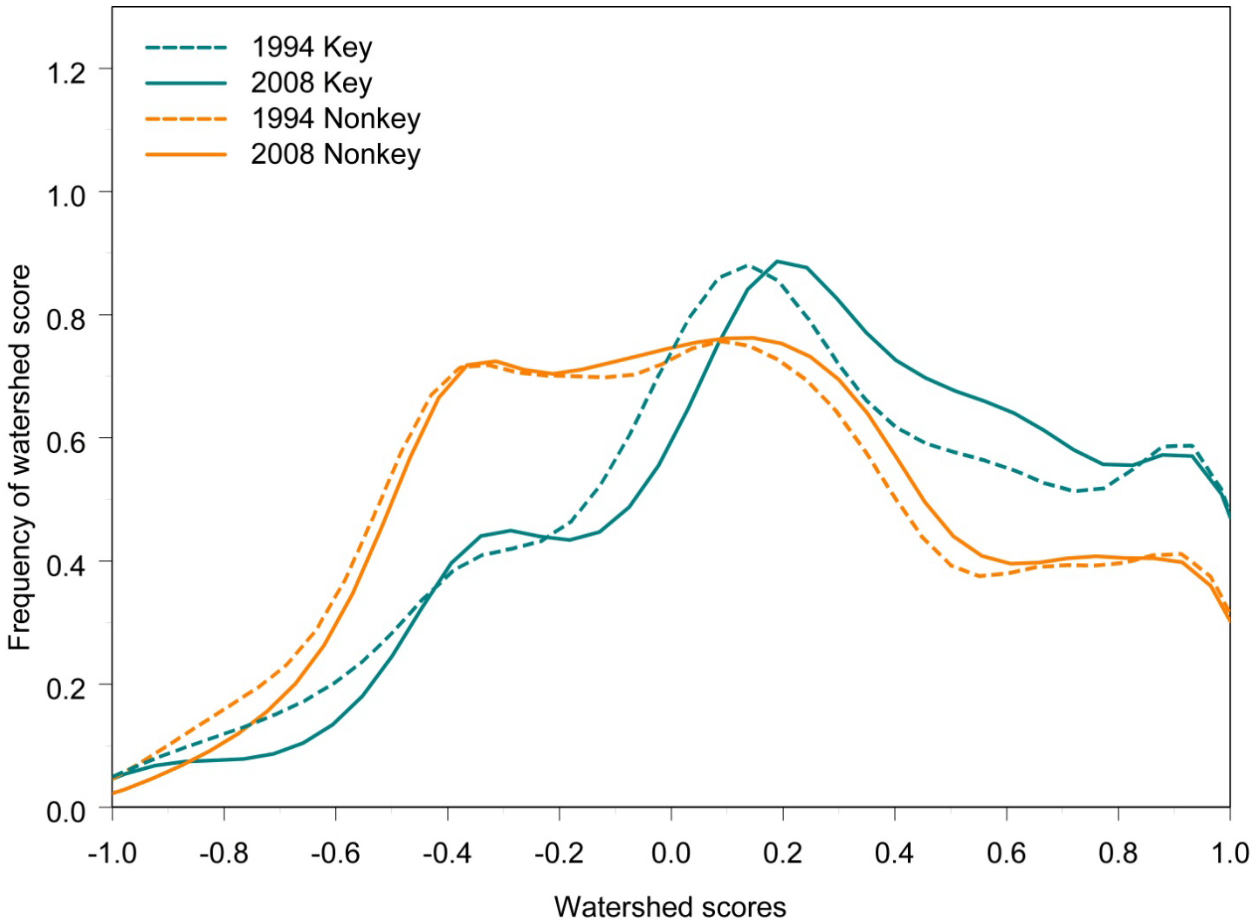


Figure 4-15-Frequency of 1994 and 2008 watershed condition scores for key and nonkey watersheds. These curves show the data in a continuous manner, rather than by data bins (i.e., histograms).

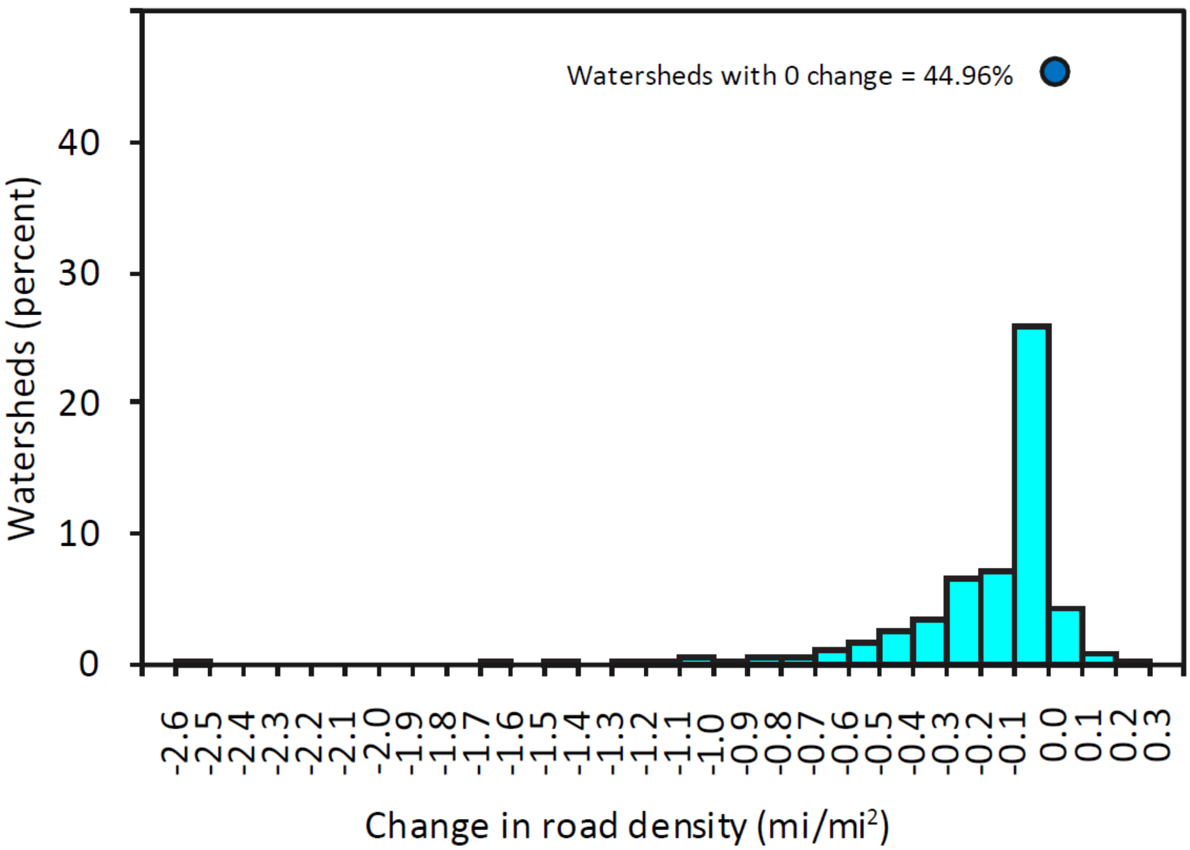


Figure 4-16-Change in road density from 1994 to 2008.

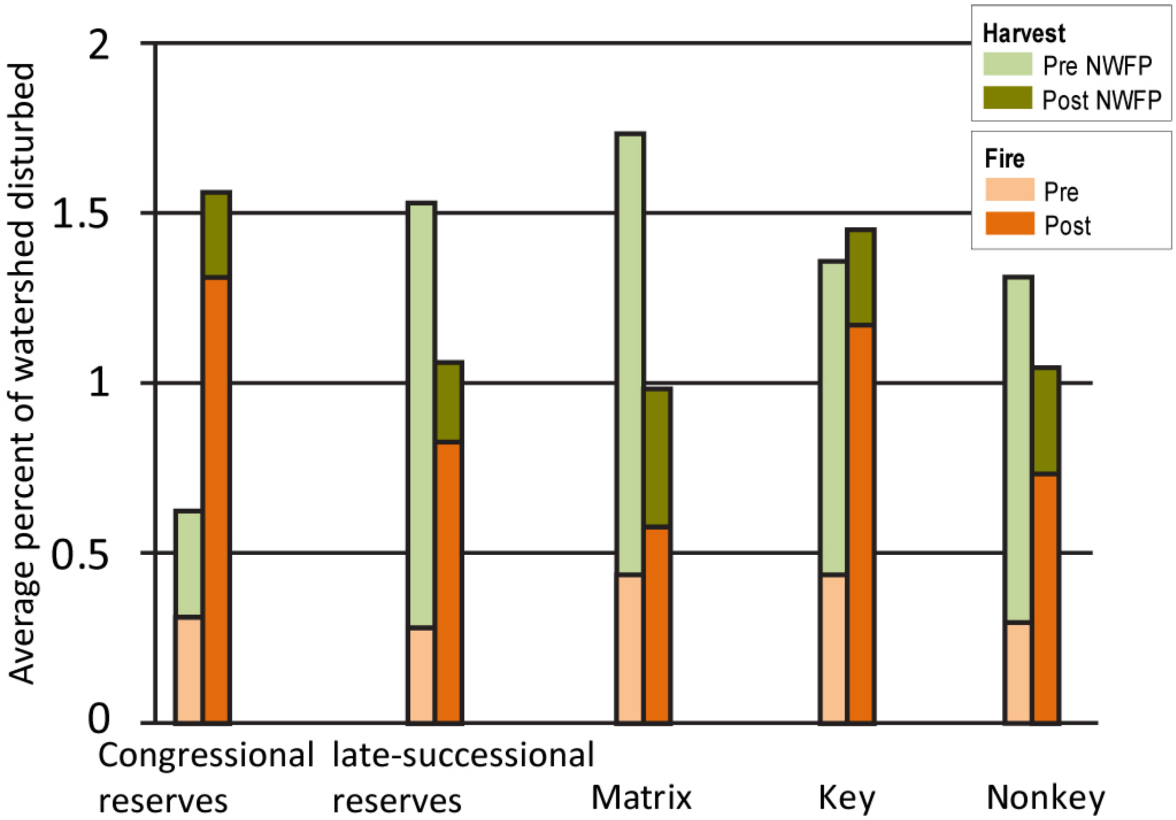
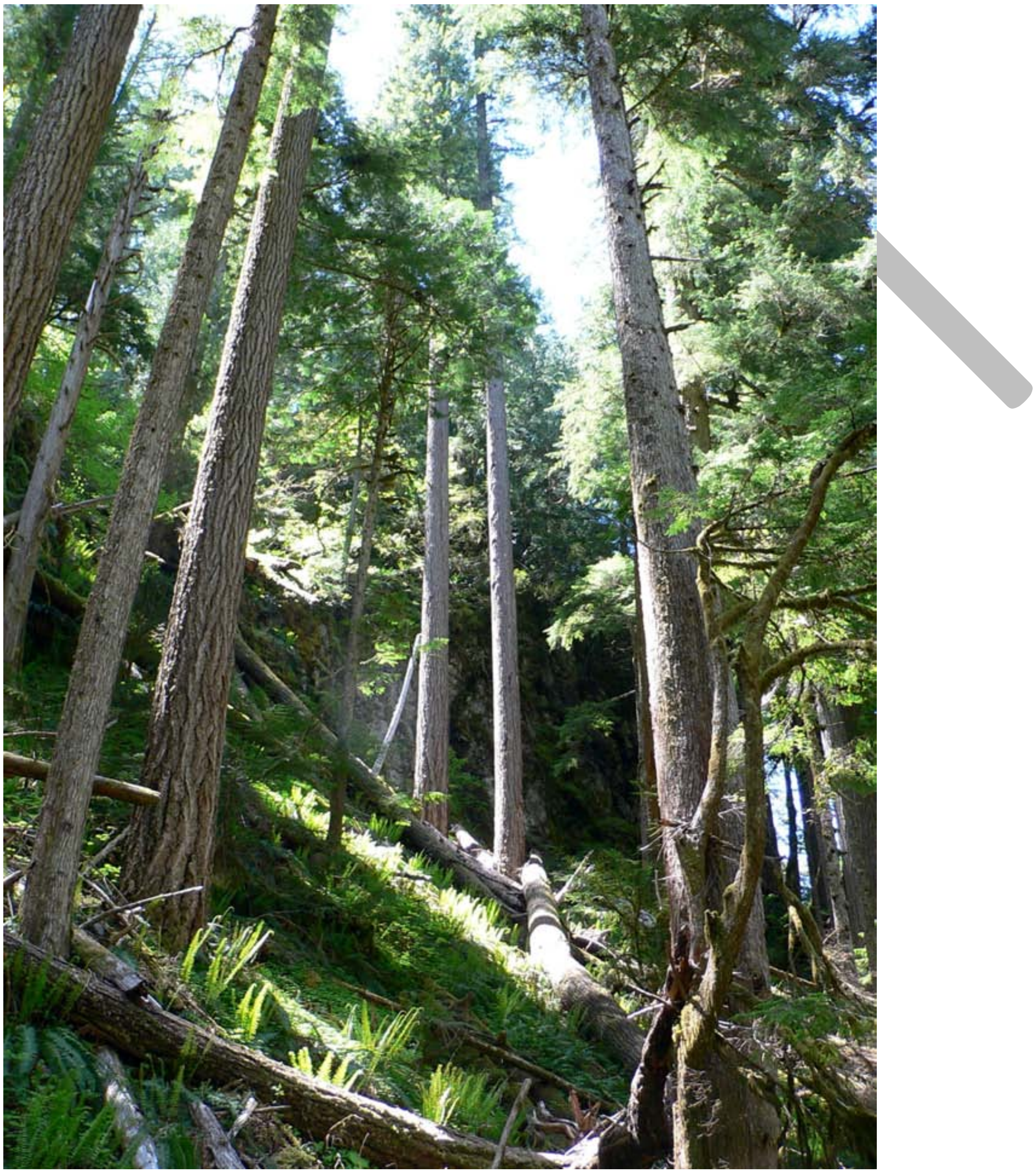


Figure 4-17-Average pre- and post-Northwest Forest Plan (NWFP) fire and harvest disturbance levels by land use allocation, and for key and nonkey watersheds. Note: No harvest occurred on congressionally reserved lands; the harvest category includes small fires and blowdown. Also, watersheds classified as reserve may have portions of nonreserve where harvest can occur. Pre-NWFP is based on data from 1985 to 1993; post-NWFP is based on data from 1994 to 2008.

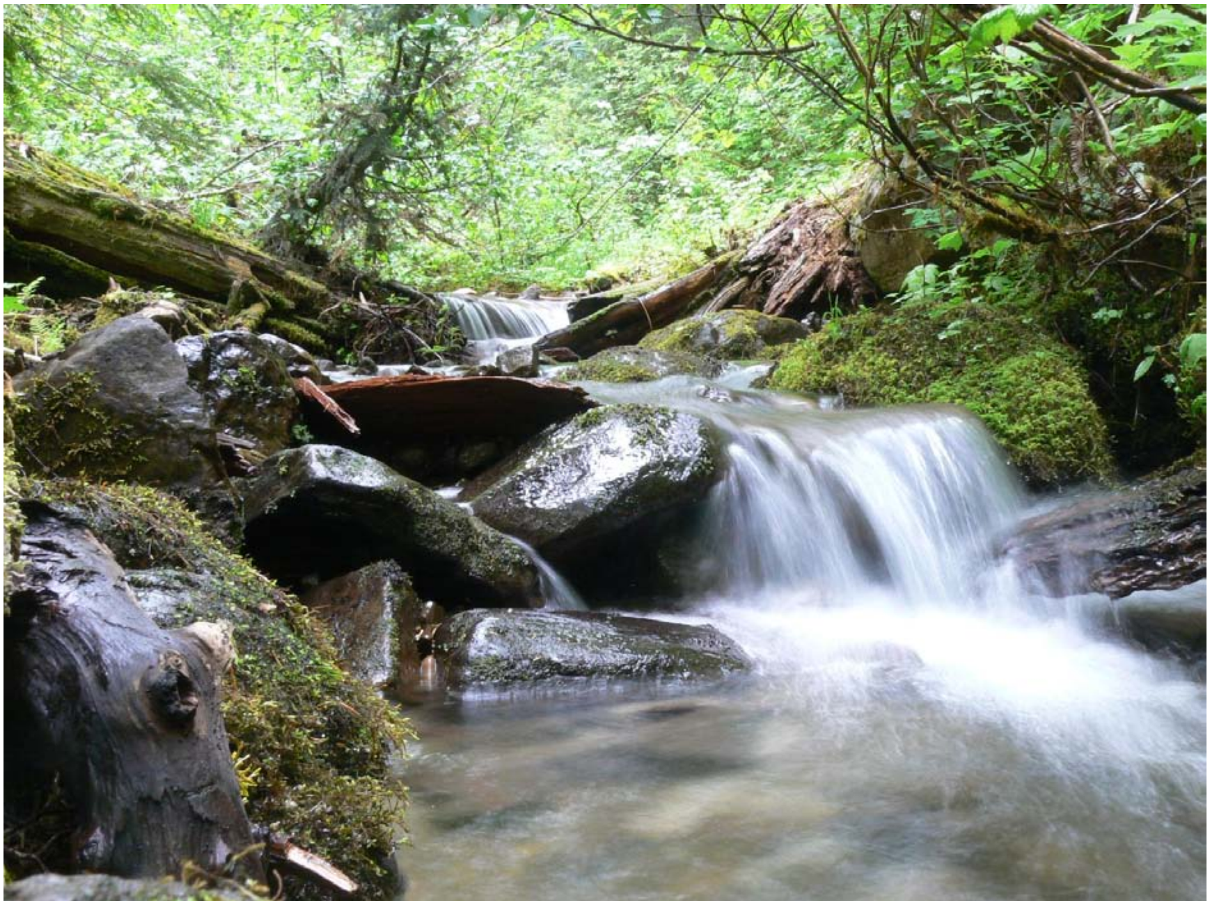
“ 

Steve Lanigan photo

Jenine Tobey photo

Kim Beedle photo

Kim Beedle photo



Steve Lanigan photo

Chapter 5: Socioeconomic Status and Trends

Elisabeth J. Grinspoon and Richard H. Phillips

Introduction

Social and economic issues are part of the controversy that led to development of the Northwest Forest Plan (NWFP) Record of Decision. This controversy emerged in the late 1970s and included three related social and economic issues: (1) the role and quantity of federal timber in the market; (2) federal agency obligations to communities near or among federal timberlands; and (3) the role forests play, especially federal forests, in local and regional economies.

Objective

The social and economic monitoring program assembles existing data to determine the status and trends in social and economic well-being in the NWFP area. The program tracks demographic data as well as data on agency expenditures and several forest-related resources to display potential trends. The data are not suitable for a statistically valid cause-and-effect analysis linking trends in socioeconomic well-being to natural resource management activities on federal lands.

Methods

Existing social, economic, and federal agency data are used to assess the status and trends in socioeconomic well-being in the NWFP area. Trends for population, ethnicity, unemployment, employment, and personal income are charted. Data on quantifiable resource management activities on federal forest lands that contribute to social and economic well-being are also tracked. These include timber, special forest products, grazing, minerals, and recreation. Of all the above attributes that contribute to socioeconomic well-being, employment is one of the foundations. Employment instability can cause severe hardships on individuals and families, as well as distress in local and regional economies. Therefore, employment is weighted as a primary factor determining socioeconomic well-being within the NWFP area over the report period.

What Is New This Time?

As part of the social and economic monitoring program, new research was conducted for the 10-year report to answer questions about predictable levels of timber and nontimber resources and changes experienced by local communities and economies. In March 2006, the Regional Interagency Executive Committee (RIEC) agreed upon new monitoring priorities and methodologies. At the same time, the RIEC developed a new socioeconomic monitoring question that replaced the questions posed for the 10-year report. The question is: What is the status and trend of socioeconomic well-being? To answer this question, the RIEC specified periodic regional analysis of existing data.

Key Results

Employment associated with Forest Service and BLM programs contribute to socioeconomic well-being in the NWFP area. Agency employment, and jobs supported by agency timber harvest and recreational activities are the largest components of these contributions. Between 2001 and 2007, overall agency employment declined, while agency timber harvest-related employment increased (fig. 5-1). Data show that recreation-related employment was substantial during the same period.

Timber harvest and related employment have been key issues in forest policy discussions since the early 1970s. Total employment in the wood products processing industries, including secondary wood manufacturing and logging, has a history of increasing and decreasing in the NWFP area. Between 2001 and 2007, total employment in the wood processing industries declined overall by nine percent (fig. 5-2). Timber employment is closely related to timber harvest. From 2001 to 2004, timber harvest levels from all ownerships rose. By 2007, timber harvest declined back to 2001 levels. This decline in harvest can be attributed mostly to reductions in timber harvest on nonfederal lands. On these ownerships, harvest decreased by 16 percent since 2004 compared to a one percent decline in timber harvest from federal lands.

Between 2001 and 2008, timber offered for sale on federal lands more than doubled, and timber harvest in 2008 was nearly double that of 2001 (fig. 5-3). In 2008, timber offered for sale was slightly over 75 percent of probable sale quantity (PSQ); timber harvest was slightly below 50 percent of PSQ. Between 2001 and 2007, the percentage of timber harvested on federal lands compared to total harvest on all ownerships increased from 2 to 6 percent.

Population size is often an indicator of economic diversity. Most people in the NWFP area live in counties that the U.S. Department of Labor describes as metropolitan. These counties contain core urban areas of 50,000 or more population. In the past decade, the population of counties that fall into the nonmetropolitan category has increased more slowly than those that fall into the metropolitan category (fig. 5-4).

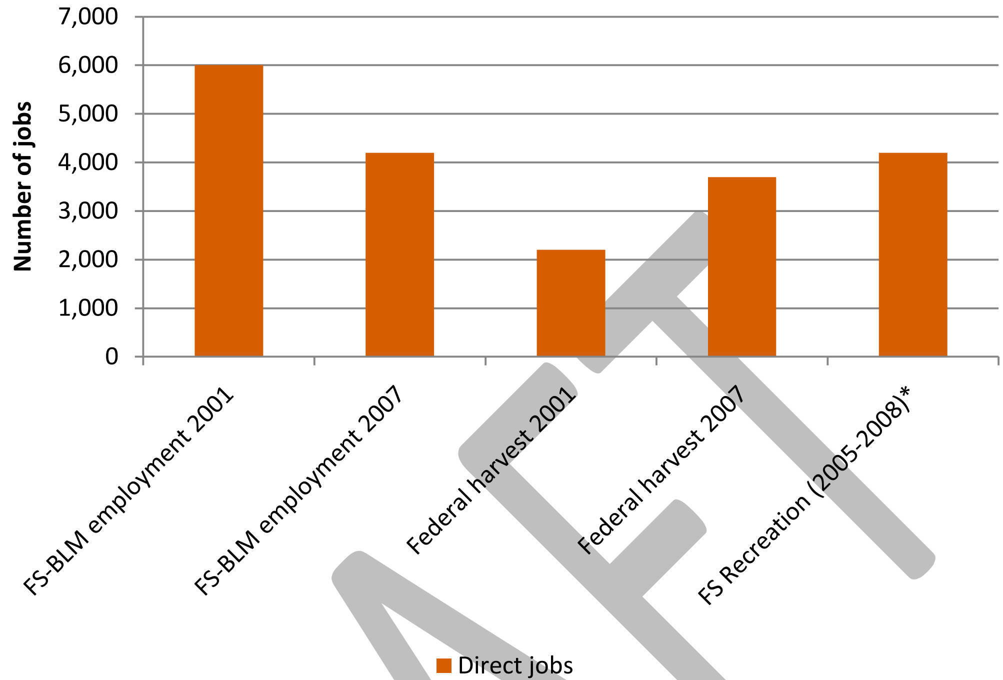
Nonmetropolitan counties are less diverse economically and more strongly tied to the wood products industry. Most of the timber harvested in the NWFP area comes from nonmetropolitan counties. Although forest products manufacturing employment is about equally split between metropolitan and nonmetropolitan counties, it accounts for roughly 10 percent of total employment in nonmetropolitan counties and only one percent in metropolitan counties. The effects of changes in timber harvest and wood-products-related employment on well-being are likely more pronounced in nonmetropolitan counties.

A discussion of social and economic well-being is not complete without mention of the recent economic downturn and associated trends in unemployment. The trends in national and world economic conditions influence well-being in the NWFP area and may mask the socioeconomic effects of federal land management actions. In three states with land in the NWFP area, unemployment increased during the latter part of the first 10-year reporting period (fig. 5-5). Unemployment then decreased during next 5 years, the time period reviewed in this 15-year report. Looking toward the 20-year monitoring report, unemployment rates are changing. Since the end of the 15-year reporting period (2007), average unemployment rates in the three NWFP area states rose from about 6 percent to about 11 percent (fig. 5-5). The large unemployment increase will likely result in declining socioeconomic well-being in the NWFP area and affect the ability to interpret the socioeconomic effects of NWFP implementation in the 20-year report.

Next Steps and Recommendations

A management review of the Social and Economic Monitoring Program is proposed for early to determine if any changes to monitoring protocols are warranted. Suggested questions for review include:

- What are the advantages or disadvantages of relying on existing data or using a combination of new research and existing data?
- Are there new technologies or monitoring programs that can help answer questions about the status and trends of social and economic well-being?
- How can the results of the Social and Economic Monitoring Program contribute to other agency programs?



* Survey data were collected on National Forests during 2005-2008. No comparable data are available for the BLM.

Figure 5-1 – Employment supported by agency programs in the NWFP area.

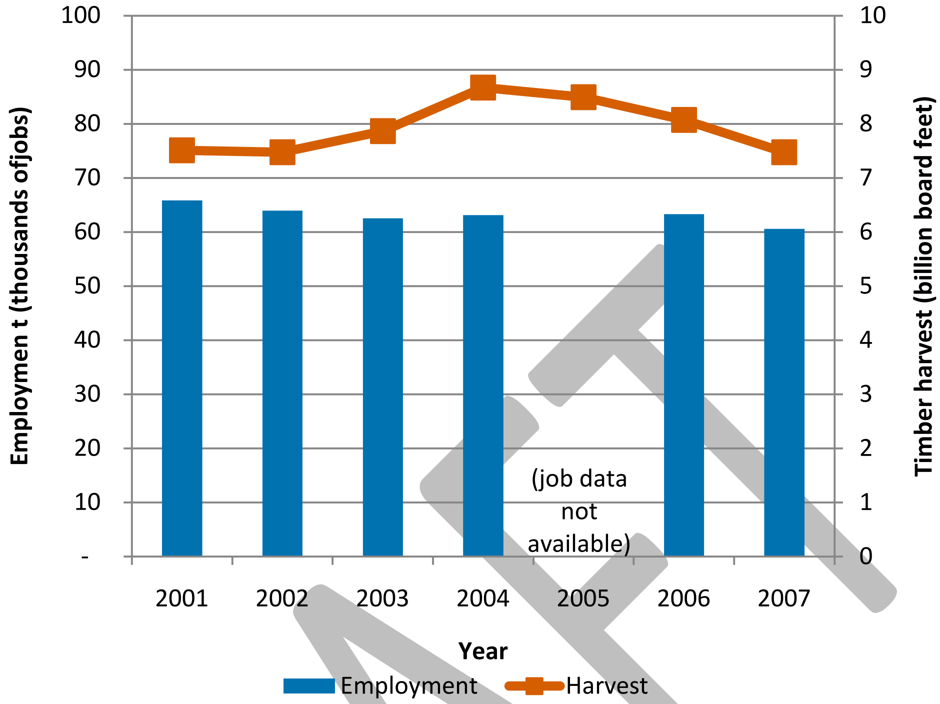


Figure 5-2–Timber-related employment and timber harvest on all ownerships in the NWFP area (2001-2007).

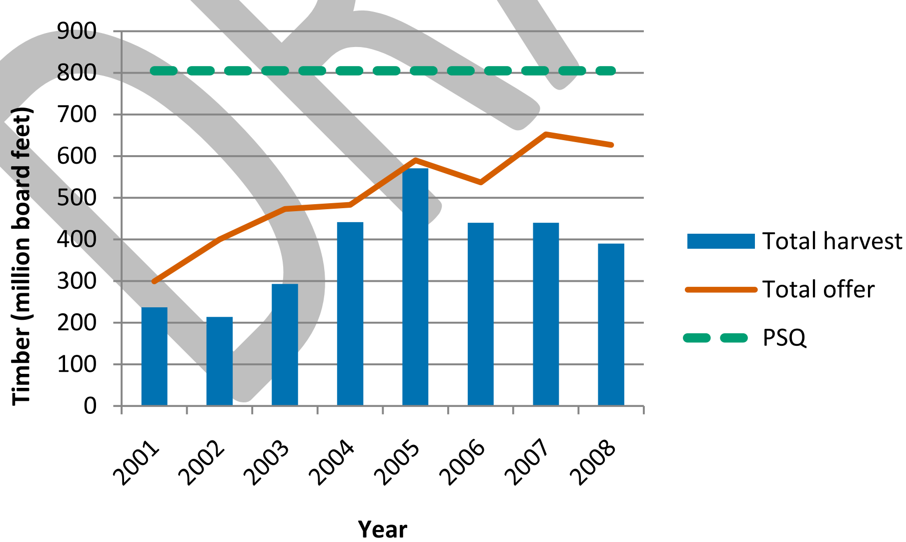


Figure 5-3–Total timber offered for sale, timber harvest and probable sale quantity (PSQ) on federal lands, 2001-2008.

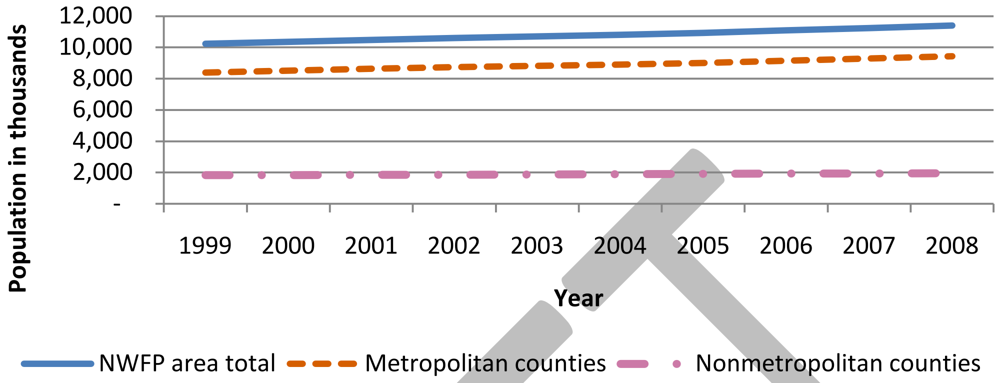


Figure 5-4 –Population change in NWFP area counties, 1999-2008.

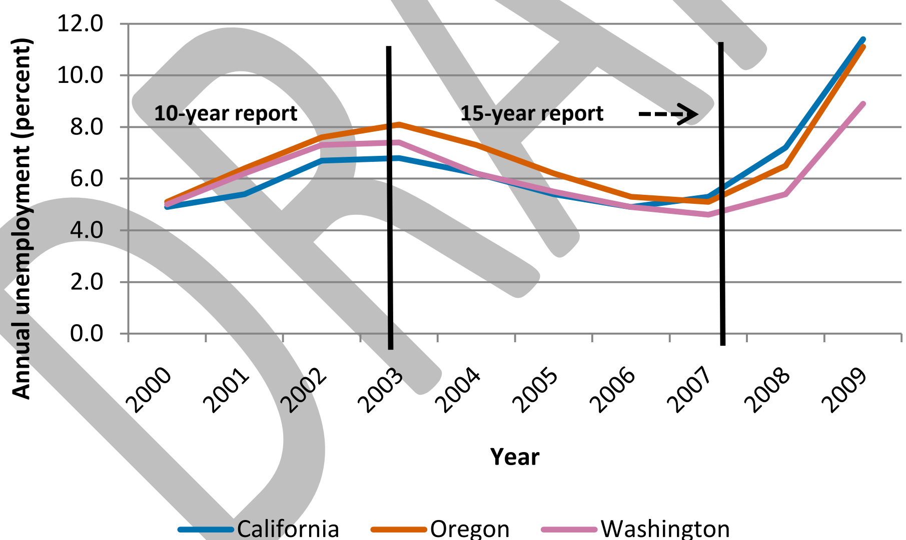


Figure 5-5–Unemployment in California, Oregon, and Washington (2000-2009).

Photos

Photo: Tom Kogut

Photo: Susan Charnley

Chapter 6: Effectiveness of the Federal-Tribal Relationship

Gary R. Harris and Merv L. George Jr

Introduction

The 1994 Northwest Forest Plan (NWFP) directs agencies that manage federal land in the range of the northern spotted owl to monitor the effects of implementation of the plan's standards and guidelines in the affected parts of Oregon and Washington, and California.

The record of decision for the NWFP calls for monitoring of a number of elements, one being "American Indians and their culture." Key issues addressed in the initial monitoring effort for this aspect include:

- Conditions and trends of the trust resources identified in treaties with American Indians.
- Effectiveness of the coordination or liaison to ensure adequate protection of religious or cultural heritage sites.
- Adequacy of access by American Indians to forest species, resources, and places important for cultural, subsistence, or economic reasons under treaties.

Method

A Tribal Monitoring Advisory Group was chartered under the direction of the Interagency Advisory Council to develop recommendations to improve the protocol and techniques from the 10-year reporting cycle to the 15-year reporting cycle that were used to monitor the federal-tribal relationship and to obtain broader tribal participation.

Monitoring questions were developed around four focus areas:

- The consultation process, outcome, and tracking
- Access and protection
- Effect on tribal values of interest
- Strengthening of the federal-tribal relationship

Two studies, one in northern California and one in western Oregon and Washington, were chartered to monitor these questions. Interviews with representatives of 34 tribes were conducted. Seven case studies were completed. The results of these case studies, together with the interviews, help illustrate issues or situations affecting tribes.

The reports examine the state of consultation under the Northwest Forest Plan with a focus on consultation experiences of individual tribes. This paper briefly summarizes the findings.

Observations, Interests, Barriers, and Opportunities

Although no one tribe or participant speaks for all interests, the recommendations and lessons learned (combined from both reports) generally include observations about the effectiveness of the plan and consultation, specific interests of the tribes, barriers to consultation, and opportunities to strengthen government-to-government relationships. Taken together, the interviews and case studies reveal various types of relevant information. There is some overlap among interests and barriers as well as opportunities in the findings presented.

Tribal Observations

Although some people commented that federal management is overall compatible with tribal values, some saw that compatibility as situational.

Repeatedly cited were the conflicts arising from the overlay of treaty rights, land designations, plans, and management activities (e.g., fire management).

Observations across tribes and regions were variable, sometimes on the same topic. Comments repeatedly revealed concerns about effects of the Northwest Forest Plan on access to cultural sites, hunting, and gathering.

Likewise, participants observed both positive and negative effects of resource management under the NWFP. For example, one respondent noted positive effects on riparian conditions, whereas others found that NWFP and consultation processes slowed resource management and trust management activities.

Similarly, multiple respondents highlighted effects of land designations, planning processes, management activities and funding shortfalls on trust resources and treaty rights, and several noted that these can conflict with tribal values.

Regarding consultation itself, multiple responses indicated that there is quite variable efficacy of current approaches to consultation, including whether consultation is taking place at all. Consultation varied by the use and agency involved, and the frequency of the activity.

Notably, a few tribes were not even aware of the Northwest Forest Plan.

Among those who were aware of the plan and had some experience with consultations, principal concerns included the absence of established procedures for meaningful use of tribal input. Thus, the use of tribal information in future efforts is both an opportunity and a concern.

Concerns also emerged that sensitive information or cultural sites are not adequately protected depending on staffing situations. In dealing with conflicts over resources, at least one tribe highlighted that the adequacy of the conflict resolution process is variable.

Tribal Interests

Multiple participants expressed a strong interest in improving resource management and decreasing the conflicts and negative effects on tribal rights and interests (e.g., access to land and resources, protection of cultural resources).

Specifically, participants expressed a need to ensure meaningful opportunities to provide knowledge and input, with meaningful results.

At least one participant pointed out that consultation is desirable for tribes of all sizes. Another identified a preference for “layered” consultation and for more formal protocols. This is both an interest and an opportunity for agencies and tribes alike. (See opportunity section for similar concepts.)

Participants expressed tribal interest in consultation in a variety of ways. Many participants highlighted a desire for access to higher level officials. Others expressed a desire for inclusion of tribal needs and opportunities for consultation in legislative proposals and initiatives.

Still others expressed interest in collaborative consultation and co-management. Others suggested seeking reestablishment of funding for initiatives including the Jobs-in-the-Woods program. Finally, some participants highlighted interest in returning land to tribes, which, although not consultation per se, is a genuine interest.

Barriers Identified by Tribes

Barriers and knowledge gaps about government-to-government consultation included confusion, often on the part of agencies, over whether collaboration counts as consultation (it does not).

A significant barrier to government-to-government relationships identified was the effect of staff changes (on both sides) on consultation relationships.

Multiple participants expressed concerns about the quality of consultation taking place. This ranged from whether consultation indeed took place; whether it allowed for meaningful input from the tribes; and a deep concern about whether there would be meaningful use of tribal input, even if it was provided, owing to no formal process for consultation or incorporating tribal input.

Some efforts have been made to formalize consultation between tribes and agencies with written protocols. Some tribes with these protocols still see room for improvement where procedures or staff relationships are not effective.

There were some specific comments regarding Provincial Advisory Committees (PACs). In many cases, participants expressed that tribes or tribal interests are not addressed in most PACs and that in some cases this has led to actual disengagement. However, there is still interest among many respondents in future engagement of tribes in PACs.

Key Findings

The findings from these monitoring efforts resulted in three principal findings all related to a federal-tribal relationship developed on meaningful government-to-government consultation:

- Consultation is the foundation of the federal-tribal relationship.
- Consultation within the context of existing memorandums of understanding (MOU) or memorandums of agreement (MOA) works best.
- Relationships are the key factor.

Next Steps and Recommendations by Tribes

The monitoring results produced a series of recommendations intended to strengthen the Federal-Tribal relationship in the context of the Northwest Forest Plan and elsewhere.

1. Although a few opportunities for enhanced relationships have been noted even in the preceding sections, suggestions from participants indicate that they see a need to institute measures for agency accountability for consultation by establishing consultation protocols at tribal, national, and district/local levels.

2. In addition, participants called for establishing ways, based on consultation itself, to develop criteria and performance measures for monitoring agency consultation, project implementation, and effectiveness.

3. Participants also see a need to strengthen the results of consultation by incorporating tribal monitoring protocols in new management plans and plan revisions. Similarly, they see a need for integrating consultation protocols into federal, state, and regional policies and programs.

4. Use of MOUs or MOAs, summit meetings, and formal protocols were identified as helpful tools that have been used with some success in some places.

5. Ongoing education and orientation of staff about consultation was also seen as a way to reduce barriers to effective consultation.

6. Strengthening Federal-Tribal relations is critical. Repeatedly, participants highlighted the need for communication, education for federal agencies, resolving existing conflicts over level of consultation and relationships, and higher level meetings.

7. There is a need to resolve existing agency differences in application of government-to-government consultation and tribal access by senior managers and executives.

The two reports contain detailed appendices and references, including comments elucidating points made in the report. No two tribes are identical, and consultation with the affected tribal government is critical to establishing processes that assist in strengthening tribal government.

Conclusion

The two reports, which include detailed descriptions of the questions asked, case studies conducted, a summary, and results, will provide further details and explanations.

Lessons learned are also presented from both reports. When applied, they may contribute to a greater understanding of meaningful consultation between tribes and federal agencies for all natural resource management issues. They can also be used to help generate effective consultation for other issues (such as health and human services) for other agencies as well.

Generally the reports point out that government-to-government consultation is required, separate from public involvement or collaboration. The monitoring studies also identify ways to make required consultation meaningful, and to build the relationships they depend on over the long term.

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