Late-successional and Old-growth Vegetation Effectiveness Monitoring Northwest Forest Plan

2002 Annual Summary Report

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Executive Summary

This report is the second annual summary of the Late-Successional and Old-growth (LSOG) Module of the Interagency Regional Monitoring Program. Major components of the LSOG Monitoring Module are 1) mapping of existing vegetation from remote sensing, 2) estimation of LSOG amounts and characteristics from statistical analysis of inventory data, and 3) change estimation from remote sensing and repeated measurements on permanent inventory plots. This report summarizes the activities and progress made in fiscal year (FY) 2002 in these major areas.

Significant progress was made in developing and assembling monitoring information needed to complete the first decadal evaluation of the effects of the NWFP on LSOG vegetation:

- Existing vegetation maps are complete for 4 of 4 physiographic provinces in Washington, 3 of 3 provinces in California and for 3 of 5 provinces in Oregon. Remaining province maps in Oregon are scheduled for completion by April 2003.
- Creation of LSOG vegetation classes from existing vegetation map layers and FRAGSTATS analysis is being piloted in two study areas in Oregon, and in one physiographic province in California. The results of the pilot will be used to determine the best approach for NWFP-wide LSOG analysis.
- Major progress was made in data compilation and methodology for assessing LSOG conditions with statistical reliability from grid plot inventory data, including development of the VIM tool (Vegetation and Inventory Monitoring tool) and a database integrating inventory data from various owners and sample designs in a common format (IDB—Integrated Data Base).
- Change detection cycles have been completed for California provinces through 1996 for Northeastern California and 1998 for the North Coast. For Washington and Oregon, mapping of stand replacing disturbances is complete for Western Washington and for Western and Eastern between 1984 and 2002. Completion of Eastern Washington disturbance maps and project wrap-up will occur by September 2003.

In addition to accomplishments made in monitoring data development and analysis, several Monitoring program plan milestones were made in FY 2002:

- Monitoring questions regarding LSOG status and trends and Plan effectiveness were refined and reviewed.
- Study plans were drafted for major analytical components of the LSOG monitoring program.
- A comprehensive work plan was prepared covering LSOG monitoring activities requisite for completing the 2004 Evaluation of NWFP Effectiveness Report.
- A Quality Assurance Project Plan for LSOG monitoring was drafted.
- An outline for the LSOG chapter of the 2004 Report was drafted.

"Data! Data! Data! I can't make bricks without clay." - Sherlock Holmes

Introduction

The goal of Effectiveness Monitoring is to evaluate the success of the Northwest Forest Plan (NWFP) in protecting and enhancing late-successional and old-growth forest and related species on Federal lands in the range of the northern spotted owl. The Interagency Monitoring Program assesses status and trends in forest conditions and related wildlife habitat and socioeconomic conditions. The Late-Successional and Old-growth (LSOG) Monitoring Module assesses the status and trends of LSOG to determine if the Plan will achieve the planned goals and objectives for maintaining and restoring LSOG forests (Hemstrom and others, 1998). The primary elements of LSOG Effectiveness Monitoring are estimates of forest baseline conditions coupled with periodic assessment of changes from the baseline.

This document reports the accomplishments of the LSOG Monitoring Module during FY 2002. This report should be viewed as an addendum to the 2001 Annual Report (Moeur, 2002a), in which program objectives and approaches are presented in greater detail.

Monitoring questions

During FY 2002, monitoring questions were refined. The resulting set of questions was reviewed and validated by the Monitoring Program Managers, the Monitoring Program's interagency oversight group.

There are two levels of monitoring questions. Monitoring questions regarding the status and trends of resources are addressed for each module. These are straightforward questions about the observed current condition and observed short-term changes in the resources. The "status and trends" questions tier to "Plan effectiveness" questions, or questions directed at evaluating the effectiveness of initiatives and strategies implemented to achieve the goals of the Northwest Forest Plan. These questions are broader in scope, and ask, in a general sense, "Is the Plan working"? The LSOG Status and Trends questions and Plan Effectiveness questions are listed in Table 1.

Monitoring approaches

The LSOG Monitoring Plan (Hemstrom and others 1998) recommended that LSOG be examined from two perspectives: 1) LSOG landscape patterns determined from remote sensing-derived maps of existing vegetation, and 2) statistical estimates of acreages and LSOG structural characteristics determined from grid-based forest inventories.

The cornerstones of the LSOG Effectiveness Monitoring strategy based upon these two perspectives are 1) mapping of existing vegetation from remote sensing, 2) estimation of LSOG amounts and characteristics from statistical analysis of inventory data, and 3) change estimation from both remote sensing data and from remeasured plot data. The following sections of this report summarize the activities and progress made in FY 2002 in these major areas.

Table 1. Summary of LOG effectiveness monitoring questions.

Status and Trends Questions
What is the current amount and distribution of LSOG and how is it changing? • What are the amount and distribution of forest classes, including LSOG, for the NWFP area?* • How accurate are these estimates? **What are the landscape metrics of LSOG forest classes?** • What are the distributions of stand sizes, stand interior areas, edges, and inter-stand distances? **What are the structure and composition characteristics of LSOG forest classes?** • Tree diameter distribution, canopy structure, snags, down woody debris? • What is the error associated with these estimates? **How have amount and distribution of LSOG forest classes changed in the first decade?** • How have they changed since the last measurement cycle? • How much are they likely to change in the near-term and long-term future? **What are the stressors causing change in the amount and distribution of LSOG forest classes?** • What are the gains from growth and succession? • What are the losses from disturbance (logging, fire, wind, insects, and disease)? *All status and trends assessments are conducted by combinations of ownerships, administrative boundaries, physiographic provinces, plant communities, and land use allocations (LUA)
Plan Effectiveness Questions
Does the monitoring information on LSOG status and trends support a conclusion that the NWFP is working effectively to maintain and restore LSOG forest conditions on federal lands? • Based on the first 10 years of monitoring results, is the federal landscape meeting or moving toward the forest conditions envisioned in the NWFP with respect to LSOG? • Are the LSOG proportions and connectivity increasing relative to the amounts present at the start of the Plan? **Are the NWFP Land Use Allocations working to maintain and restore LSOG?** • Is the distribution of forest condition classes present in the Reserve system** on federal lands capable of supplying an LSOG network that meets the thresholds for Abundance & Diversity, Process and Function, and Connectivity discussed in the Monitoring Plan (Hemstrom and others 1998)? • If not currently capable, when is it projected that these thresholds will be achieved? • Is the LSOG balance changing across land allocations? **How do observed changes to LSOG compare with expected rates of change stated in the NWFP ROD**? • How much stand-replacing disturbance has occurred in the first 10 years compared to NWFP expectations? • How much in-growth has occurred in the first 10 years compared to NWFP expectations? • What is the balance between LSOG gains and losses in the first 10 years? ** Late-Successional Reserve + Riparian Reserve + Congressionally Reserved + Administratively Withdrawn

Existing Vegetation Mapping

Monitoring LSOG in the NWFP area is dependent on an accurate baseline of existing forest conditions at the start of the Plan. Consistent and continuous maps of existing forest vegetation maps from remote sensing data provide a baseline estimate of LSOG landscape-level conditions at the beginning of the Plan, and from which future changes can be benchmarked.

Two ongoing projects are engaged in mapping existing vegetation for the NWFP area—IVMP in Washington and Oregon, and CALVEG in California.

Interagency Vegetation Mapping Project (IVMP)

IVMP combines remotely sensed satellite imagery (Landsat TM), digital elevation models (DEMs), and aerial photo interpretation to classify existing vegetation. USFS and BLM Current Vegetation Survey (CVS), and Forest Inventory and Analysis (FIA) inventory plot information are used as reference data for model building and accuracy assessment. IVMP thematic map products are percent total vegetation cover, percent conifer cover, percent broadleaf cover, and size (quadratic mean diameter [QMD] of the overstory) predicted for 25-m pixels. Cover is predicted in 1% classes from 0 to 100 percent; and QMD is predicted in 1” diameter classes from 0 to 75 inches. Image classification details and map accuracy assessments are given in IVMP documentation produced for each Physiographic Province (O’Neil and others, 2001, 2002; Browning and others, 2001).

At present, IVMP maps have been completed for seven of nine provinces in Washington and Oregon (Figure 1). Klamath and Willamette Valley maps are expected by April, 2003.

In FY 2002, province maps were released for Eastern Cascades Oregon (ECO) and for Eastern Cascades Washington (ECW). A significant departure in methodology was necessitated for east-side provinces for QMD layers. In these provinces, QMD is mapped in 5-inch classes instead of in 1-inch classes, because reliable models could not be constructed at the higher resolution (map accuracies were below 50%). Cover was mapped in these provinces in accordance with standard methodology (1% cover classes).

Documentation was finalized and released following review of map data for Western Cascades Washington and Western Washington Lowlands provinces (Browning and others 2002).

IVMP thematic map data, documentation and accuracy assessment are downloadable from a BLM website:

http://www.or.blm.gov/gis/projects/vegetation/.

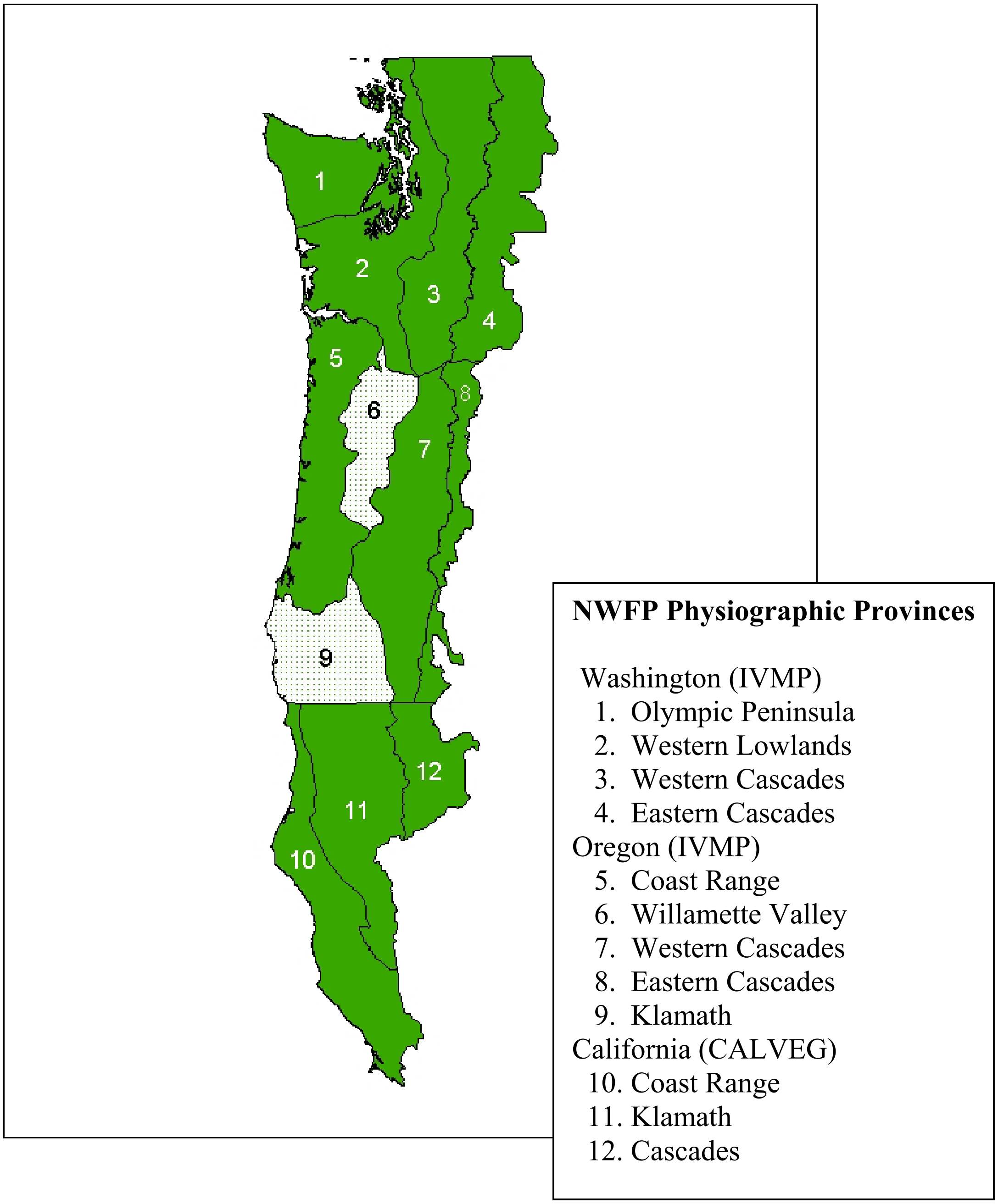


Figure 1. Existing vegetation maps have been completed for the Provinces shown in solid green (as of March 31, 2003). Oregon Klamath and Willamette Valley are scheduled for completion in July 2003.

Existing Vegetation Mapping in California (CALVEG)

CALVEG is a polygon-based map of existing vegetation created though an image segmentation process from Landsat TM imagery and DEMs using FIA grid plot reference data. Minimum mapping unit is 2.5 ha. CALVEG polygons are labeled according to life form, species type, tree crown size, canopy closure, size class, and canopy structure using supervised and unsupervised classification methods (USDA Forest Service 1981; Schwind and others, 1999).

Baseline CALVEG maps for the three Northwestern California provinces (Figure 1) used 1994 imagery (USDA Forest Service 2000). Recent map updates have been completed for Northwestern California incorporating change detection results and map edits. Change detection has been completed for the Six Rivers, Mendocino, and Shasta Trinity NFs, and private lands to the coast and south to the Bay Area from 1994-1998. The interior area, including the Klamath NF, was updated from 1991-1996; areas around the Lassen and Modoc NFs have had two updates, from 1991-1996, and from 1996-1999. Also new in FY 2002 is the release of accuracy assessment statistics for the map updates, arranged in different geographic extents to allow for more spatially accurate accuracy reporting. CALVEG map data, accuracy assessment, and documentation are downloadable from the R5-Remote Sensing Lab website: http://www.fs.fed.us/r5/rsl/projects/mapping/.

The next scheduled CALVEG update for the North coast and most of the Klamath province will be in FY05. Assuming similar budgets, the mapping work will be making a significant shift from 30m based polygons to 5m based polygons. This offers more potential for delineation of features that are not adequately resolved on TM alone. The CALVEG map update schedule is at: http://www.fs.fed.us/r5/rsl/projects/monitoring/veg-update.shtml.

LSOG Spatial Analysis

IVMP and CALVEG provide thematic maps of vegetation cover type, percent cover, canopy structure, and size. LSOG maps must be derived subsequently from these attributes by processing and re-classifying the thematic map data through a specific set of definitions. Forest classes interpreted from remote sensing reported in the LSOG Monitoring Plan (Hemstrom and others 1998) will be used to derive an LSOG map from existing vegetation maps (Table 2). Table 2 defines 19 exclusive forest condition classes based on canopy cover, QMD, canopy structure, and conifer/hardwood composition. Structure classes 8-19 (QMD > 20 inches) qualify as late-successional or old-growth forest.

Two pilot project areas are being used to test the creation of LSOG classes from IVMP map data (the Alsea watershed in the Oregon Coast Range province, and HJ Andrews Experimental Forest in the Western Cascades Oregon province). To validate the robustness of the selected approach, a third pilot area has been chosen – a fourth field watershed in the Klamath physiographic province. We anticipate this region to be one of the most difficult areas to model due to complexity in topography, species composition, and stand structure. In California, the creation of an LSOG map from CALVEG polygon data is being piloted in the Cascades physiographic province.

Table 2. Forest classes interpreted from remote sensing used to derive LSOG classes from maps of existing vegetation (modified from Hemstrom and others [1998], Table 1).

	Vegetation** Class	Canopy Cover (%)	DBH (inches)	Canopy Structure	Species Mix
	Young Forest:				
1	PF	< 10	NA	NA	NA
2	SS-D	>10	0-10	any	> 80% Deciduous
3	SS-M	>10	0-10	any	20%-80% Either
4	SS-C	>10	0-10	any	> 80% Conifer
5	SSS-D	>10	10-20	simple	> 80% Deciduous
6	SSS-M	>10	10-20	simple	20%-80% Either
7	SSS-C	>10	10-20	simple	> 80% Conifer
	Late-Successional Forest:				
8	MSS-D	>10	20-30	simple	> 80% Deciduous
9	MSS-M	>10	20-30	simple	20%-80% Either
10	MSS-C	>10	20-30	simple	> 80% Conifer
11	MMS-D	>10	20-30	complex	> 80% Deciduous
12	MMS-M	>10	20-30	complex	20%-80% Either
13	MMS-C	>10	20-30	complex	> 80% Conifer
	Old-Growth Forest:				
14	LSS-D	>10	>30	simple	> 80% Deciduous
15	LSS-M	>10	>30	simple	20%-80% Either
16	LSS-C	>10	>30	simple	> 80% Conifer
17	LMS-D	>10	>30	complex	> 80% Deciduous
18	LMS-M	>10	>30	complex	20%-80% Either
19	LMS-C	>10	>30	complex	> 80% Conifer

**Vegetation class names	Species Composition		
	Deciduous (D)	Mixed (M)	Conifer (C)
Non-Forest (NF)			
Potentially forested (PF)	PF	PF	PF
Seedling and sapling (SS)	SS-D	SS-M	SS-C
Small single-storied (SSS)	SSS-D	SSS-M	SSS-C
Medium and large single-storied (MSS)	MSS-D	MSS-M	MSS-C
Medium and large multistoried (MMS)	MMS-D	MMS-M	MMS-C
Large single-storied (LSS)	LSS-D	LSS-M	LSS-C
Large multistoried (LMS)	LMS-D	LMS-M	LMS-C

The pilot is also addressing the challenge of developing a seamless LSOG map across the entire NWFP area from the two inherently different map types (pixels for IVMP, stand polygons for CALVEG). Alternative approaches being tested in the pilot include application of "clump and eliminate" rules to filter the pixilated IVMP data, ecological rule-based filters to aggregate IVMP pixels to patches, and direct image segmentation of IVMP pixel data using eCognition Image Analyst software.

Following the pilot, final LSOG maps will be created from IVMP and CALVEG existing vegetation layers and assessed for accuracy using old growth ground reference data mapped by other projects (Warbington and Beardsley 2002; Beardsley and Warbington 1996; Spies pers. commun.). LSOG patch characteristics (sizes, distributions, and spatial pattern) will then be analyzed using FRAGSTATS (McGarigal and Marks 1995).

Statistical Analysis of Inventory Plot Data

The second component of LSOG monitoring calls for data from agency grid plot inventories to be analyzed to produce statistically reliable estimates of the LSOG amount and distribution. Estimates derived from sample plot summary attributes will be used to classify plots into vegetation classes listed in Table 2 based on cover type, canopy cover and structure, and tree size. Area-based estimates are possible because the sampling weight (acres represented) and associated sampling variability is known for each plot.

A major challenge to be overcome in this portion of the LSOG monitoring analysis is the necessity for developing consistent processing steps for inventory data from a variety of programs: 1) Current Vegetation Survey (CVS) installed by USFS on Region 6 National Forest lands (R6-CVS), 2) Current Vegetation Survey installed by BLM on BLM district lands (BLM-CVS), 3) Forest Inventory installed by USFS on Region 5 National Forest lands (R5-FI), 4) Forest Inventory and Analysis Periodic inventory installed on non-federal (state and private) ownerships in Regions 5 and 6 and administered by Pacific Northwest Research Station FIA program (PNW-FIA periodic inventory), and 5) Forest Inventory and Analysis Annual inventory on all federal and non-federal ownerships in Regions 5 and 6 (PNW-FIA annual inventory).

Significant progress was made during FY 2002 in three projects contributing to the ultimate objective of completing a statistical analysis of the inventory data in the NWFP area: 1) Compilation of and preliminary analysis of the Forest Service and BLM CVS data in Washington and Oregon, 2) development of the VIM tool (short for Vegetation and Inventory Monitoring), a software interface between the inventory database and a structured query tool for analyzing the data, and 3) development and release of PNW-FIA's Integrated Database (PNW-IDB) for housing data from various owners and sample designs in a common format.

Preliminary analysis of CVS dataset

CVS data for the completed first measurement occasion for Forest Service and BLM lands in the Northwest Forest Plan area in Washington and Oregon were compiled and analyzed. The purpose of this exercise was to develop the analysis steps and produce example output that will ultimately be applied to the entire collection of data from the inventories noted above. The R6-CVS and BLM-CVS data in this analysis represent the measurement period from 1993 to 1997 for R6 and 1997 to 2001 for BLM. The data compilation step merges tree and plot-level data from the CVS database, with plot-level summary values computed from the tree list and spatial location attributes derived from GIS intersections. Tables 3, 4, and 5 show acres by overstory age and diameter classes summarized from the compiled CVS data set. This preliminary example demonstrates the type of information that can be presented from the analysis. In the example, areas are shown by combinations of states, physiographic provinces, and land use allocations. Acre values in Tables 3-5 should not be considered final until methodology and data are more thoroughly reviewed.

VIM (Vegetation and Inventory Monitoring tool)

The VIM project was launched in FY 02 and development is continuing in FY03. VIM is a software tool that will allow users to easily access and analyze the NWFP inventory data in order to address complex monitoring questions. Examples of question types that VIM is designed for are: “How many acres in X contain Y”?, where X might be defined as the entire NWFP area; and Y might be a customized old growth definition for Douglas-fir series. Examples of such questions are shown in Figure 2. VIM can also be used to analyze average structure and composition characteristics by analysis area, such as the average density of snags and logs on plots meeting old growth criteria based on minimum canopy cover and density of large live trees, or distribution of acres by age class by series by land use allocation.

VIM interfaces a structured query language builder with the inventory data, and with ArcGIS software. The user defines an area for analysis from combinations of states, ownerships, physiographic provinces, land use allocations, and administrative units. Then a query builder is used to create customized definitions using structural attributes, and extract sample plot data meeting the definition criteria. Statistical and graphical summaries of results are produced for either estimated acres meeting user-defined criteria, or of estimates of structural attributes by user-defined criteria. The statistical estimates are bounded by bootstrap confidence intervals. Plot-level results can be also be displayed on user-supplied spatial layers through an ArcGIS linkage. Eventually, users will be able to select analysis areas as well as display results directly within the ArcGIS/VIM interface

VIM development is a partnership between the Effectiveness Monitoring program and the Inventory programs of Region 6 and BLM. It is envisioned that the tool will be useful to a wide audience of inventory specialists and analysts in addition to being used for NFWP effectiveness monitoring analysis. To date, a beta version of VIM is being developed against a prototype database for R6 and BLM CVS data in Washington and Oregon. The beta version will be released for testing in mid-April, 2003, and thereafter development of the VIM application will continue through summer 2003.

Table 3. First approximation of acres by age class in land allocation groups in the NWFP area. For Forest Service and BLM land in Washington and Oregon, only. Acre values should not be considered final until methodology and data are more thoroughly reviewed.

	NWFP Acres in LS Reserve							NWFP Acres in Withdrawn						
State/Physiographic	Age of overstory (yrs)						LSR	Age of overstory (yrs)						Withdrawn
Province	0-39	40-79	80-119	120-199	200+	No data	Total	0-39	40-79	80-119	120-199	200+	No data	Total
Washington														
Olympic Peninsula	152,200	60,100	65,700	80,800	39,400	13,200	**411,400**	26,100	17,400	8,700	19,300	8,700	8,700	**88,900**
Western Lowlands	0	0	0	1,900	0	0	**1,900**	0	0	0	0	0	0	**0**
Western Cascades	368,200	174,200	141,200	194,700	207,900	45,700	**1,131,900**	289,400	171,900	187,400	217,900	157,000	187,800	**1,211,400**
Eastern Cascades	199,800	330,200	184,900	91,400	28,000	117,100	**951,400**	214,200	402,100	240,300	174,300	74,600	468,800	**1,574,300**
Total, Washington	720,200	564,500	391,800	368,800	275,300	176,000	2,496,600	529,700	591,400	436,400	411,500	240,300	665,300	2,874,600
Oregon														
Coast Range	445,900	245,100	100,300	80,100	82,200	1,900	**955,500**	52,400	0	0	1,800	0	9,300	**63,500**
Willamette Valley	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
Western Cascades	309,500	275,600	221,300	237,900	256,000	20,400	**1,320,700**	248,100	226,400	215,200	68,600	42,500	51,700	**852,500**
Eastern Cascades	81,900	114,700	101,400	49,300	17,100	9,500	**373,900**	99,800	210,400	133,500	51,500	3,800	51,500	**550,500**
Klamath Mountains	235,300	184,000	116,400	175,100	97,300	9,500	**817,600**	85,300	93,000	63,900	39,600	22,500	8,200	**312,500**
Total, Oregon	1,072,600	819,400	539,400	542,400	452,600	41,300	3,467,700	485,600	529,800	412,600	161,500	68,800	120,700	1,779,000
Total for WA and OR	1,792,800	1,383,900	931,200	911,200	727,900	217,300	5,964,300	1,015,300	1,121,200	849,000	573,000	309,100	786,000	4,653,600

	NWFP Acres in Matrix/RR							NWFP Acres in AMA						
State/Physiographic	Age of overstory (yrs)						Mat/RR	Age of overstory (yrs)						AMA
Province	0-39	40-79	80-119	120-199	200+	No data	Total	0-39	40-79	80-119	120-199	200+	No data	Total
Washington														
Olympic Peninsula	0	0	0	0	0	0	**0**	105,200	7,500	3,800	3,800	3,700	0	**124,000**
Western Lowlands	0	0	0	0	0	0	**0**	1,900	0	0	0	0	0	**1,900**
Western Cascades	226,300	82,800	37,600	47,100	49,000	9,400	**452,200**	97,300	30,000	11,200	13,000	9,500	1,900	**162,900**
Eastern Cascades	278,200	199,700	112,100	56,000	18,700	18,400	**683,100**	31,800	26,200	15,000	26,300	16,800	20,300	**136,400**
Total, Washington	504,500	282,500	149,700	103,100	67,700	27,800	1,135,300	236,200	63,700	30,000	43,100	30,000	22,200	425,200
Oregon														
Coast Range	214,100	68,800	26,800	16,000	12,300	0	**338,000**	57,300	13,100	5,600	3,800	0	0	**79,800**
Willamette Valley	9,400	3,500	0	0	0	0	**12,900**	0	0	0	0	0	0	**0**
Western Cascades	729,400	401,100	291,100	295,000	222,800	29,400	**1,968,800**	79,100	47,200	21,800	47,900	47,800	9,100	**252,900**
Eastern Cascades	198,100	173,600	98,300	56,400	16,600	9,600	**552,600**	0	0	0	0	0	0	**0**
Klamath Mountains	221,600	179,800	142,700	117,500	72,400	0	**734,000**	53,400	98,900	53,200	33,600	1,900	1,800	**242,800**
Total, Oregon	1,372,600	826,800	558,900	484,900	324,100	39,000	3,606,300	189,800	159,200	80,600	85,300	49,700	10,900	575,500
Total for WA and OR	1,877,100	1,109,300	708,600	588,000	391,800	66,800	4,741,600	426,000	222,900	110,600	128,400	79,700	33,100	1,000,700

Table 4. First approximation of acres by diameter class in land allocation groups in the NWFP area. For Forest Service and BLM land in Washington and Oregon, only. Acre values should not be considered final until methodology and data are more thoroughly reviewed.

	NWFP Acres in LS Reserve							NWFP Acres in Withdrawn						
State/Physiographic	Quadratic mean diameter of overstory (inches)						LSR	Quadratic mean diameter of overstory (inches)						Withdrn
Province	0-4.9	5-9.9	10-19.9	20-29.9	30+	No data	Total	0-4.9	5-9.9	10-19.9	20-29.9	30+	No data	Total
Washington														
Olympic Peninsula	45,100	63,900	129,600	97,700	62,000	13,100	411,400	8,700	8,700	34,800	19,300	8,700	8,700	88,900
Western Lowlands	0	0	1,900	0	0	0	1,900	0	0	0	0	0	0	0
Western Cascades	95,200	156,000	365,200	323,000	146,800	45,700	1,131,900	112,100	156,400	341,200	322,500	91,400	187,800	1,211,400
Eastern Cascades	31,700	136,100	569,300	86,000	11,200	117,100	951,400	62,400	305,600	570,100	149,200	18,200	468,800	1,574,300
Total, Washington	172,000	356,000	1,066,000	506,700	220,000	175,900	2,496,600	183,200	470,700	946,100	491,000	118,300	665,300	2,874,600
Oregon														
Coast Range	49,300	133,200	288,900	272,900	209,300	1,900	955,500	5,600	15,000	0	20,500	13,100	9,300	63,500
Willamette Valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Western Cascades	47,600	143,500	364,300	452,600	292,300	20,400	1,320,700	23,600	51,300	449,300	245,100	31,500	51,700	852,500
Eastern Cascades	1,900	64,900	214,200	79,700	3,700	9,500	373,900	13,400	76,300	346,700	60,700	1,900	51,500	550,500
Klamath Mountains	49,100	189,300	317,300	181,000	71,400	9,500	817,600	21,400	87,700	138,700	38,500	18,000	8,200	312,500
Total, Oregon	147,900	530,900	1,184,700	986,200	576,700	41,300	3,467,700	64,000	230,300	934,700	364,800	64,500	120,700	1,779,000
Total for WA and OR	319,900	886,900	2,250,700	1,492,900	796,700	217,200	5,964,300	247,200	701,000	1,880,800	855,800	182,800	786,000	4,653,600

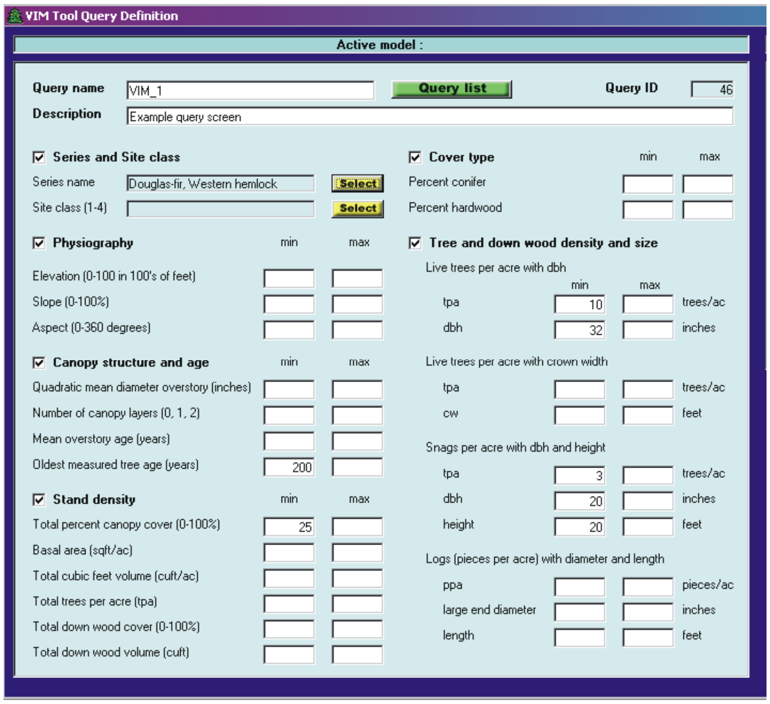
	NWFP Acres in Matrix/RR							NWFP Acres in AMA						
State/Physiographic	Quadratic mean diameter of overstory (inches)						Mat/RR	Quadratic mean diameter of overstory (inches)						AMA
Province	0-4.9	5-9.9	10-19.9	20-29.9	30+	No data	Total	0-4.9	5-9.9	10-19.9	20-29.9	30+	No data	Total
Washington														
Olympic Peninsula	0	0	0	0	0	0	0	11,300	37,600	65,700	5,600	3,800	0	124,000
Western Lowlands	0	0	0	0	0	0	0	0	1,900	0	0	0	0	1,900
Western Cascades	48,900	77,100	194,200	90,400	32,200	9,400	452,200	14,900	37,500	76,800	29,900	1,900	1,900	162,900
Eastern Cascades	93,500	141,800	356,600	65,300	7,500	18,400	683,100	5,600	26,200	59,900	22,500	1,900	20,300	136,400
Total, Washington	142,400	218,900	550,800	155,700	39,700	27,800	1,135,300	31,800	103,200	202,400	58,000	7,600	22,200	425,200
Oregon														
Coast Range	30,100	46,400	175,800	50,300	35,400	0	338,000	9,500	7,600	38,100	22,700	1,900	0	79,800
Willamette Valley	3,800	1,900	5,400	1,800	0	0	12,900	0	0	0	0	0	0	0
Western Cascades	132,900	320,000	695,700	548,900	241,900	29,400	1,968,800	13,000	40,200	58,900	80,600	51,100	9,100	252,900
Eastern Cascades	20,200	112,600	340,000	64,800	5,400	9,600	552,600	0	0	0	0	0	0	0
Klamath Mountains	51,200	166,200	323,300	132,200	61,100	0	734,000	9,000	72,700	111,400	46,100	1,800	1,800	242,800
Total, Oregon	238,200	647,100	1,540,200	798,000	343,800	39,000	3,606,300	31,500	120,500	208,400	149,400	54,800	10,900	575,500
Total for WA and OR	380,600	866,000	2,091,000	953,700	383,500	66,800	4,741,600	63,300	223,700	410,800	207,400	62,400	33,100	1,000,700

Table 5. Acre totals for age class and diameter class (Tables 3 and 4). Acre values should not be considered final until methodology and data are more thoroughly reviewed.

State/Physiographic Province	NWFP Acres Province Total
Washington	
Olympic Peninsula	624,300
Western Lowlands	3,800
Western Cascades	2,958,400
Eastern Cascades	3,345,300
Total, Washington	6,931,700
Oregon	
Coast Range	1,436,800
Willamette Valley	12,900
Western Cascades	4,394,900
Eastern Cascades	1,477,000
Klamath Mountains	2,106,900
Total, Oregon	9,428,500
Total for WA and OR	16,360,200

Acres by Age class summary			
Totals for Wa and OR, all LUAs			
Age class	Acres	% area	Cum. %
0-39	5,111,200	31.2	31.2
40-79	3,837,300	23.5	54.7
80-119	2,599,400	15.9	70.6
120-199	2,200,700	13.5	84.0
200+	1,508,500	9.2	93.3
No data	1,103,100	6.7	100.0
Total	16,360,200	100.0	

Acres by Size class summary			
Totals for Wa and OR, all LUAs			
Size class	Acres	% area	Cum. %
0-4.9	1,011,000	6.2	6.2
5-9.9	2,677,600	16.4	22.5
10-19.9	6,633,300	40.5	63.1
20-29.9	3,509,800	21.5	84.5
30+	1,425,400	8.7	93.3
No data	1,103,100	6.7	100.0
Total	16,360,200	100.0	



Select samples with:

- ✓ In DF or WH series
- ✓ 200+ yr old tree present
- ✓ 25% Cover
- ✓ At least 10 trees/ac 32"+ dbh
- ✓ At least 3 snags/ac 20"+ dbh and 20' tall

Figure 2. Example query screen from VIM, showing attributes that can be combined to estimate acres and average attribute values by user-defined criteria.

Integrated Database (IDB)

The VIM tool is one component of an integrated NWFP analysis approach. Another crucial step in developing a consistent approach to analyzing inventory data for the NWFP area is to integrate data from different owners and inventory sample designs covering the NWFP into a common format.

In FY 2002, the Forest Inventory and Analysis Program of the Pacific Northwest Research Station developed an Integrated Database (IDB) for housing inventory data from different owners and sample designs in a common format. The following text describing IDB is quoted from Waddell and Hiserote (2003):

> The Integrated DataBase (IDB) combines data from eight different forest inventories conducted by the Forest Service and the Bureau of Land Management in California, Oregon, and Washington. … PNWFIA has recognized the need for a database that integrates technical information about western forests across owners and states. In response to the high demand for forest inventory data, a database was developed (The PNW-IDB) from the most recently completed inventories available from the National Forest System, BLM, and PNWFIA. Data acquired from each inventory program were transformed into databases with a common set of formats, definitions, codes, measurement units, column names, and table structures. …The result is an integrated

database, where items such as net volume, current annual growth, or forest type are calculated with the same methods. Our goal was to produce a database that is easy to use, well documented, and standardized across owners and states.

A meeting of NWFP monitoring team members with FIA scientists in April 2002 laid out specifications for a unified approach for processing FIA and CVS plot data for NWFP monitoring analysis. These requirements were subsequently incorporated into the IDB common database structure. IDB was demonstrated to users in late March 2003, during PNW-FIA's annual Client meeting.

The integrated sample data compiled in IDB will allow a streamlined analytical approach to LSOG amounts and distributions across ownerships and states for the NWFP area. Specifically, further development of the VIM interface will proceed against the IDB. This development will extend the VIM application from operating only on the CVS data in Region 6 only to the other inventories listed below (from Table 1, Waddell and Hiserote (2003):

IDB Source and Dates of Inventory Data

Data Source	Data source name	Primary States	Dates of Inventory	Density of sample grid for plot selection
R5	Region 5, Pacific Southwest	CA	1993-2000	3.4 mile
R6	Region 6, Pacific Northwest	OR, WA	1993-1997	1.7 mi (3.4 mi in wilderness)
BLMWO	Bureau of Land Management	OR, WA	1997	3.4 mi
FIAEO	FIA, Eastern Oregon	OR	1998-1999	3.4 mi
FIAWO	FIA, Western Oregon	OR	1995-1997	3.4 mi
FIACA	FIA, California	CA	1991-1994	3.4 mi
FIAEW	FIA, Eastern Washington	WA	1990-1991	3.4 mi
FIAWW	FIA, Western Washington	WA	1988-1990	2.4 mi

Change Estimation

Monitoring for trends requires establishment of baseline conditions, and a means of tracking changes from the baseline. The goal of change detection is to track losses and gains in forest conditions from a variety of sources such as harvest, wildfire, and natural succession. Remote sensing can be used to track large-scale changes (stand-replacing disturbances) at periodic intervals. Remote sensing change detection is sensitive to land cover changes resulting from regeneration harvest and land use conversion, severe wildfire, and severe insect and disease outbreaks. Remote sensing is not a reliable method for detecting less severe disturbances, or disturbances that occur more frequently than the mapping interval. For example, changes due to growth and succession will be tracked on remeasured inventory plots.

Remote Sensing Disturbance Mapping

The general approach used in remote sensing change detection is to analyze differences in paired satellite images captured during periodic cycles (4- to 5-year intervals) to map the location and cause of change. By integrating change detection and vegetation mapping, the existing vegetation maps representing the amount and arrangement of forest conditions across the landscape at the beginning of the NWFP can be used as a baseline that can be continually updated using the change layers.

Remote Sensing Disturbance Mapping in Washington and Oregon

A major remote sensing change detection project was launched in the Region 6 portion of the NWFP area in FY02. This work is being conducted by the Pacific Northwest Research Station (PNW) in Corvallis. The goal of the project is to map stand-replacing disturbances from 1994 through fall 2002. The disturbance map layers developed by this project will be used to overlay with the existing vegetation baseline map to determine losses in LSOG forest conditions during the years following Plan implementation. The project also is mapping disturbance between 1984 and 1994 in order to obtain a retrospective comparison of rates of change in the decade preceding the Plan.

The OR/WA Disturbance Mapping Team has made important strides toward the completion of a map of the region's fires and harvests from 1984 to 2002. All of Oregon's physiographic provinces have been mapped, and much of Washington has also been completed. Technical advances made by the Team in the area of change detection have contributed to this relatively rapid progress. When completed, the map will provide a spatially explicit picture of stand-replacing disturbance across the entire landscape of Pacific Northwest. The map will also highlight changes in harvest patterns that have occurred on both public and private lands during the periods preceding and then subsequent to the signing of the Northwest Forest Plan.

In FY 2002, stand-replacing disturbances were mapped between 1984 and 1996 in Western WA with reported accuracies 88% to 94%. Stand-replacing disturbances between 1984 and 2002 were mapped in Eastern and Western OR. The Team also developed a new change detection technique that has significantly reduced processing time. An example of the results is shown in Figure 3.

By September, 2003, the following activities are planned: 1) Complete the WA disturbance map (both East and West sides) through 2002; 2) Mosaic the data by scene and province-based processing units into a seamless disturbance map product; 3) Perform an error assessment of the disturbance map; and 4) Analyze the disturbance map to identify trends in harvest and fire over different ownerships, physiographic provinces, and time.

Methodological details and results for Western Oregon through 1992 have been recently published (Cohen and others, 2002). NWFP change detection project details and interim map results an be found at the website:

http://www.fsl.orst.edu/larse/wov/88wov.html

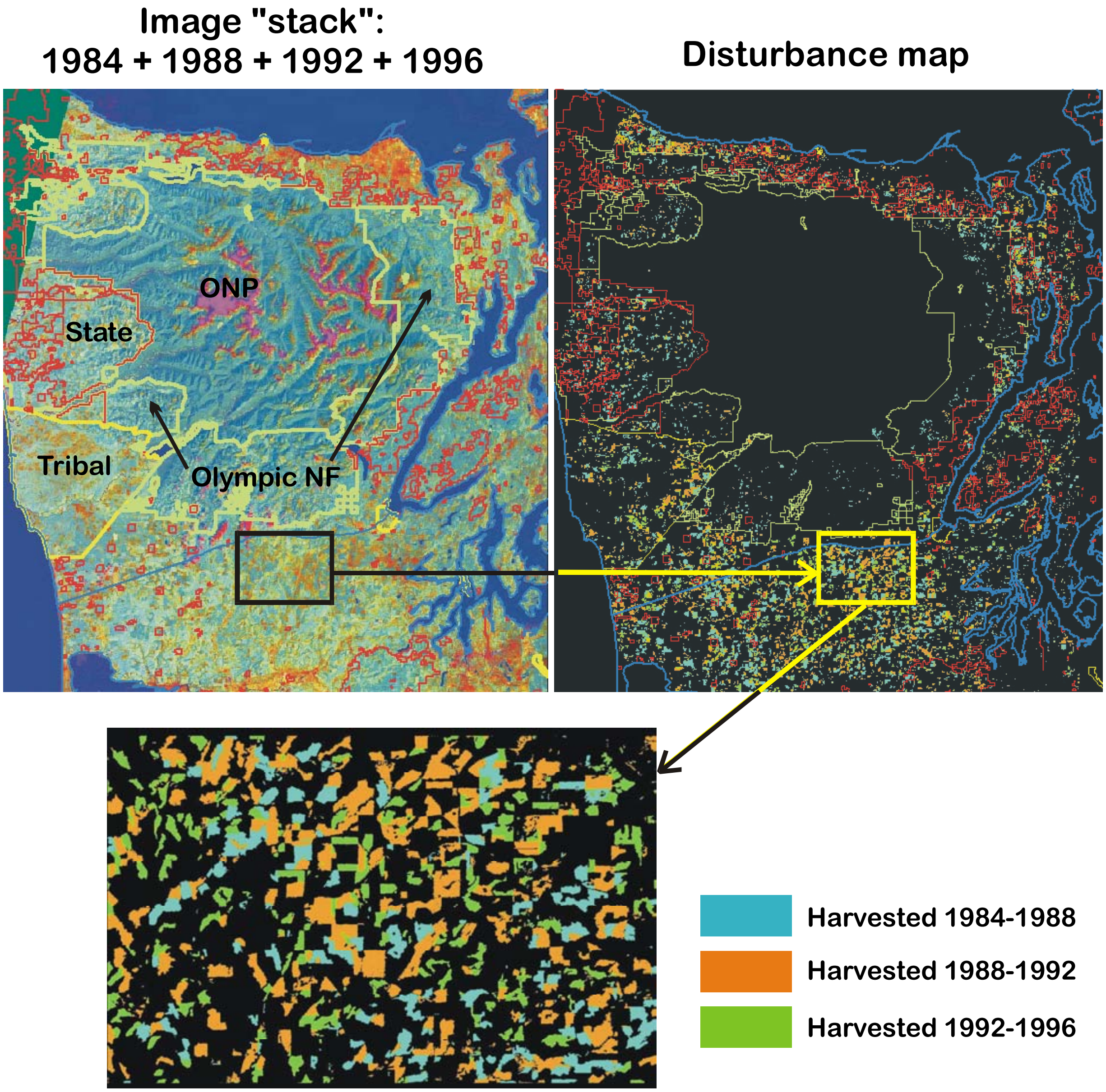


Figure 3. Example of remote sensing change detection in the Olympic Peninsula surrounding Olympic National Park. Stand-replacing disturbances between 1984 and 1996 are shown on private lands, state lands (red outline), tribal lands (yellow outline), and Olympic NF (green outline).

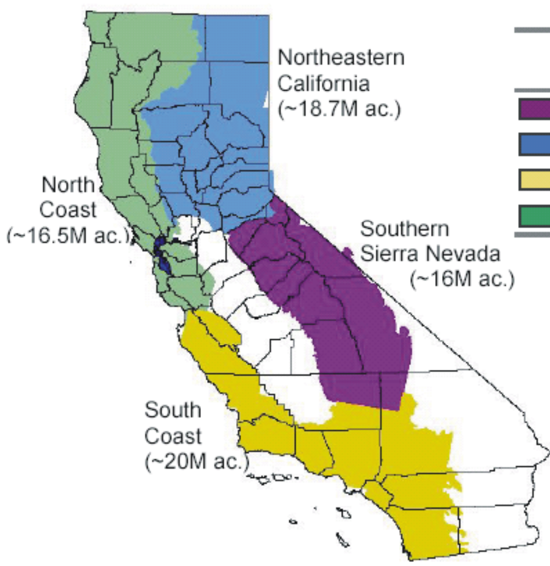
Remote Sensing Change Detection in California

Change detection work in the California portion of the Northwest Forest Plan area is conducted by the Remote Sensing Lab of Region 5 under their integrated mapping, monitoring and inventory program. Monitoring vegetation change for the first statewide cycle occurs in one of four unique project areas per year (Figure 4).

Change detection results have been published for the Northeastern California project area (Levien and others, 2002), and will be published for the North Coast project area in April 2003 (Levien and others, in press). The causes of change are also determined for change areas. The monitoring data has an overall accuracy of 89% for the Northeastern California project area.

For the North Coast project area (comprising most of the California land area encompassed by the NWFP), the change period is between 1994 and 1998. For the Northeastern California project area, changes are determined between 1991 and 1996. In both areas, the next scheduled change detection update in 2005 (Figure 4).

Project details, publications, and map results an be found at the website:
http://frap.cdf.ca.gov/projects/change_detection/changedetectfr.html



	Project Area	Image Dates (approximate)	Change Data Complete
	Southern Sierra	1990 to 1995	1996
	Northeastern CA	1991 to 1996	1997
	South Coast	1993 to 1997	1999
	North Coast	1994 to 1998	2000

Figure 4. Change detection cycle in California (from Levien and others 2002).

Analysis of Remeasured Inventory Plots

Analysis of stand-scale information on remeasured permanent plots provides a statistical sample reflective of periodic changes in forest conditions at the full range of disturbance scales—from stand loss due to management or natural disturbance, to successional change resulting from ingrowth, growth, and mortality. Analysis of change on permanent plots is inherently limited by the fact that inventory grid plots are remeasured on a long cycle (for example, 1/3 of a 4-panel rotating system is remeasured annually in the R6-CVS inventory, with a measurement cycle completed every 12 years); thus, knowledge about change is only partial in any given year because the sample of remeasured plots is always incomplete. The 2004 Comprehensive Evaluation of NWFP Effectiveness by the Interagency Monitoring will analyze data collected as late as field season 2002. By 2002, some 60% of CVS plots will have been remeasured on R6 National Forest lands, 25% of CVS plots on BLM lands in Oregon, and 50% of R5 lands in California. On plots on private and state lands, there has been a transition between the old inventory design (FIA-periodic) and annual inventories (FIA-annual) beginning in 1999 in California, 2000 in Oregon, and 2001 in Washington. This means that varying portions of the plots on non-federal lands will have been remeasured in each state using an new sample design, and there will be an issue in developing a consistent estimate from the transitional data.

One objective of the change estimation analysis is to statistically estimate the acres classified as LSOG that have been lost or gained between analysis cycles. This is essentially a statistical research question delegated to the FIA Statistics Band. That group met in late March to discuss statistically reliable change estimates from various rotating panel designs. A second preliminary analytical process for estimating transitions between vegetation classes has been designed (Moeur, 2002b). The proposed analysis will track the proportion of acres classified in a given vegetation class at the first measurement transitioning into a different class in the second measurement. Transition probabilities derived from remeasured subset of the entire inventory will be used to estimate the total amount of forest transitioning between classes across the NWFP.

Refined trend analysis

While the 2004 Comprehensive Evaluation of NWFP Effectiveness will focus on LSOG baselines established for the start of the Plan and observed changes since 1994, probable long-term effects can be studied using simulation models. Models with the capability of producing realistic projections of future vegetation conditions under various assumptions of planned management activities and natural disturbance probabilities will allow the current conditions observed in the short-term under the Plan to be projected for future decades. This will facilitate the comparison of likely future conditions with trends expected under the activities, standards, and guidelines established in the NWFP Record of Decision.

LSOG Monitoring will employ simulation models applied to baseline data to refine expected trends. Models for advancing (i.e. projecting) the landscape (using map data) and individual stands (using inventory plot data) are well accepted in the natural resources planning community. Examples are Vegetation Dynamics Development Tool (VDDT) at the landscape level and Forest Vegetation Simulator (FVS) at the stand scale.

Major work on simulation modeling of current vegetation conditions will be initiated following the 2004 Evaluation Report.

Monitoring Program Reports

Monitoring Program planning played a significant role in FY 2002 efforts.

1) Status and trends monitoring questions and Plan Effectiveness questions were refined and reviewed (see Table 1).

2) A monitoring web site was launched that includes information about the overall Interagency Monitoring Program, individual monitoring module programs, and data and publication:
http://www.reo.gov/monitoring

3) A general publication that provides an overview of the program and contact information was prepared and distributed:
http://www.reo.gov/monitoring/GlossyOverview.pdf

4) The first Annual Summary Report for LSOG monitoring was prepared (Moeur, 2002a).

5) Study plans were drafted for major analytical components of the LSOG monitoring program (Moeur, 2002b).

6) Monitoring modules began coordinated work needed to satisfy cross-module dependencies for vegetation data and analytical approaches. Specifically, LSOG spatial analysis and habitat mapping for northern spotted owls follow parallel approaches.

7) A comprehensive work plan with milestones for tracking progress of major LSOG components was prepared.

8) A Quality Assurance Project Plan was drafted for LSOG monitoring (Moeur, 2003).

2004 Monitoring Interpretive Report

All current work within the LSOG module is directed at making progress toward completion of a first-decadal Comprehensive Evaluation of NWFP Effectiveness to be published in 2004. All monitoring data development and assemblage will be completed in September 2003. Full-scale analysis will begin in September using vegetation maps completed and analytical approaches developed approaches discussed in this report and in study plans on file (Moeur, 2000b).

The LSOG portion of the 2004 Report will contain a complete analysis of baseline conditions summarized from completed existing vegetation maps and from first-occasion grid plot inventory data. It will contain a first approximation of trends (observed changes from baseline condition) using available updated map and inventory information. Most importantly, it will make interpretive links between LSOG monitoring results and the expectations of the plan to address management-related questions summarized in Table 1.

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Key Partners

Bureau of Land Management

USDA Forest Service, Pacific Southwest Region (Region 5)

USDA Forest Service, Pacific Northwest Region (Region 6)

USDA Forest Service, Pacific Northwest Research Station

Titan Systems Corporation

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Website

Descriptions of the Monitoring modules are available to clients and the general public through an Interagency Regional Monitoring website at http://www.reo.gov/monitoring.

A Glossy brochure featuring highlights of Monitoring Program elements is also available at the Interagency Regional Monitoring website, http://www.reo.gov/monitoring/GlossyOverview.pdf.

Budget

FY 2002 LSOG Monitoring Module budget

Function	2002 Budget (thousands)			
	Total	R-6	R-5	BLM
LSOG Program Management	120	120		
IVMP	163	72		91
Change Detection PNW	68	68		
Remote Sensing in R5	25		25	
FIA Inventory in R5	110		110	
MODULE TOTAL	486	260	135	91

FY 2001 LSOG Monitoring Module budget

Function	2001 Budget (thousands)		
	Total	R-6	BLM
LSOG Program Management	100	100	
IVMP	201	137	64
Spatial Analyst PNW	70	70	
Change Detection PNW	50	50	
FIA Inventory in R5	50	50	
MODULE TOTAL	471	407	64