Oregon Department of Forestry Best Management Practices Compliance Monitoring Project: **Final Report**

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COMMITTEES AND COORDINATORS

This study was conducted with the oversight of external and internal review committees. The committees' main functions were to review and approve the study design, methods, and reports. The committees met over the course of four years of development, implementation, analysis, and reporting of the project.

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ODF BMP Compliance Monitoring Project

INTRODUCTION

The Oregon Department of Forestry (ODF) regulates forestry operations on non-federal land. Landowners and operators are subject to the Forest Practices Act and Rules when they conduct any commercial activity relating to the growing or harvesting of trees. The Oregon Forest Practices Act (FPA) was adopted in 1972. The overarching objective of the Act is to

> …encourage economically efficient forest practices that assure the continuous growing and harvesting of forest tree species and the maintenance of forestland for such purposes as the leading use on privately owned land, consistent with sound management of soil, air, water, fish and wildlife resources and scenic resources within visually sensitive corridors as provided by ORS 527.755 that assures the continuous benefits of those resources for future generations of Oregonians. (ORS 527.630 Policy, Oregon Forest Practices Act)

The Oregon Board of Forestry has been vested with exclusive authority to develop and enforce statewide and regional Forest Practice Rules. These rules are designed to address the resource issues identified in the FPA policy (sound management of forest, soil, air, water, fish and wildlife resources, and scenic resources). The rules are categorized into divisions (Table 1), each with its own description of purpose. The purpose statements further refine the broad objectives of the Rules and Act. All divisions are within Oregon Administrative Rules chapter 629.

Table 1. Oregon Department of Forestry Administrative Rules

Division	Division Description
600	Definitions
605	Planning Forest Operations
606	Stewardship Agreements
610	Reforestation Rules
611	Afforestation Incentive
615	Treatment of Slash Rules
620	Chemical and Other Petroleum Product Rules
625	Road Construction and Maintenance Rules
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665	Specified Resource Site Protection Rules
670–680	Civil Penalties, Appeals, Hearings Procedures, Stay of Operations, Access to Notifications and Written Plans, Regional Forest Practice Committees, and the Resource Site Inventory and Protection Process

The Forest Practices Program is responsible for administering and monitoring the Forest Practice Rules. These rules are subject to revision as necessary based on the best available science and monitoring data. Such revisions shall maintain the policy of the FPA as described above. The Rules have undergone many revisions since 1972. The most recent changes to the water protection rules were in 1994, 1995, and

1996. Therefore, this project was monitoring some rules that had only been in place for approximately three years.

The Forest Practice Rules cover a wide range of issues pertaining to forest operations and resource protection. In general, the Rules are designed to minimize impacts of forest activities on other forest resources. Among other things, the rules focus on minimizing sediment delivery to channels, providing 50-year flow and juvenile fish passage through culverts, maintaining function of riparian areas, and protecting water quality, air quality, wildlife and fish habitat. It is important to recognize that the Rules address minimizing impacts versus having no impact. This is a practical approach to both maintaining an economically viable forest industry and protecting other forest resources.

The Rules vary by georegion and by stream type. There are seven georegions defined as geographic areas with similar vegetation type, climate, physiography. There are nine stream types defined by stream size (stream flow) and beneficial use. This approach endeavors to recognize that forests are dynamic, with regional differences resulting from inherent characteristics and disturbance regimes.

The Forest Practices Act and Rules are considered a Best Management Practices (BMPs) program. BMPs are defined as practices that are practical and effective at reducing non-point source pollution to standards compatible with water quality goals. Once an agency's BMPs are approved by the state water quality regulatory agency, they are certified as the water quality management plan (WQMP) for landowners that implement them. A WQMP illustrates how a landowner will achieve acceptable water quality. When forest landowners properly implement BMPs, they are actually implementing a WQMP designed to maintain water quality. It is the responsibility of the ODF to monitor the effectiveness and implementation of BMPs in achieving that objective.

The ODF Forest Practices Monitoring Program implemented this study to monitor compliance with BMPs on non-federal forestland. The BMP Compliance Monitoring Project (BMPCMP) was a three-year project designed primarily to look at how the department, landowners, and operators are implementing the Forest Practice Rules relating to water quality. The first year of the project (1998) was a pilot study used to revise the site selection and data collection protocols, determine the needed sample size, and provide preliminary compliance results. During the 1999 and 2000 field seasons, the final version of the BMPCMP was implemented. The goal of the BMPCMP was to identify the level of forest operations in compliance with the Forest Practice Rules based on a statistically reliable sample and to determine if adjustments to the administration of the compliance program are needed, such as areas where forest practice rule language can be clarified, administration of the rules can be improved, or where additional education and training are needed.

The BMP Compliance Monitoring Project is just one component of the Forest Practices Monitoring Program (Dent, 1997). The strategy of the monitoring program is to monitor compliance separately from effectiveness and validation monitoring. The Forest Practices Monitoring Program currently coordinates separate projects to monitor the effectiveness of Forest Practice Rules with regard to landslides, riparian function, stream temperature, chemical applications, and turbidity and sediment delivery from forest roads. Validation monitoring is being conducted to test the basic assumptions underlying BMPs.

Background

The ODF achieves BMP compliance through a balanced program of rule education, technology transfer, incentives, and enforcement. The ODF employs 52 forest practice foresters (FPFs), stationed in 25 unit

and district offices throughout the state. Through a series of inspections and field visits, FPFs work with landowners and operators to facilitate proper implementation and compliance with the Forest Practice Rules. Not all operations are inspected by FPFs due to extremely heavy workloads, therefore, FPFs prioritize operations to determine inspection schedules. When rules are not properly applied and an unsatisfactory condition exists, the FPF may issue a written statement of unsatisfactory condition that requires immediate action to prevent damage. When a violation exists and damage occurs, the FPF may issue a citation and a repair order. A civil penalty may also be assessed.

Citation records are a valuable monitoring tool, but a statistically reliable sample of BMP compliance is needed to more precisely determine the degree to which the compliance program is producing the desired results and to identify areas of low compliance. Furthermore, more detailed information is needed on compliance rates of specific practices and rules and to quantify resource damage that occurs as a result of noncompliance.

Compliance Monitoring in Other States

Other states have implemented projects to assess compliance rates and effectiveness of administration programs to protect natural resources. Most commonly these projects have utilized an interdisciplinary team approach and combined compliance and effectiveness monitoring. Projects typically consist of some sort of rating criterion on which to assess both compliance and effectiveness. Ellefson *et al*. (2001) found that 34 states had instituted some sort of compliance monitoring project of voluntary or mandatory forest practices requirements. The following is a summary of some of these other programs.

California

A 1999 report from California (CDF, 1999) evaluated both compliance and effectiveness of Forest Practice Rules in protecting water quality. Registered professional foresters and an earth scientist evaluated forest practices on 150 randomly selected sites. The authors conclude that California Forest Practice Rules are effective at protecting water quality, since 95% of the sediment issues resulted from noncompliant practices. Roads and crossings had the greatest potential to deliver sediment to streams. Of particular concern were stream crossings; construction, spacing, maintenance, and size of drainage structures; erosion of fill from road discharge; and sidecast on steep slopes. Compliance rates were lowest for road-related rules and roads had a much greater impact on water quality than landings and skid trails. Compliance rates related to the protection of streams and lakes were very high.

Idaho

An interdisciplinary team was used consisting of a representative from forest landowners, Idaho Department of Fish and Game, U.S. Forest Service, Plum Creek Timber Co., Bureau of Land Management, Department of Lands, and DEQ (Idaho Department of Health and Welfare, 1997). The study focused on practices that could result in delivery of pollutants to streams. Effectiveness and implementation was rated as poor to excellent. Forty sites were monitored from July through September 1996. Results indicate 97% compliance. Rule effectiveness was rated as 99% effective, yet half the sites delivered sediment to the stream as a result of forest activity. Most common departures from BMPs were associated with road rules.

Minnesota

The Minnesota Department of Natural Resources began implementing an effectiveness and compliance monitoring program in 2000. Surveys were conducted on 108 sites by an independent contractor across all land ownerships. These surveys were conducted to collect baseline harvesting and management data for future annual monitoring. Areas identified as having the lowest compliance were retention of required filter

strips and RMA vegetation along streams, lakes, and wetlands; effective diversions of road drainage at approaches to streams and wetlands; rutting levels of roads and skid trails; and leave-tree retention levels specific to management classifications.

Washington

In Washington, three "surveyors" accompanied by one Department of Natural Resources (DNR) staff person evaluated compliance and public resource damage on private forest operations (TFW, 1992). Data forms and questionnaires were developed to assess all Forest Practice Rules that applied to the site. One hundred and ninety-one sites were randomly selected from notifications and assessed during the summer of 1991. Low compliance was most commonly associated with maintenance of active and inactive roads, harvest activities within riparian management areas, and "special conditioning," which refers to wildlife protection.

Montana

In the state of Montana, application and effectiveness of Forest Practice Rules were rated on federal, state, and both non-industrial and industrial forestland in 1994 (Frank, 1994), 1996 (Mathieus, 1996), and 1998 (Fortunate *et al*., 1998). Three to four interdisciplinary teams were used, each consisting of a fish biologist, a forester, a hydrologist, a conservation group representative, a road engineer, and a soil scientist. Forty-two to 47 sites were monitored for each year of surveys. Results indicated that in 1994, 1996, and 1998, compliance with minimum BMP requirements was 91%, 92%, and 94%, respectively. Compliance was 83%, 81%, and 89% for high-risk sites in 1994, 1996, and 1998, respectively. The greatest impacts and highest percent of departure from BMPs were associated with road drainage and maintenance during all of the monitoring periods.

West Virginia

The West Virginia Division of Forestry conducts compliance surveys of logging BMPs on a recurring basis. Surveys have been completed and reported in 1981, 1987, 1991, and 1996. West Virginia's BMPs focus on conducting road, landing, and skid trail practices to limit erosion and sediment delivery to streams. The most recent report (Egan et al., 1998) discusses results from 95 sites. All sites were surveyed by a single outside consultant in 1995 and 1996. The majority of sites were non-industrial private ownership (79) and the rest (16) were industrial private ownership. Areas of lowest compliance were road and skid trail drainage relief and stabilization of exposed soils. Compliance rates were highest on industrially-owned sites.

Maryland

In Maryland, survey teams were formed of representatives from each agency with a vested interest in resource protection (Koehn and Grizzel, 1995). Team members were fixed for the field season, yet varied between sites. A field-based questionnaire was implemented on sites grouped by physiographic region. Compliance was rated qualitatively as: excellent, fair, good, or poor for each BMP. They also used a landowner/operator questionnaire to determine BMP awareness. Ninety-nine sites were sampled from summer through fall 1994. Results indicate an 82% compliance rate overall. Poorest compliance was associated with soil stabilization on road fill and cut slopes, skid trails and road drainage.

Florida

Compliance with best management practices has been monitored by The Florida Division of Forestry since 1981 (Vowell, 2000). Compliance monitoring is done biennially on 150-200 sites by a professional forester. Virtually all aspects of the operation are assessed, and the site is given a pass/fail based on the data collection. Statewide compliance with BMPs ranged from 84 – 94%, and averaged over 90% through 1993. Surveys conducted in 1995, 1997, and 1999 found results of 96% compliance each year.

Virginia

A 1997 report from the Virginia Department of Forestry reported that sediment production resulting from timber harvesting has increased in Virginia (Austin, 1997). This increase was estimated using a computer model that utilized measured sediment volumes from research and monitoring sites, BMP compliance rates, and the area logged each year. The model estimates sediment load from harvesting, burning, and bulldozing; sediment reduction from BMPs; and the post-harvest rates of decline in sediment yield. The increased sediment production was attributable to two factors: decreasing compliance with Forest Practice Rules and increasing rate of harvest. Results indicate that as compliance with BMPs decreased from 1992 through 1997, the sediment yield increased. In addition, the estimated land area being logged each year increased.

Southern Group of State Foresters

A regional BMP Task Forces was assembled in the fall of 1993 to establish criterion for BMP Compliance Monitoring (Southern Group of State Foresters, 1994). Under consideration were the frequency, site selection, categories to be evaluated, methodology, enforcement issues, and precision. The group recommended a biennial review on sites that were no more than 2 years old. The sites are selected using a random, stratified process, and the sample size should be large enough to achieve a 5% precision level. Timber harvesting, site preparation, roads, stream crossings, streamside management areas, chemical applications, burning and harvest plans should be evaluated. Evaluations and reports are to be provided at the rule level, the practice level, and at the operation level. BMPs are to be compliant or noncompliant (i.e., not marginally noncompliant) and operation compliance level should be based on the number of practices that applied at the site. A risk or impact assessment should be made. If significant noncompliance is identified and the party is unwilling to comply with correction recommendations, enforcement should be taken.

Related Monitoring and Research

ODF Stream Rule Research

Compliance rates can be a function of landowner support of current rules and regulations. Hairston-Strang and Adams (1997) researched the response of landowners and operators regarding Oregon 1994 stream rule changes. This study looked at what kinds of factors influenced the willingness and support of industrial landowners, non-industrial private landowners and logging operators to participate in the administrative program. There was a significant difference in response based on survey group (industrial, non-industrial, and operator). Hairston-Strang and Adams interpreted this as a reflection of different social norms for these groups and recommended reaching the respective groups with techniques that speak to these norms.

Cost and personal control were most commonly listed as reasons for lack of support. Factors which influenced support for the rules include understanding and involvement in the rule revision process (without prerequisite of technical knowledge), economic incentives, rules based on social norms, and good science and assurance of no increased regulation.

The Hairston-Strang and Adams study documented a sentiment that due to the importance of road sediment control, more literature needs to be available to operators on such topics as waterbars, culverts and road fills. Forest practice foresters should emphasize beginner and small ownership reforestation inspections, give less attention to proven operators and landowners, and be freed up from paperwork.

Water Quality in Relation to Compliance Monitoring

Results from past monitoring and research indicate that road systems are by far the greatest chronic sources of sand and/or fine sediment to stream systems. Of all the activities that take place on a forest

operation, roads are considered to have the greatest potential to impact water quality (Megahan and Ketcheson, 1996). Compliance monitoring may reveal more than water quality monitoring, especially in the arena of roads (MacDonald and Smart, 1993). Instream measures are an integration of everything upslope. Consequently, instream measurements can be a diluted or exaggerated version of what is occurring higher up in the channel network or on adjacent slopes. It is usually easier to accurately identify a drainage-related sediment source and to quantify the volume of sediment it produced than it is to measure sediment in the stream and work backwards to the source.

Burroughs and King (1989) demonstrated that certain practices can reduce the delivery of road sediment to stream channels. Examples include surfacing the road, erosion control on fill slopes, increasing distance between fill slopes and streams, reducing connectivity to stream crossings, adequate and functional cross drains, and rocking ditches (Burroughs and King, 1989; Skaugset and Allen, 1998). Implementation monitoring of these practices can improve our understanding of how to further minimize road-related impacts.

OBJECTIVES AND MONITORING QUESTIONS

The purpose of this project is defined by the objectives below, with specific monitoring questions created to outline the types of information to be gathered and analyzed.

Objectives

The ODF BMP Compliance Monitoring Project was designed based on previous monitoring and research studies of Forest Practice Rules and utilized lessons from projects undertaken by other states. The specific objectives are as follows:

1) Determine, through statistically valid sampling, the level of operator/landowner compliance with best management practices (BMPs) designed to protect water quality, and

2) Identify opportunities to improve program administration, operator education, and technology transfer, or rule clarity.

Monitoring Questions

In order to meet these objectives, the following monitoring questions were designed:

1) How often did operators comply with BMPs described in the Forest Practice Rules pertaining to water protection, road construction and maintenance, harvesting, and high-risk sites?

2) Have stream crossing structures on newly constructed and/or reconstructed roads been designed and installed according to ODF guidelines regarding fish passage and the 50-year peak stream flow event?

3) How do the statistical sample results compare with results based on forest practice foresters (FPF) inspections? Is there a correlation between number of FPF inspections and compliance rates? How statistically representative are the results of this project?

4) *Are there particular rules that consistently have a higher or lower level of compliance? If the latter, can the guidance and/or rule language be modified to improve compliance? Are there educational and training opportunities/materials regarding those rules?*

5) *When BMP compliance is inadequate, to what extent are quality and function of riparian areas, stream channels, and/or fish habitat compromised?*

STUDY DESIGN

At selected harvest unit sites, practices and features within that unit (harvest practices, roads, skid trails, etc.) were evaluated for compliance with 150 Forest Practice Rules relating to the protection of water quality and fish habitat. A brief description of the site selection process and data collection methodology follows. Please visit http://www.odf.state.or.us/FP/fpmp/default.htm to view the detailed protocol for this project. Stream crossing structures (bridge, culvert or ford) were evaluated for fish passage and 50-year event stream-flow capacity using a separate selection process and field protocol. These detailed stream crossing results are reported in a supplement to this report, *Compliance with Fish Passage and Peak Flow Requirements at Stream Crossings* (ODF, 2002[A]). The stream crossing report will not be discussed further in this document, but can be found online at http://www.odf.state.or.us/FP/fpmp/default.htm.

Site Selection

Defining the Population

The focus of this project was to monitor forest operations that had to comply with 1994 rule revisions and that had the potential to affect waters of the state (WOS). Therefore, "eligible notifications" had to meet both of the following criteria to be field surveyed:

- harvest units associated with any stream or wetland, and
- harvest units with a 1998 notification.

Stratification

The sample was stratified by district, stream classification, and ownership to address three characteristics that warranted further consideration in the sampling design. These included:

- Regional differences in the numbers of notifications and types of practices implemented,
- Heightened concern for fish-bearing streams, and
- Differences between industrial, non-industrial, and other landowners.

District Stratification. Oregon is partitioned into 14 ODF districts covering the state. FPFs in district offices are responsible for administering the FPA on non-federal ownership that fall within their areas. The sample distribution was weighted to match that of the statewide district distribution of notifications, with goal of a minimum of 10 units per district.

Stream Classification. The ODF uses a designation of Type F for fish-bearing streams, Type D for domestic water sources that are not fish-bearing, and Type N for streams that are neither fish-bearing nor domestic water sources. Streams with no classification were referred to as "unknown." Because of the critical issues surrounding fish habitat, sampling stratification was intentionally biased to capture more fish-bearing streams. An additional justification was that most fish-bearing streams are likely to have small Type N streams as tributaries within the operation unit. Therefore, the selection process, although biased towards fish-bearing streams, was still likely to capture a sufficient number of small Type N streams for analysis. Consequently, the goal was to have 60% of the units contain fish-bearing streams. The remaining

40% were partitioned according to the relative proportions of Type N and unknown-usage streams in the population. The result was 10% of the units being known N or D streams and 30% unknown. Streams of unknown-usage were updated to either Type F, D, or N upon survey of the unit, thus potentially altering this distribution somewhat. The weakness of this stratification is that it may undersample steep terrain as these units are less likely to have Type F streams.

Land Ownership Stratification. The landowner classes were industrial, non-industrial, and other. "Other" includes lands owned by state or local governments, as well as nonprofit organizations. While the numbers of notifications for industrial versus non-industrial were comparable (1,998 and 1,578), the average size of an operation with a stream was twice as large for industrial (137 acres) than for non-industrial landowners (64 acres). Therefore, the sample size for each landowner class was weighted to be proportionate to the total acreage of operations with streams for each class. The relative sampling proportions used, based on acreage, were 70% industrial, 20% non-industrial, and 10% other (Table 2). It is important to note that the operation size only applies to operations with streams and may be artificially high due to this focus.

Table 2. Landowner Population Characteristics

Landowner Class	Number of Notifications	Average Acres	Total Acres	Percent of Total
1 State, Local, Other	433	84	36,184	9%
4 Non-Industrial	1,578	64	101,464	25%
5 Industrial	1,998	137	274,282	67%

Selection

A total of 4,075 eligible notifications were compiled with a query of the Forest Activities Computerized Tracking System (FACTS) database, then stratified by the criteria described above.

Based on the results of the pilot study, it was estimated that a sample of roughly 190 units would be needed to represent compliance for the defined population with 95% confidence. Notifications were randomly ordered within each of the sub-samples created by district, stream type, and ownership stratification and then reviewed for meeting the criteria of this study. In the process of identifying and surveying the desired sample of qualified units from each sub-population, a total of 464 notifications were reviewed, with 275 disqualified during this process (Table 3).

Table 3. Units Reviewed During Selection Process Which Did Not Meet Survey Criteria

Reason Unit Disqualified	Units
Did Not Meet WOS Criteria	128
Did Not Meet Harvest Criteria	119
Operation Did Not Occur (51) Operation Still Active (27) Non-Harvest Operation (16) Land Use Change Following Operation (11) Non-Forest Practices Operation (8) Removal of Hazard Trees Only (6)	
Survey Could Not Be Arranged	25
Landowner Not Available (13) Access Denied (12)	
File Not Found	3
Total Units Disqualified	**275**

Of these 275 operations, 124 were not surveyed because they did not have any waters of the state associated with the operation. A total of 119 operations were dropped for a variety of harvest criteria: 51 operations did not occur, 27 were still active at the time of review, 16 were non-harvest activities only (pick-up log decks, site preparation, or road maintenance), 11 were land-use changes, 8 were various non forest practices related activities, and 6 were removal of hazard trees (along roads, homes, or utility lines). Twenty-five operations were dropped because surveys could not be arranged, with the landowner unavailable for 13 of these and access denied by the landowner for 12. The file was misplaced and could not be reviewed for three of the notifications selected.

Site Characteristics

Data collection was completed on a total of 189 units around the state (Figure 1). The ownership, classification and stream type are listed in Table 4. Distributions vary somewhat from targets as units were dropped for a variety of reasons over the course of the survey period. Seventy-seven percent of the sampled units were under industrial ownership, 15% non-industrial, and 8% were under other ownership (Figure 2). Fifty-six percent had Type F streams and 44% had only Type D or N streams or significant wetlands. The distributions of stream types and RMA harvest prescriptions are detailed in the *Vegetation Retention Along Streams* portion of the *Results* section of this paper.

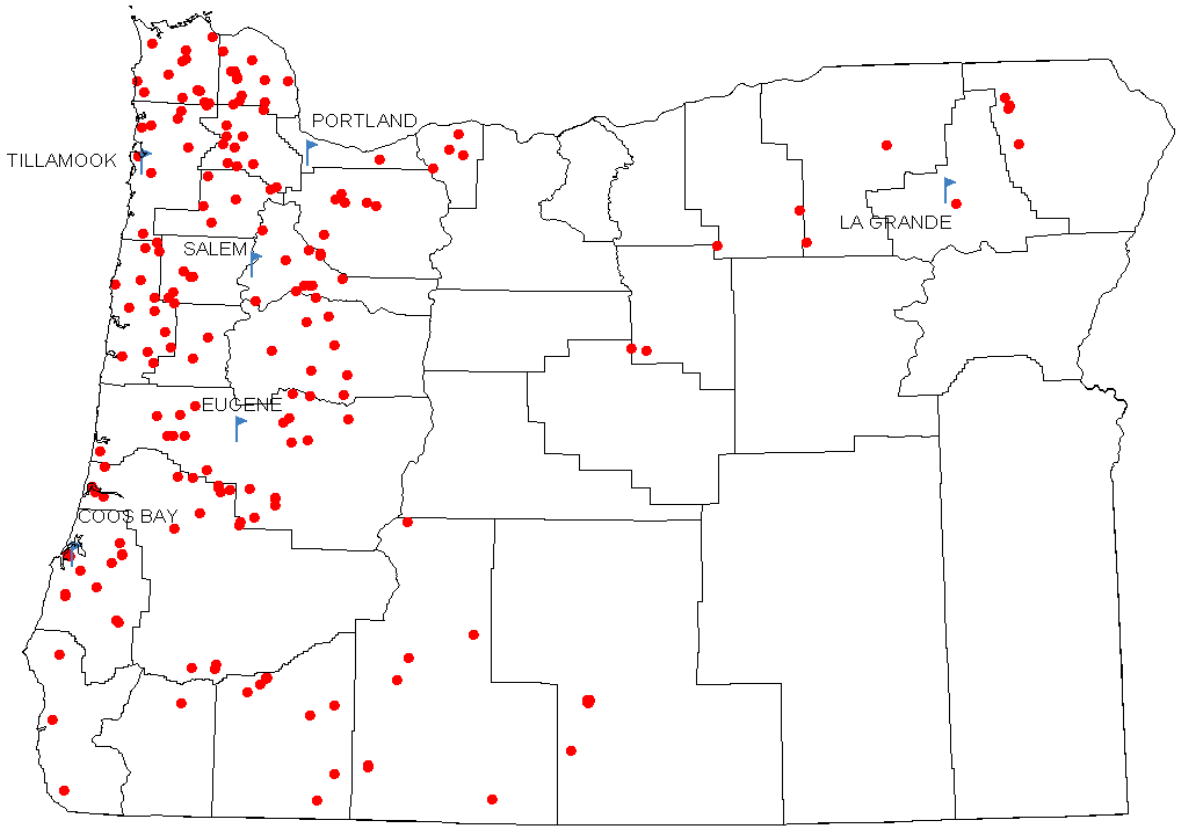

Figure 1. Location of Units Surveyed for BMP Compliance

Table 4. Units Surveyed by Ownership and Stream Class for Each ODF District

	Total	Landowner Class			Stream Type	
ODF District	Visited	Industrial	Non-Ind.	Other	Type F	No Type F
Astoria	10	7	1	2	3	7
Tillamook	9	7	0	2	5	4
Forest Grove	28	22	4	2	15	13
West Oregon	24	19	4	1	10	14
Clackamas-Marion	16	8	6	2	10	6
Linn	9	8	1	0	4	5
Eastern Lane	14	14	0	0	11	3
Western Lane	10	8	1	1	7	3
Douglas	9	7	2	0	5	4
Northeast Oregon	9	6	3	0	4	5
Coos Bay	19	14	4	1	12	7
Southwest Oregon	11	8	0	3	7	4
Klamath-Lake	14	11	3	0	10	4
Central Oregon	7	6	0	1	2	5
Total	**189**	**145**	**29**	**15**	**105**	**84**

Figure 2. Distribution of Units by Ownership Class

Rule Focus

The Forest Practice Rules designed to protect water quality and fish habitat are detailed, complex, and span multiple rule divisions. Potentially, 150 rules could be assessed at any given unit, with multiple applications of some rules possible.

Rules in 10 divisions were assessed: Planning Forest Operations (division 605), Treatment of Slash (division 615), Chemical and Other Petroleum Products (division 620), Road Construction and Maintenance (division 625), Harvesting (division 630), Vegetation Retention Along Streams (division 640), Significant Wetlands (division 645), Lakes (division 650), Other Wetlands and Seeps (division 655), and Operations Near Waters of the State (division 660). The individual rules surveyed and rule requirements are detailed in the *Results* section of this report.

Rules that are designed to maintain productivity and wildlife habitat or that describe the purpose of the rules, have not been assessed by this project for three reasons. First, the focus of this project is BMPs that are designed to protect waters of the state (WOS). Secondly, some of the rules must be assessed at the time of application, prior to application, or a few years after application. The BMP evaluations occurred one to two years after application. Finally, rules that describe the purpose and background of the division do not define how a practice should be implemented and therefore cannot be readily monitored for compliance.

FIELD AND ANALYTICAL METHODS

In an effort to answer the monitoring questions, the ODF developed a protocol with two approaches to data collection: (1) compliance rating data and (2) numeric data. Data collected from these two approaches were combined to quantify compliance and impacts on riparian and channel conditions. A brief description of these methods follows. Please refer to the protocol for this project (*Oregon Department of Forestry's BMP Compliance Monitoring Project*) for a detailed description of the data collection methods and field forms. This protocol, as well as information on other projects, is available online at http://www.odf.state.or.us/FP/fpmp/default.htm.

Compliance Rating System

An experienced, retired FPF evaluated each unit using the compliance rating system. The compliance rating system provides qualitative data regarding rule compliance. All the rules that applied to each unit were rated as Compliant or Noncompliant. Noncompliance, when identified, was further described as Administrative, Potential Resource Impact, or Resource Impact. For the purposes of this project, observable impacts to riparian, stream channel, or wetland conditions were used as surrogates for water quality impacts. Instances when vegetation-retention rule requirements were exceeded were also documented and are discussed in the *Results* section.

Administrative Noncompliance

Administrative noncompliance refers to an activity that did not comply with notification and/or written plan requirements described in the rules. For example, if a unit was harvested within 100 feet of a Type F stream without a written plan, this would have been an *administrative* noncompliance. This type of noncompliance was for rules which deal only with procedural and documentation requirements and not those directly governing on-the-ground harvesting practices which could potentially lead to resource impacts.

Potential Resource Impact

There were other situations where noncompliance was with a practice in the field, yet there were no immediate, identifiable impacts to riparian or channel conditions. For example, OAR 629-615-100 (2) requires the disposal of unstable slash accumulations around landings to prevent their entry into streams. Noncompliance with this rule may identify unstable landing slash that has not entered the stream, but has the potential to impact riparian or channel conditions in the future. This would be identified as a *potential resource impact*.

Resource Impact

Noncompliant practices that result in significant loss of riparian vegetation, channel alteration, or delivery of sediment, slash, or other waste to WOS were considered to have a *resource impact*.

Numeric Data Collection

A two-person field team also surveyed the units collecting numeric data. The numeric data are a combination of quantitative and categorical assessments. For example, in the case of riparian management areas, the BMP field team established transects spaced 200 feet apart for the entire length of the RMA. Along each transect, the team documented area (quantitative) and source (category) of vegetation and ground disturbance, accumulations of slash in the channel (category) width of no-cut buffers (quantitative), sediment delivery (quantitative and source category), and effects of ground and vegetative disturbance on stream and riparian resources (quantitative and categorical). In addition, if the riparian area was managed to meet a basal area target, the team conducted a 100% cruise of conifers and other trees and snags that count towards the basal area target (quantitative). A similar approach was used for notifications, written plans, wetlands, yarding, treatment of slash, road maintenance, road drainage, road location, stream crossings, skid trails, temporary crossings, landings, waste areas, rock pits, and high-risk sites.

Quality Assurance and Quality Control

In order to test the reliability of the numeric data collection methods, six units were revisited and measurements of RMA and road conditions repeated. The results of these repeat measurements demonstrate the degree to which the numeric data can vary. For example, the road length recorded for every location and drainage condition category when revisited was within two 100-foot stations of that recorded on the first visit (see Tables C-1 and C-2 in Appendix C). This variation was expected because conditions were categorized into stations, and because of the error involved in measuring great distances of road with a hip chain or odometer.

The reliability of the numeric data collection is most critical for the survey of RMAs because it was used to directly evaluate compliance. Ten RMAs were resurveyed for uncut tree width. The measured uncut width did not differ between the two visits for a single transect in any of these ten RMAs (Table C-3 in Appendix C). Four RMAs were resurveyed for tree counts, with differences between visits of 0, 1, 1 , and 5 trees (Table C-4 in Appendix C). These four RMAs were also resurveyed for basal area, with differences between visits of 3.7, 1.5, 4.6, and 3.0 total square feet (Table C-5 in Appendix C). These variations were due to the difficulty in determining the exact beginning or end of an RMA and whether particular trees were in the RMA or out of the unit at these RMA edges.

Sediment Sources

The Forest Practice Rules, in part, are designed to minimize sediment delivery to stream systems, and interpretation of compliance often hinges on whether sediment was delivered to the stream or not. For the purposes of this study, all sediment delivery reported here is the result of noncompliant forest practices. Included is sediment which is observed to have eroded into a channel, material that was placed so that it is actively or imminently eroding to the channel (generally below the high water line, e.g., temporary crossing fill not completely removed), and instances where there is clear evidence of sediment which has been eroded to a channel and transported off site by an erosional feature (e.g., rill, gully, concave area left after a landslide). Sediment volume estimates were made from observed delivered material or from concave erosional features. Because of the lack of precision of this method, sediment delivery volumes were estimated within broad categories: 0-1 cubic yards, 1-10 cubic yards, 10-100 cubic yards, and greater than 100 cubic yards.

There are limitations to this approach to sediment input monitoring. This approach captures only sediment input that can be traced during the dry, summer field season. Road maintenance practices themselves can

eliminate evidence of erosion. In addition, over time, evidence of erosion can be obscured by vegetation. The ODF has done extensive work assessing forest practices and landslides (Robison *et al*., 1999) and on the potential of forest roads to deliver sediment to streams (Skaugset and Allen, 1998), but more monitoring is needed on chronic sources of sediment from wintertime equipment operation and road use. The ODF is currently conducting a study to evaluate the impacts of road use and surfacing material on stream turbidity during wet weather.

Calculating Compliance

The rating system and the numeric data were used to assess the same rules. The numeric data were used to report feature conditions and distributions (e.g., lengths of road by location or drainage type, lengths of RMA by prescription used, number of landings in a unit, etc.). The numeric data were also drawn on to determine compliance for 52 rules with numeric criteria or measurable standards written into the rules. For example, the Riparian Vegetation Retention rules provide precise measures of compliance that can be evaluated numerically (e.g., no-cut buffer widths, basal area retention, etc.). Other rules require operators to meet subjective requirements, such as minimize and avoid resource impacts. These 67 rules require judgement on the part of an experienced forest practice forester or natural resource specialist to determine compliance. For example, road construction and maintenance rules require that operators locate roads to minimize the risk to waters of the state and avoid steep slopes. The numeric data can be used to describe the percent of roads in different locations, but the compliance assessment data is needed to assess if those roads were in compliance with these sort of subjective road location rules. Compliance for the remaining 30 rules evaluated was determined by combining both the numeric and compliance assessment data. These rules were those for which compliance could be measured by either method (e.g., removal of all petroleum-related products from the unit). The distribution of these three sources of compliance determinations is shown in Figure 3.

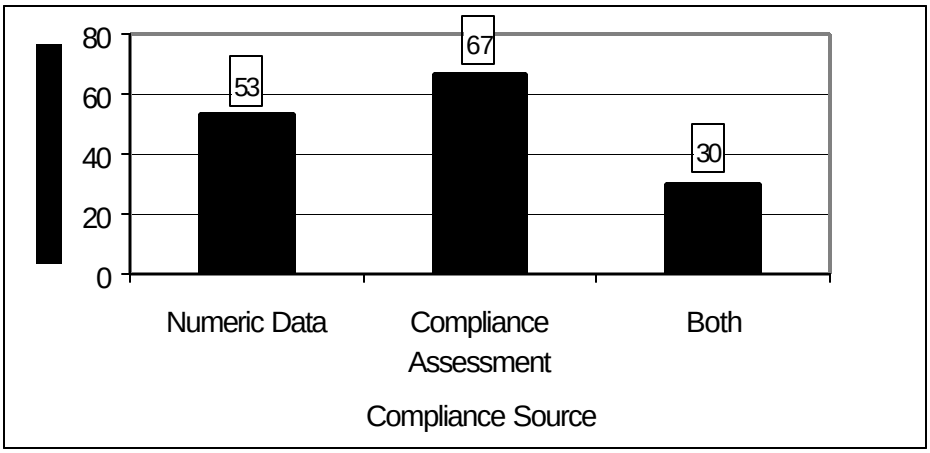

Figure 3. Sources of Rule Compliance Determination

Compliance rates are calculated and reported at a unit level and at a rule level based on the total number of rule applications evaluated for each unit or rule. For 70 rules, compliance was evaluated once for each unit as a whole (e.g., reforestation), and for 80 rules, it was evaluated for each feature to which it applied within the unit (e.g. removal of temporary crossings).

RESULTS

Surveys were conducted on 189 harvest units for the applications of up to a 150 rules relating to specific harvesting practices and features that could potentially impact water quality. This resulted in the evaluation of compliance and resource-impacts for 13,506 total BMP applications. Survey results are discussed in detail at two levels: (1) compliance rates by unit surveyed (unit level) and (2) compliance rates by rule surveyed (rule level). The unit-level results summarize overall compliance for each of the 189 units surveyed. The rule-level results summarize compliance for all applications of each of the rules surveyed. See the *Field and Analytical Methods* section for a detailed description of how compliance rates were calculated.

Unit-level Compliance

The average unit-level compliance rate was 96.1%. Compliance rates for each unit ranged from a low of 78.8% (26 compliant practices out of 33 applied) on one unit to 100% compliance on 46 units (Figure 4).

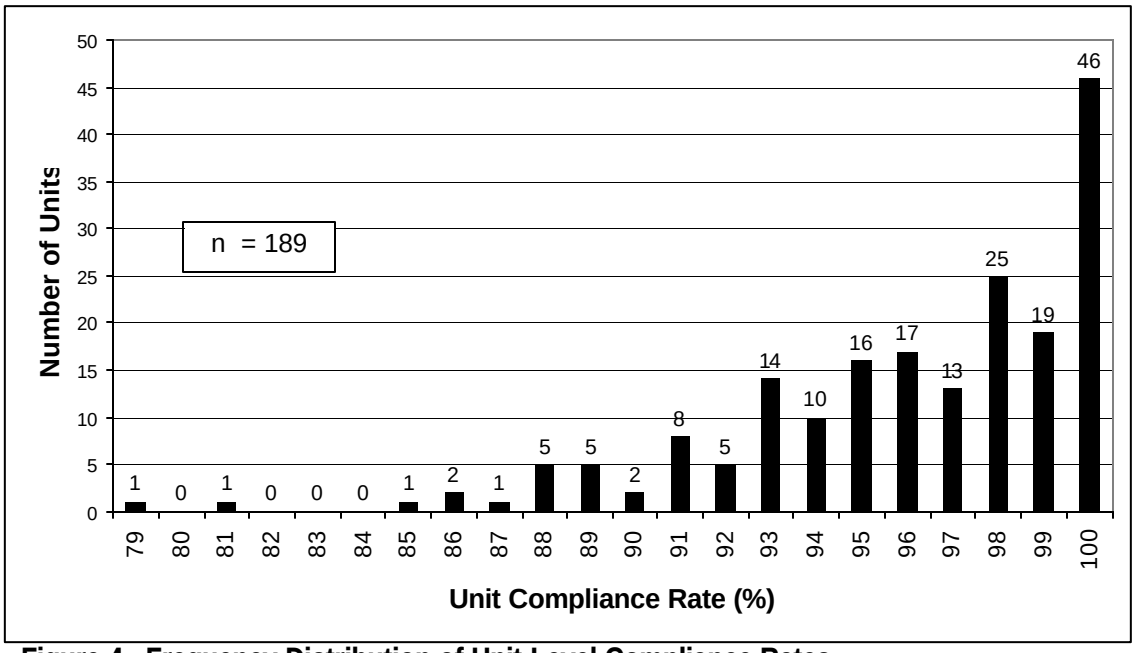

Figure 4. Frequency Distribution of Unit-Level Compliance Rates
(All units had a compliance rate of 79% or greater.)

Only a portion of all rules considered actually applied to each unit, with an average of 49 different rules applying per unit (ranging from 17 to 80). However, a particular practice was often repeated within a unit (e.g., multiple stream crossings), for an average of 71 total *rule applications* surveyed per unit (ranging from 17 to as many as 419). The number of rules applied, number of rule applications, and compliance rate for each unit are shown in Table A-1 of Appendix A. Because each of these rule applications is a BMP designed to protect water quality, unit-level compliance is reported as the number of compliant practices (compliant rule applications) out of the total number of rule applications surveyed on a unit. This means that rules which applied more frequently weighed more heavily in unit compliance, but it creates a more complete representation of compliance and potential resource impacts.

The achievement of high compliance with the Forest Practice Rules depends on effective interactions between the Oregon Department of Forestry, landowners, and forest operators. It is important to recognize the number of BMPs that must be properly implemented to put these results into perspective. A total of 13,506 individual applications of rules designed to protect waters of the state were surveyed for this project. There are also a host of other rules that must be properly implemented on each unit (relating to wildlife protection, soil productivity, and reforestation outside of RMAs, for example) that were not evaluated by this project.

Unit Noncompliant Practices

There was an average of 2.7 noncompliant practices per unit (3.9% of total practices per unit) ranging from 0 to 14. In general, this number is not correlated to the number of practices that applied to a unit. All noncompliant practices surveyed fell into one of three categories relative to water quality protection: administrative issues relating only to notification and public record requirements (1.0 per unit), general resource issues with the potential to impact future water quality (0.8 per unit), and observed impacts to riparian and channel conditions (0.9 per unit). The number of noncompliant practices of each type for each unit are given in Table A-1 in Appendix A, and specific resource impacts are further detailed in the *Findings* section.

Unit Compliance Trends in Ownership

Three ownership classes were examined to investigate relationships between ownership and compliance: industrial, non-industrial, and other (state and local government lands). The average unit-level compliance rates were similar across all three ownership types (Table 5). The average unit-level compliance rates were 96%, 97%, and 98% for industrial, non-industrial, and other ownerships, respectively. All ownership classes had at least one unit which met the maximum compliance rate of 100%. The minimum unit compliance rates for each of the three classes were more divergent, however, at 79%, 81%, and 94% for industrial, non-industrial, and other ownerships, respectively. These differences may very well be due to sample size, as the ownership classes with the least number of units surveyed have the lowest range of compliance rates.

Table 5. Unit-Level Compliance Rates by Ownership Class

Unit-level Compliance Statistics	Industrial	Non-Industrial	Other
Number of Units	145	29	15
Average Unit Compliance	96%	97%	98%
Max. Unit Compliance	100%	100%	100%
Min. Unit Compliance	79%	81%	94%

Rule-level Compliance

The Forest Practice Rules and Regulations are organized into divisions addressing the various aspects of forest operations and administration. Compliance for the 150 rules surveyed is reported here in 11 sections which follow this formal division format. The exception is that all procedural and documentation requirements are pulled from all divisions and reported in a single section titled “Administrative Requirements.” Within each section, individual rules are further organized for reporting purposes into sub-sections by the specific harvesting practice or feature which they address (Table 6).

Table 6. Rules and Regulations Sections Monitored

Chapter - Division	Section Heading	Practice or Feature Sub-Sections
629-610	**Reforestation**	RMA Reforestation Timing
629-615	**Treatment of Slash**	Harvesting Slash Disposal
629-620*	**Chemicals and Petroleum Products**	Chemical Applications Petroleum Products*
629-625	**Road Construction and Maintenance**	Road Location Road Prism Design Road Stream Crossing Design Road Drainage Design Road Drainage Maintenance Road Waste and Stabilization Road Vacating Rock Pits
629-630	**Harvesting**	General Yarding Practices Felling and Harvesting Slash Cable Yarding Near WOS Ground Equipment Near WOS Harvesting Waste Landings Skid Trails Temporary Crossings
629-640	**Vegetation Retention Along Streams**	Type F RMAs Type D/N RMAs
629-645	**Protection Measures for Significant Wetlands**	Significant Wetlands
629-650	**Protection Measures for Lakes**	Lakes
629-655	**Protection Measures for Other Wetlands**	Other Wetlands
629-660	**Operations Near WOS**	Stream Channel Changes
All*	**Administrative Requirements**	Notification Prior Approval Written Plans

* Includes one petroleum-related rule from Division 629-630

The compliance rate for all 13,506 rule applications surveyed for this project was 96.3%, with compliance rates for each rule division section ranging from 70% to 100% (Figure 5). Both the Reforestation (division 629-610) and Operations Near WOS (division 629-660) sections had 100% compliance for all rules. Compliance rates were lowest for rule applications in the Protection of Other Wetlands (division 629-655) and Administrative Requirements (pulled from all divisions) sections, at 70% and 83%, respectively.

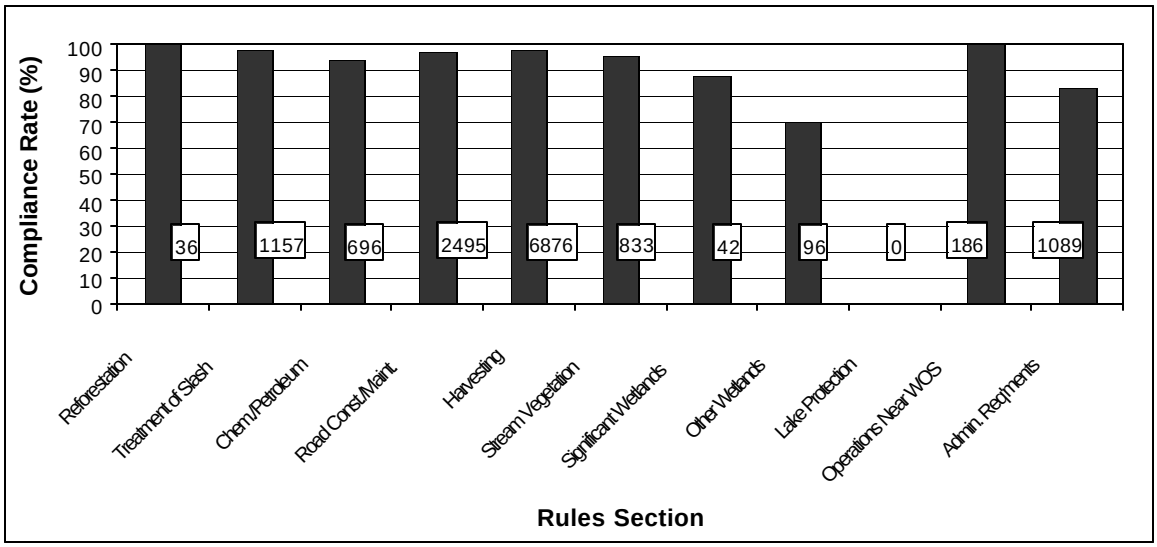

Figure 5. Compliance Rates for Rule Sections
(Number of rule applications surveyed for each section shown in boxes.)

What follows are detailed survey results for each of the specific practices or features surveyed for this project and listed in Table 6. These include total compliance results for each sub-section, individual rule compliance rates, explanation of the source of rule applications, and discussion of cause of noncompliant practices and resulting impacts to water resources.

Reforestation (OAR 629-610)

Compliance was 100% for both reforestation rules evaluated within harvested portions of RMAs. Rules were evaluated on a unit-wide basis, with no issues on any of the units to which they applied (Table 7). The two rules evaluated for this section dealt with the requirements to begin (within 12 months) and complete (within 24 months) reforestation when RMA harvesting reduced trees below the stocking standard. These rules applied to 34 and 2 units, respectively, with the rest of the units surveyed either harvested too recently for these rules to apply or exempted from reforestation requirements by zoning changes to non-forestry land uses.

Table 7. Compliance Results for RMA Reforestation Timing Rules

 # Rule Applications = total number of rule applications surveyed, *Percent Compliant* = percent of rule applications compliant, *NC: Pot. Impact* = noncompliant rule applications with a potential riparian/channel impact (e.g., placement of material in unstable location above stream channel), *NC: Impact* = Noncompliant rule applications with an observed impact on riparian/channel resources (e.g., sediment delivery to a stream), *NC: Admin.* = Noncompliant rule applications relating to administrative requirements only (e.g., failure to gain prior approval for harvesting within 100' of a stream)

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-610- 040 *2*	RMA Reforestation Begun w/in 12 Months	34	100.0	0	-
629-610- 040 *3*	RMA Reforestation Completed w/in 24 Months	2	100.0	0	-
Compliance of All Section Rule Applications		**36**	**100.0**	**0**	**-**

Treatment of Slash (OAR 629-615)

Compliance was 98.2% for all applications of treatment of slash rules. There were 1,157 total applications of 7 rules in this section (Table 8). These rules applied three aspects of post-harvest disposal of slash: slash around landings that could enter streams, mechanical site preparation near waters of the state, and protection of RMAs during prescribed burning.

Surveys for disposal of unstable slash accumulations (615-100 (2)) at 868 landings revealed 99.2% compliance. Six noncompliant practices had a potential resource impact and one delivered slash to waters of the state. Four mechanical site preparation rules (615-200 (1), (2), (3), (4)) evaluated unit-wide found 14 total noncompliant practices on 77 units. These resulted in seven cases of potential sediment or slash delivery to WOS, five cases of observed slash delivery, and two cases of observed sediment delivery. The lowest compliance in this section was with mechanically-gathered slash placed in a stable location away from WOS (629-615 200 (4)). Compliance was 89.6%, with eight noncompliant practices. The protection of RMA vegetation and removal of RMA slash before burning (615-300 (2d) and (2e)) were 100% compliant for all three units with broadcast burning.

Table 8. Compliance Results for Treatment of Slash Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-615- 100 *2*	Landing Slash - Unstable Accumulations Disposed	868	99.2	6	1
629-615- 200 *1*	Mech. Site Prep. - No Sed./Debris Delivery to WOS	77	94.8	1	3
629-615- 200 *2*	Mech. Site Prep. - WOS Filtering Distance Provided	77	97.4	2	0
629-615- 200 *3*	Mech. Site Prep. - RMA Soil Protected	52	100.0	0	0
629-615- 200 *4*	Mech. Site Prep. - Debris Placed Away From WOS	77	89.6	4	4
629-615- 300 *2d*	Prescribed Burning - RMA Vegetation Protected	3	100.0	0	0
629-615- 300 *2e*	Prescribed Burning - Chan./RMA Slash Removed	3	100.0	0	0
Compliance of All Section Rule Applications		**1157**	**98.2**	**13**	**8**

Chemical and Other Petroleum Products (OAR 629-620)

Compliance was 94.3% for all applications of petroleum product and chemical application rules. There were 696 total applications evaluated for six rules in this section. Compliance rates for individual rules are discussed in two sub-sections titled *Petroleum Products* and *Chemical Applications*. Rule 630-400 (3) is reported here with the Division 620 rules in the *Petroleum Products* sub-section for continuity of all petroleum-related rules.

Petroleum Products. Compliance was 93.3% for the protection of steam and soil resources from petroleum product pollution. There were 567 total applications of three rules in this sub-section. These rules were evaluated for each of the 189 units surveyed. Compliance was 97.9% with the requirement to prevent the leaking of petroleum products (620-100 (1)), with four noncompliant practices due to oil leaks on the ground. No petroleum products were found delivering to WOS, but these cases were potential threats for future water quality. Compliance was 100% for rule 620-100 (2) requiring adequate precaution be taken to ensure no petroleum products enter WOS during the operation. The lowest compliance in this section was with removal of all petroleum-related products from units. Compliance with this rule (630-400 (3)) was 82.0%. Noncompliant practices consisted of oil filters, oil containers, or grease-tubes found on 34 units, mainly at landings. None of these were found near WOS, but were considered to be concerns for future water quality.

Table 9. Compliance Results for Petroleum-Related Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-620- 100 *1*	Petroleum Leaks Prevented	189	97.9	4	0
629-620- 100 *2*	Petroluem Delivery to WOS Prevented	189	100.0	-	0
629-630- 400 *3*	Petroleum-Related Waste Removed	189	82.0	34	0
Compliance of All Sub-Section Rule Applications		**567**	**93.3**	**38**	**0**

Chemical Applications. Compliance was 98.4% for all rule applications in this sub-section. There were 129 total applications of three rules evaluated for the protection of waters of the state when applying chemicals (620-400 (1, 2, and 5)). These rules applied to 43 units surveyed with herbicide applications (Table 10). Compliance was 100% with protection requirements for both RMA vegetation and specified water resources. Two noncompliant practices were observed, however, with adherence to product label requirements (95.3% compliance). These were both from the direct application of herbicide to open small wetlands and resulted in vegetation damage.

Table 10. Compliance Results for Chemical Application Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-620- 400 *1*	WOS Protected and Label Followed	43	95.3	-	2
629-620- 400 *2*	RMA Vegetation Protected	43	100.0	-	0
629-620- 400 *5*	Veg. w/in 10' of Specified WOS Protected	43	100.0	-	0
Compliance of All Sub-Section Rule Applications		**129**	**98.4**	**-**	**2**

Road Construction and Maintenance (OAR 629-625)

Compliance was 97.6% for all applications of road construction and maintenance rules. There were 2,495 total applications of 33 rules in this section. These rules were evaluated for 80 units with new road construction and 171 units with new or existing roads. New roads are those that were constructed specifically to access the operation being surveyed following the 1996 road regulation revisions and were generally constructed 1-3 years prior to survey.

In total, 148.4 miles of existing road and 38.5 miles of new road were surveyed for BMPs that establish standards for effective road surface drainage. New roads, stream crossings, and rockpits were also evaluated for location, design, construction, and stabilization BMPs relating to providing the maximum practical protection of water quality and fish habitat.

Across all road rules, there were 61 noncompliant practices observed on 41 units. Of these, 23 had no observed impact on riparian or channel conditions, but had the potential to impact resources (unstable material or drainage maintenance issues). The remaining 38 noncompliant practices had observed impacts due to erosion of fill or waste material (13), ineffective surface drainage design (12), inadequate drainage maintenance (10) and machine activity in a channel (3). Resulting resource impacts were sediment delivery (36) and stream channel disturbance (2). The compliance rates of specific road rules are detailed in the road sub-section discussions which follow.

Road Location. Compliance was 100% for rules requiring roads be located to minimize stream crossings and disturbance to water resources (Table 11). There were 240 total applications of three road location rules. Each of these rules applied to the 80 units with new road construction.

Table 11. Compliance Results for Road Location Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-625- 200 *2*	Disturbance to WOS Minimized	80	100.0	0	0
629-625- 200 *3*	Layout in Resource Areas Avoided	80	100.0	0	0
629-625- 200 *4*	Stream Crossings Number Minimized	80	100.0	0	0
Compliance of All Sub-Section Rule Applications		**240**	**100.0**	**0**	**0**

New and existing road lengths were documented by the location categories shown in Table 12. This shows the distribution of road locations surveyed and does not reflect compliance, as road construction can be allowed in some resource areas if done properly and alternative locations do not exist. The location descriptors are ordered from left to right by highest general potential to impact on water resources. Roads in the "other" category are areas least likely to impact stream resources. Road location distribution was similar for new and existing roads, with the greatest differences being in newly constructed road length within RMAs and on slopes over 65%.

Table 12. Percent of New and Existing Road Lengths in Each Location

Road Age	Number of Units	Total Length (ft)	Percent of Total Length	Percent of Total Road Length Located in Each Category: Highest Res. Impact → Lowest Res. Impact					
				High Risk Site	High Water	Seeps Springs	RMA	Slopes >65%	Other
New Roads	80	203,100	21%	0.6%	0.0%	0.6%	0.0%	3.1%	95.6%
Existing Roads	144	783,500	79%	0.6%	0.1%	0.1%	1.4%	1.2%	96.6%

Road Prism Design. Compliance was 99.4% for all applications of road prism design rules. There were 320 total rule applications of four rules evaluated for long-term road stability on 80 units with new road construction (Table 13). Compliance was 100% for requirements minimizing road prism in resource areas (625-310 (1)) and the end-hauling of construction waste material on steep slopes (625-310 (2)). There was one potential resource impact noncompliance for the requirement that road widths be minimized (625-310 (3)), and noncompliance with the requirement for the stable design of road fills (625-310 (5)), resulting in sediment delivery to a stream channel.

Table 13. Compliance Results for Road Prism Design Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-625- 310 *1*	Road Prism in Resource Areas Minimized	80	100.0	0	0
629-625- 310 *2*	Waste Material End-Hauled	80	100.0	0	0
629-625- 310 *3*	Road Width Minimized	80	98.8	1	0
629-625- 310 *5*	Road Fill Design Stabilize	80	98.8	0	1
Compliance of All Sub-Section Rule Applications		**320**	**99.4**	**1**	**1**

Stream Crossing Design. Compliance was 94.1% for all rule applications in this sub-section. There were 204 total applications of five stream crossing design rules, four of which applied to each of the 51 new crossings surveyed (Table 14). There were no temporary road crossings on any of the units surveyed. Fill volume was minimized for all crossings (655-320 (1bA)), but stability of fill (625-320 (1bC)) was found to be

an issue, with only 84.3% compliance. Unstable fill at eight crossings resulted in sediment delivery to the stream channel. Sediment delivery also occurred from one crossing not designed to pass the 50-year peak flow (625-320 (2a)) and three crossings with excess channel disturbance during installation (625-430 (1)).

Table 14. Compliance Rates for Road Stream Crossing Design Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-625- 320 *1bA*	Design - Minimum Fill Volume	51	100.0	0	0
629-625- 320 *1bC*	Design - Prevent Erosion of Fill/Channel	51	84.3	0	8
629-625- 320 *2a*	Design - Pass 50-Year Peak Flow	51	98.0	0	1
629-625- 430 *1*	Construct. - Min. Machine Activity in Channels	51	94.1	0	3
629-625- 430 *5*	Temporary Road Crossings Removed	0	-	-	-
Compliance of All Sub-Section Rule Applications		**204**	**94.1**	**0**	**12**

Because of their location, road stream crossings have the potential to greatly impact water quality. A variety of numeric and categorical data were collected on a total of 157 existing stream crossings as well as 51 new stream crossings (installed under 1995 amended rules). This information, summarized in Table 15, describes conditions for both new and existing crossings and does not necessarily represent compliance.

Table 15. Characteristics of 208 Road Stream Crossings Surveyed

Crossing Characteristics (sample size)	Number of Crossings	Percent of Crossings
Stream Class (n=208)		
Small N	171	82%
Small D	3	1%
Small F	23	11%
Medium F	10	5%
Large F	1	1%
Feature Type (n=208)		
Round Pipe	179	86%
Pipe Arch	4	2%
Log Puncheon	2	1%
Bridge	4	2%
Ford	19	9%
Fill Depth (n=185 no fords or bridges)		
Less than 15'	167	91%
Greater than 15'	18	9%
Fill Stabilization (n=185, no fords or bridges)		
Effectively Vegetated	106	57%
Effectively Armored	57	31%
None - Not Needed	11	6%
Fill Unstable	11	6%

Road Drainage Design. Compliance was 97.3% for all rule applications in this sub-section. There were 993 total applications of eight road drainage design rules, most of which applied to both new and existing roads (Table 16). Stream channel diversions were avoided (625-330 (2)) on all 80 units with new road construction. Compliance was also 100% for ditches kept clear of slash and debris (625-420 (1)), the construction of effective crossdrains (625-420 (2)), and the removal of road berms (625-420 (5)) on all 171 units with either new or existing roads.

Table 16. Compliance Rates for Road Drainage Design Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-625- 330 *1*	Design - Effective Surface Drainage	171	86.5	14	9
629-625- 330 *2*	Design - Diversion of Streams Avoided	80	100.0	0	0
629-625- 330 *3*	Design - Effective Filtering at Stream Crossings	51	98.0	0	1
629-625- 330 *4*	Design - Effective Seeps/Springs Drainage	171	99.4	0	1
629-625- 330 *5*	Design - Drainage to Unstable Areas Avoided	7	71.4	2	0
629-625- 420 *1*	Condition - Ditches Cleared of Slash/Debris	171	100.0	0	0
629-625- 420 *2*	Condition - Effective Crossdrains Provided	171	100.0	0	0
629-625- 420 *5*	Condition - Road Berms Removed	171	100.0	0	0
Compliance of All Sub-Section Rule Applications		**993**	**97.3**	**16**	**11**

The majority of road drainage design noncompliant practices were with the installation of an effective overall road surface drainage design (625-330 (1)). Compliance with this rule was 86.5% for the 171 units with roads. Roads in 14 units had the potential to impact riparian and channel conditions, and nine had observed sediment delivery to a channel. Sediment delivery also resulted from noncompliant practices for ineffective filtering of road ditchflow at one stream crossing (625-330 (3)) and one ineffective drainage design of a road through a seep (625-330 (4)).

The lowest sub-section compliance was with avoiding drainage discharge to high risk, or landslide-prone, slopes (625-330 (5)). Compliance with this rule was 71.4%, with noncompliant practices on two of the seven units with new roads on high risk slopes. These were considered potential resource issues, with no erosion or soil instability evident. Complicating compliance evaluation for this rule is the fact that one of these two discharge sites was actually deemed to have been the best option for long-term water quality protection. Given the specifics of this situation, the design of a road surface drainage relief point at this particular high risk slope was considered less likely to cause slope or fill instability issues than would the routing of this drainage water down the road surface.

Table 17. Distribution of Road Drainage Design Installed

Surface Drainage Design	Ditch/Culvert	Outsloped	Waterbars	None Installed
Length (Miles)	79.2	73.0	31.1	3.5
Percent of Total	42%	39%	17%	2%

Because it is often directly connected to the stream system, installation of an effective road drainage system is critical to reducing surface erosion, sediment delivery to channels, and landslide risk. The road surface drainage design type installed was documented for 187 miles of new and existing road on 171 units (Table 17). Drainage design was categorized for each 100-foot station as: ditch with culvert (42%), outsloped road surface (39%), waterbars (17%), and no drainage installed (2%). These data are summarized here to show the distribution of road surface drainage methods used and do not reflect compliance rates, which is detailed above.

Spacing was also evaluated for 424 cross-drain culverts on roads that used a ditch and culvert drainage method. Of these, spacing was considered likely to be inadequate for six cross-drains. The distance between these culverts and the nearest uphill cross-drain or drainage break was great enough to likely cause future erosion and stability issues.

The dispersal of drainage water before it enters waters of the state is also critical to reducing sediment delivery. One factor influencing the likelihood of sediment delivery is the unfiltered ditch length at stream crossings. This is the length of road ditch draining directly into a channel without being filtered through vegetation of the forest floor. This length was documented for the 51 new stream crossings surveyed and represents the longer of the two lengths of unfiltered ditch approaching the crossing. This length averaged 41 feet per crossing, with 33 crossings having no unfiltered ditch draining to the channel and none greater than 400 (Table 18).

Table 18. Unfiltered Ditch Length Draining to Channel at New Stream Crossings

Unfiltered Ditch Length (Feet)	0	1 to 100	101 – 200	201 – 400	> 400
Number of Crossings	33	12	3	3	0
Percent of Total	65%	24%	6%	6%	0%

Road Drainage Maintenance. Compliance was 96.7% for all rule applications in this sub-section. There were 369 total applications of three road drainage maintenance rules, each of which applied to all new and existing roads surveyed (Table 19). Ineffective maintenance of road surface drainage (625-600 (2)) had the lowest compliance rate of these rules at 94.2%. Noncompliant practices were observed on 10 units; two were potential resource issues and eight had already resulted in sediment delivery to WOS. The requirement to place removed ditch waste in a stable location (625-600 (7)) was also noncompliant on two units, both resulting in sediment delivery. The openings of all 27 non-ford crossings on Type F streams surveyed were free of significant obstructions (625-600 (8)). Compliance with fish passage and flow capacity design requirements of new stream crossing structures was evaluated with a separate methodology (Please see ODF Technical Report 14, *Compliance with Fish Passage and Peak Flow Requirements at Stream Crossings* for results, online at http://www.odf.state.or.us/FP/fpmp/default.htm).

Table 19. Compliance Rates for Road Drainage Maintenance Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-625- 600 *2*	Maintenance - Surface Stability/WOS Protected	171	94.2	2	8
629-625- 600 *7*	Maintenance - Ditch Waste in Stable Location	171	98.8	0	2
629-625- 600 *8*	Fish Passage Maintained	27	100.0	0	0
Compliance of All Sub-Section Rule Applications		**369**	**96.7**	**2**	**10**

As with drainage design, proper maintenance of the road drainage system is a critical means of reducing surface erosion, channel sediment delivery, and landslide risk. Categorical data on drainage maintenance condition was recorded for every 100-foot station for 187 miles of new and existing road on 171 units. This data is summarized here to show the distribution of drainage maintenance conditions and does not reflect compliance, which is detailed above. These surveys were conducted during the summer while Forest Practice Rules require effective road drainage be maintained only during the wet season. Because of this, compliance evaluations were based on evidence of drainage conditions and issues as they appeared to have existed during the previous wet season and not those that had not yet weathered runoff. The impact of hauling during wet weather is currently being evaluated through a separate study.

Effective drainage conditions (functional ditch, outsloped road, and functional waterbars) made up 97% of total road length. The remaining 3% was made up of ineffectively-maintained drainage conditions (rutted road surface, bermed road with no drainage, eroding ditch, non-functional waterbars, and filled ditch), shown in Table 20.

Table 20. Distribution of Road Drainage Maintenance Condition

Surface Drainage Condition	Functional Drainage	Rutted	Berms/No Drainage	Eroding Ditch	Non-Funct. Waterbars	Filled Ditch
Length (Feet)	957,400	9,900	8,500	4,200	3,500	3,100
Percent of Total	97.0%	1.0%	0.9%	0.4%	0.4%	0.3%

Road Waste and Stabilization. Compliance was 97.1% for all rule applications in this sub-section. There were 258 total applications of four rules evaluated for the stabilization of exposed and potentially unstable material (Table 21). These rules applied to 80 units with new road construction and 18 waste areas. There were three noncompliant practices of unstable road debris (625-410) and four of exposed material not stabilized (625-440 (1)). Sediment delivery to WOS resulted from one and three of the noncompliant practices of these two rules, respectively. No logs or slash were found incorporated into any newly constructed road fills (625-440 (3)) and all road waste areas were located on stable sites (625-340).

The frequency of roads with unstable conditions was tallied numerically by 100-foot stations with greater than 2 feet of sidecast on slopes greater than 65% (potentially unstable sidecast), and the length of road with unstable fill or cutslopes. Results show that the occurrence rate of these conditions is quite low, with unstable sidecast, fillslopes, and cutslopes found along only 0.1%, 0.2%, and 0.2% of newly constructed road length, respectively.

Table 21. Compliance Results for Road Waste and Stabilization Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-625- 410 -	Debris/Waste Located to Protect WOS	80	96.3	2	1
629-625- 340 -	Waste Areas Located on Stable Sites	18	100.0	0	0
629-625- 440 *1*	Exposed Material Stabilized	80	95.0	1	3
629-625- 440 *3*	Logs/Slash in Fill Avoided	80	100.0	0	0
Compliance of All Sub-Section Rule Applications		**258**	**97.3**	**3**	**4**

Vacated Roads. Compliance was 96.2% for the one rule in this sub-section (Table 22). Vacated roads surveyed on 26 units were required to be effectively drained and blocked following the operation (625-650 (2)). There was one noncompliant practice for a vacated road not adequately blocked and drained, allowing vehicle traffic and potential water resource impacts.

Table 22. Compliance Rates for Vacated Road Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-625- 650 *2*	Vacated Roads Effectively Drained and Blocked	26	96.2	1	0

Rock Pits. Compliance was 100% for all rock pit rules. There were 85 total applications of five rules relating to stability, location, waste, erosion, and vacation on 17 rock pits surveyed (Table 23).

Table 23. Compliance Rates for Rock Pit Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-625- 500 *1*	Unstable Slopes and Water Quality Protected	17	100.0	0	0
629-625- 500 *2*	Location - Outside of Channels	17	100.0	0	0
629-625- 500 *3*	Petroleum Products/Waste in WOS Prevented	17	100.0	0	0
629-625- 500 *4*	Surface Erosion and Landslides Prevented	17	100.0	0	0
629-625- 500 *5*	Rock Pits Properly Vacated	17	100.0	0	0
Compliance of All Sub-Section Rule Applications		**85**	**100.0**	**0**	**0**

Harvesting (OAR 629-630)

Compliance was 98.1% for all applications of harvesting rules. There were 6,876 total applications of 34 rules surveyed in this sub-section. These rules establish standards for harvesting practices designed to minimize soil and debris from entering waters of the state and protect wildlife and fish habitat. Rules were evaluated on a unit-wide basis for sub-sections dealing with harvesting practices (general yarding practices, cable yarding near WOS, ground equipment near WOS, harvesting waste, and felling and harvesting slash) for each unit surveyed. Rules were evaluated on an individual feature basis for sub-sections dealing with constructed features (landings, skid trails, and temporary crossings).

There were 45 noncompliant practices in this division with a potential resource issue, and 86 with an observed impact. Of those with an impact, 45 were slash accumulations below a high water line, 32 were sediment delivery, and nine were physical bed or bank disturbances. A more detailed discussion of compliance and resource impacts for each harvesting sub-section is given below.

General Yarding Practices. Compliance was 99.5% for all rule applications in this sub-section. There were 407 total applications evaluated for three rules, each dealing with yarding practices related to slope (Table 24). Rules requiring soil protection for yarding on slopes over 35% (630-100 (2)) and uphill yarding whenever practical (630-100 (6.1)) were evaluated for all 189 units surveyed. Soil protection requirements for yarding on high risk slopes (630-100 (6.2)) applied to 29 units. There were only two noncompliances in this sub-section, both with rule 630-100 (2), where deep yarding gouges on slope over 35% resulted in sediment delivery to stream channels.

Table 24. Compliance Rates for General Yarding Practices Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-630 100 *2*	Soil Protected for Yarding on >35% Slopes	189	98.9	0	2
629-630- 100 *6.1*	Uphill Yarding Whenever Practical	189	100.0	0	0
629-630- 100 *6.2*	Soil Protected for Yarding on HR Sites	29	100.0	0	0
Compliance of All Sub-Section Rule Applications		**407**	**99.5**	**0**	**2**

Felling and Harvesting Slash. Compliance was 92.0% for all rule application in this sub-section. There were 722 total applications of four rules governing the felling of trees near WOS and the removal of excessive slash accumulations below high water lines (Table 25).

Compliance with protection requirements on all 189 units for felling near WOS or on steep slopes (630-600 (2)) was relatively low at 83.1%. There were 32 noncompliant felling practices observed, 29 along small

Type N streams and three along Type F streams. Of this total, 15 had a potential resource issue and 17 had an impact. Impacts were 15 slash accumulations below high water lines, one disturbance of stream channel bed or banks, and one sediment delivery.

Compliance was also low (83.9%) for the removal of excessive slash from Type N streams (630-600 (3b)). There were 155 units with Type N streams surveyed; three with accumulation considered potential resource issues and 22 with slash accumulations below the high water line. Excessive slash in Type N streams is described in the rule guidance manual as covering greater than 50% of the channel such that it is difficult to walk up the channel or when stream function is impaired. Compliance with the removal of slash accumulations on Type F and D streams and significant wetlands (630-600 (3a)) was much higher, however, with only one noncompliant practice on 109 applicable units. All slash removed from WOS was placed above high water lines (630-600 (3c)) for all 189 units surveyed.

Table 25. Compliance Rates for Felling and Harvesting Slash Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-630- 600 *2*	Felling - Stream Bed and Bank Protection	189	83.1	15	17
629-630- 600 *3a*	Slash - Removed from F/D or S. Wetland	109	99.1	0	1
629-630- 600 *3b*	Slash - Type N Stream Accums. Limited	155	83.9	3	22
629-630- 600 *3c*	Slash - Placed Above High Water Line	189	100.0	0	0
Compliance of All Sub-Section Rule Applications		**722**	**92.0**	**18**	**40**

Cable Yarding Near WOS. Compliance was 99.7% for all rule applications in this sub-section. There were 376 total applications of five rules evaluated for the protection of WOS related to cable yarding on 93 units (Table 26). Compliance was 100% for soil and vegetation protection when cable yarding near WOS (630-700 (1)), minimizing cable yarding across WOS (630-700 (2)), minimizing the width of yarding corridors across streams (630-700 (3.1)), and protection of channels and RMAs when yarding across Type N streams (630-700 (5)). The lone noncompliant practice in this sub-section was with logs not completely suspended (630-700 (4)) for 1 of the 10 Type F stream yarding corridors, resulting in sediment delivery to the channel.

Table 26. Compliance Rates for Cable Yarding Near WOS Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-630- 700 *1*	RMAs and Specified WOS Protected	93	100.0	0	0
629-630- 700 *2*	Yarding Across WOS Minimized	93	100.0	0	0
629-630- 700 *3.1*	Corridors - Number and Width Minimized	93	100.0	0	0
629-630- 700 *4*	Corridors - Type F/D Channel/RMA Protected	10	90.0	0	1
629-630- 700 *5*	Corridors - Type N Chan./RMA Protected	87	100.0	0	0
Compliance of All Sub-Section Rule Applications		**376**	**99.7**	**0**	**1**

Ground Equipment Near WOS. Compliance was 99.2% for all rule applications in this sub-section. There were 624 total applications of four rules evaluated for the protection of WOS related to ground-based yarding equipment on 156 units (Table 27). The operation of this equipment in a stream channel (630-800 (2)) resulted in one noncompliant practice causing a potential resource issue and two causing sediment delivery to a stream. There was also one potential resource issue resulting from a unit with excessive stream crossings (630-800(3)) and sediment delivery resulting from excessive soil disturbance from harvesting equipment operated near a stream (630-800 (7)).

Table 27. Compliance Rates for Ground Equipment Near WOS

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-630- 800 *1*	RMAs and Specified WOS Protected	156	100.0	0	0
629-630- 800 *2*	Stream Channels Avoided	156	98.1	1	2
629-630- 800 *3*	Stream Crossings Number Minimized	156	99.4	1	0
629-630- 800 *7*	Disturbance Near Specified WOS Minimized	156	99.4	0	1
Compliance of All Sub-Section Rule Applications		**624**	**99.2**	**2**	**3**

Harvesting Waste. Compliance was 96.5% for all rule application in this sub-section. There were 567 total applications of three rules evaluated for general harvesting waste compliance at all 189 units (Table 28). Compliance was 90.5% for the requirement that all debris, slash, and sidecast be placed to prevent entry into WOS (630-400 (1)). There were 18 noncompliant practices with this rule, mainly from upslope harvesting slash accumulations not stabilized following harvest. Seven of these had a potential resource issue, seven had resulted in slash delivering to a stream, and four had resulted in delivery of sediment. Soils exposed during harvesting were not stabilized on two units (630-400 (2)), resulting in one potential resource issue and one instance of sediment delivery. No waste metal was found in WOS on any of the units (630-400 (4)).

Table 28. Compliance Rates for Harvesting Waste Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-630- 400 *1*	Waste/Slash Prevented from Entering WOS	189	90.5	7	11
629-630- 400 *2*	Exposed Soils Stabilized	189	98.9	1	1
629-630- 400 *4*	Waste Metal Removed from WOS	189	100.0	0	0
Compliance of All Sub-Section Rule Applications		**567**	**96.5**	**8**	**12**

Landings. Compliance was 99.8% for all rule applications in this sub-section. There were 3,472 total applications of four landing rules (Table 29). These rules applied to the design, location, waste stability, and drainage of 868 landings. No issues were found with the minimization of landing design size (630-200 (1)). One landing was located on an unstable slope (630-200 (2)), resulting in a potential resource issue. Landing waste was not stabilized above WOS (630-200 (5)) for two landings, and drainage was not effective (630-300 (4)) on five landings, all considered potential resource issues.

Table 29. Compliance Rates for Landing Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-630- 200 *1*	Design - Minimum Landing Size	868	100.0	0	0
629-630- 200 *2*	Location - Stable Sites Used	868	99.9	1	0
629-630- 200 *5*	Waste - Stablized to Protect WOS	868	99.8	2	0
629-630- 300 *4*	Drainage - Effective	868	99.4	5	0
Compliance of All Sub-Section Rule Applications		**3472**	**99.8**	**8**	**0**

Skid Trails. Compliance was 96.4% for all rule applications in this sub-section. There were 636 total applications of six rules governing location and drainage practices for skid trails on 106 units (Table 30).

Compliance was 99.1% for rules requiring both sidecast stability and stable skid trail location (630-100 (3) and (4), respectively). The only noncompliant practices were one case of sediment delivery to a stream from unstable sidecast and one potential resource issue from an unstable skid trail location. Compliance was 91.5% for avoiding skid trial location within 35 feet of Type F streams (630-800 (8)), with three potential resource issues and six sediment delivery noncompliant practices. Compliance was 92.5% for avoiding skid trails in stream channels (630-800 (9)), with channel disturbance but no sediment delivery resulting from skid trails in Type N streams on eight units.

Drainage compliance was measured through two broad rule requirements. Compliance was 97.2% for filtering of drainage before entering waters of the state (630-300 (2)). Poor filtering caused one potential resource issue and two sediment deliveries. Compliance was 99.1% for effective skid trail surface drainage (630-300 (3)), with one trail drainage segment with potential resource issue.

Table 30. Compliance Rates for Skid Trail Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-630- 100 *3*	Location - Minimum/Stable Sidecast	106	99.1	0	1
629-630- 100 *4*	Location - Stable Sites Used	106	99.1	1	0
629-630- 300 *2*	Drainage - Filtered Before WOS	106	97.2	1	2
629-630- 300 *3*	Drainage - Effective	106	99.1	1	0
629-630- 800 *8*	Location - 35' from Type F/D Streams	106	91.5	3	6
629-630- 800 *9*	Location - Outside of Stream High Water	106	92.5	0	8
Compliance of All Sub-Section Rule Applications		**636**	**96.4**	**6**	**17**

As with roads, skid trails were surveyed by tallying categorical location and drainage condition data for each 100-foot station. This was done for 69.0 total miles of skid trail on 106 units. These data are summarized here to show the distribution of skid trail locations and drainage types and do not reflect compliance rates, which were detailed above. Of the total length, 96.3% was categorized as "Other" location (not associated with a potential water resource impact) and 3.7% was located in water resource-related areas with potential impacts (Table 31). Results were similar for skid trail drainage conditions, with 97.5% of total length having functional drainage and 2.5% with a potential resource concern related to drainage condition (Table 32).

Table 31. Skid Trail Location Distribution

Number Of Units	Total Length (Miles)	Percent of Total Road Length Located in Each Category Highest Impact → Lowest Impact Type F Channel	Type N/D Channel	Unstable Slopes	Wet-Land	W/in 35' Type F	RMA	Slopes >35%	Other
106	69.0	0.0%	0.5%	0.1%	0.6%	0.2%	0.8%	1.6%	96.3%

Table 32. Skid Trail Drainage

Number Of Units	Total Length (Miles)	% of Total Skid Trail Length in Each Category Highest Impact → Lowest Impact Rutting	Excessive Spacing	Significant Ponding	Functional
106	69.0	1.4%	0.7%	0.4%	97.5%

Temporary Stream Crossings. Compliance was 90.8% for all rule applications in this sub-section. There were 152 total applications of five rules dealing with design, location, fill removal, and sediment barriers for 41 temporary crossings (Table 33). Compliance was 100% for the three rules which addressed temporary crossing design and location. All 41 crossings surveyed were designed to minimize sediment delivery to WOS (630-800 (4a)) located to minimize channel disturbance (630-800 (4b)), and all six crossings on Type F streams were designed so as to not impair juvenile fish passage (630-800 (4d)).

Compliance was only 47.8%, however, for the proper removal of the 23 temporary crossings which used fill material (630-800 (4e)). Only 11 of these crossings had fill material fully removed and placed in a stable location following completion of the operation. Sediment delivery to the stream channel resulted from five crossing structures not removed at all, three with fill material only partially removed from the channel, and four with fill material removed but located so that it re-entered the stream channel. Potential resource issues were identified for two crossings with removed fill located such that it was likely to re-enter the stream channel.

Compliance was 95.1% for the installation of effective sediment barriers at all 41 temporary crossings (630-800 (6)). Effective sediment barriers were not installed at two crossings; one resulting in a potential resource issue and one resulting in sediment delivery to the channel. This rule applied only to the proper routing and filtering of the skid trail surface drainage at the approach to the crossing. It did not apply to drainage or erosion issues related to the storage of removed fill material, which is discussed above for rule 630-800 (4e).

Table 33. Compliance Rates for Temporary Crossing Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-630- 800 *4a*	Design - Minimum Sediment To WOS	41	100.0	0	0
629-630- 800 *4d*	Design - Provide Fish Passage	6	100.0	0	0
629-630- 800 *4b*	Location - Minimum Cut/Fill/Disturbance	41	100.0	0	0
629-630- 800 *4e*	Fill Removal - Timing and Location	23	47.8	2	10
629-630- 800 *6*	Sediment Barriers - Effectively Installed	41	95.1	1	1
Compliance of All Sub-Section Rule Applications		**152**	**90.8**	**3**	**11**

Vegetation Retention Along Streams (OAR 629-640)

Compliance was 96.4% for all applications of streamside vegetation retention rules. There were 833 total applications of 24 rules in this sub-section. Of these, there were six noncompliant practices resulting in a potential resource issue, and 24 that resulted in streamside vegetation damage. Vegetation retention compliance and resource impacts are detailed below by stream type sub-sections.

The purpose of streamside vegetative requirements is to produce the desired future conditions for the wide range of stand types, channel conditions, and disturbance regimes that exist throughout forestlands in Oregon. The desired results vary depending on the site conditions but, in general, the goal is to grow and retain stands that mimic mature forest conditions on fish-bearing streams. The goal along non-fish bearing streams is to support the functions and processes that are important to downstream fish and domestic uses, and to protect water quality.

Compliance was measured through detailed RMA transect and cruise surveys. These were conducted on 65 RMAs with neither fish nor domestic use (Type N), six RMAs with domestic water supply use (Type D), and 182 RMAs with fish use (Type F), broken out in Table 34. The small Type N RMAs listed here are those which meet the georegion-specific criteria of this rule division (see Table 5 of the *Oregon Forest Practice Rule and Statutes*). These numbers do not represent all Type F RMAs found on the units surveyed. A total of 210 Type F RMAs were observed on all units, but due to time constraints, detailed RMA transect and cruise surveys could only be conducted on 182 of these. RMAs were randomly ordered within a unit so that there

was no bias to which RMAs were surveyed within time constraints (see *ODF Best Management Practices Compliance Monitoring Project Protocol* for sampling design and detailed survey methods).

Table 34. Number of Streams, Total Length, and RMA Width by Stream Size and Type Class

RMA Class	Number of RMAs Surveyed	Total Length of RMA Surveyed (Feet)	RMA Width (Feet)
Small Type N	65	Unknown	10
Small Type D	6	2.350	20
Small Type F	76	72,895	50
Medium Type F	62	82,465	70
Large Type F	45	53,720	100

Vegetation Retention for Type F RMAs. Compliance was 96.1% for all rule applications in this sub-section. There were 750 total applications of 16 Type F RMA vegetation retention rules (Table 35). The surveys conducted on these RMAs also provide a detailed quantitative measure of the level of resource impacts as well as of compliance. Both vegetation retention compliance and resource impacts for specific rules are detailed below for three areas: the 10-foot "no-touch" zone, the 20-foot "no-cut" zone, and tree retention for the entire RMA.

Table 35. Compliance Rates for Vegetation Retention Rules for Type F RMAs

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-640- 100 *2a*	General - Vegetation within 10' of hwl Retained	182	96.7	0	6
629-640- 100 *2b*	General - Trees within 20' of hwl Retained	174	97.1	0	5
629-640- 100 *3*	General - RMA Down Wood Retained	182	98.9	0	2
629-640- 100 *5*	Gen. Rx - Reqd. Live Trees/1000' Retained	21	95.2	0	1
629-640- 100 *6a*	Gen. Rx - Standard Target BA Retained	62	93.5	0	4
629-640- 100 *6b*	No-Harvest Rx - RMA Conifers Retained	93	96.8	0	3
629-640- 100 *12*	Island Rx - Tree Retention	0	-	-	-
629-640- 110 *11*	Active Man. Rx - Required Trees/1000' Retained	0	-	-	-
629-640- 300 *2*	Conv. Rx Application - RMA < 1/2 Standard Target	6	66.7	2	0
629-640- 300 *4c.1*	Conv. Rx Layout - Conversion Blocks < 1/2 RMA	6	66.7	2	0
629-640- 300 *4c.2*	Conv. Rx Layout - Conversion Blocks < 500' Long	8	75.0	2	0
629-640- 300 *4c.3*	Conv. Rx Layout - Conversion Blocks 200' Apart	2	100.0	0	0
629-640- 300 *4dA*	Conv. Rx Conv. Blocks - Veg. w/in 10' of hwl Ret.	8	100.0	0	0
629-640- 300 *4eA*	Conv. Rx Ret. Blocks -Conifers w/in 50' for Large F	5	80.0	0	1
629-640- 300 *4eB*	Conv. Rx Ret. Blocks - Conifers w/in 30' for Med. F	1	0.0	0	1
629-640- 300 *4eC*	Conv. Rx Ret. Blocks -Conifers w/in 20' for Small F	0	-	-	-
Compliance of All Sub-Section Rule Applications		**750**	**96.1**	**6**	**23**

- 10-Foot "No-Touch" Zone: The first level of Type F RMA vegetation retention requirements is that all vegetation within 10 feet of the high water line be retained (640-100 (2a)). This 10-foot "no-touch" buffer was fully retained on 176 of the 182 Type F RMAs surveyed (96.7% compliance). Although six RMAs had a noncompliant practice of harvesting-related vegetation disturbance within 10 feet of the high water line, most of the area of these "no-touch" buffers was undisturbed. Overall, 99.6% of the total 10-foot "no-touch" buffer area surveyed (Total Type F RMA length X 10 feet) was undisturbed.

- 20-Foot "No-Cut" Zone: The second level of Type F RMA vegetation retention requirements is for the retention of all trees within 20 feet of the high water line (640-100 (2b)). This 20-foot "no-cut" buffer

was fully retained on 169 of the 174 applicable Type F RMAs surveyed (97.1% compliance). This requirement did not apply to the eight conversion blocks discussed below. Although there were five noncompliant practices for harvesting within 20 feet of the high water line, the majority of the area of these "no-cut" buffers was uncut. Overall, 99.9% of the total 20-foot "no-cut" buffer area surveyed (Total applicable Type F RMA length X 20 feet) had no trees cut.

- The third level of Type F RMA vegetation retention requirements is for tree retention in the entire RMA and depend on the harvesting prescription applied. There is a variety of RMA prescription options available within the Forest Practice Rules depending on stand conditions and harvest type. The majority of RMAs surveyed were treated with a no-harvest buffer or a basal area prescription; some were treated with a conifer restoration alternative prescription or a site-specific prescription (Table 36). Compliance and tree retention levels for these four prescriptions are detailed below. The retention of down wood in the RMA is required for all prescriptions (640-100 (3)) and was compliant on 180 of the 182 RMAs surveyed (98.9%).

Table 36. Harvest Prescriptions for Type F RMAs Surveyed

(RCR = Riparian Conifer Restoration.)

RMA Prescription	Number of RMAs Surveyed	Total Length of RMA Surveyed (Feet)	Percent of Total Type F Length
No-Harvest	93	124,495	60%
Basal Area	62	69,630	33%
Site-Specific	7	7,475	4%
RCR Conversion	8	3,150	2%
RCR Retention	6	4,330	2%

For ownership class (industrial, non-industrial and other), the most common RMA prescription was a no-harvest buffer (51%, 45%, and 61%, respectively), followed by standard basal area target (39%, 41%, and 22%, respectively). Site-specific plans (4%, 5%, and 6%, respectively), riparian conifer restoration (RCR) conversion blocks (4%, 5%, and 11%, respectively), and RCR retention blocks (3%, 5%, and 6%, respectively) were used less often (Figure 6).

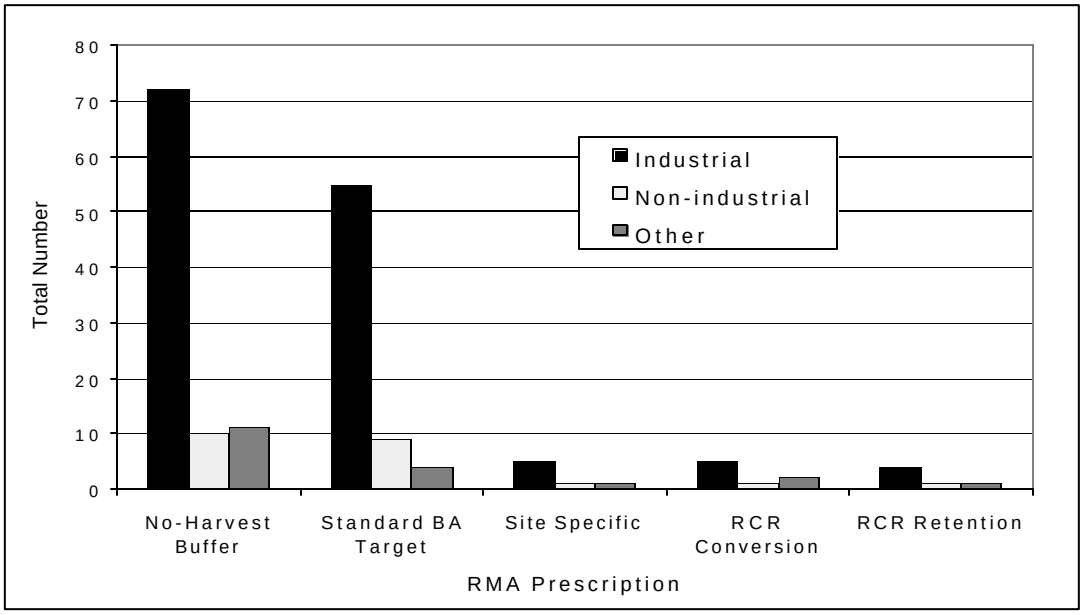

Figure 6. Riparian Prescription and Ownership Class

RCR = Riparian Conifer Restoration.

- No-Harvest Buffer: When RMA stocking levels are between 50 and 100% of the standard target, operators are required to leave all conifers in the RMA unharvested (640-100 (6b)). Compliance for this prescription was 96.3% for 93 surveyed RMAs to which it was applied. Noncompliance resulted from RMA conifers harvested on three of these RMAs, all large Type F RMAs with a 100-foot uncut conifer buffer required. These three RMAs had minimum uncut conifer buffer widths of 50, 45, and 85 feet, and averaged 67, 82, and 99 feet, respectively.

  The uncut conifer buffers for the 52 clear-cut RMAs harvested with this prescription were an average of 117% of the required width (RMA width). The average uncut buffer widths for these RMAs are shown in Figure 7. Within a substantial portion of these RMAs, stocking levels were actually high enough to have allowed for the harvesting of some conifers under the basal area prescription. This no-RMA-harvest approach and leaving of unit wildlife trees within and along an RMA were common practices by landowners seeking to provide stream protection beyond the minimum rule requirements or to simplify harvesting adjacent to these streams.

- Basal Area Prescription: When RMA stocking levels exceed the standard target (shown in Tables 2 and 3 of *Oregon Forest Practice Rules and Statutes* (ODF, 2000[A])), operators may be able to harvest trees within the RMA. Application of this prescription and harvesting depend on RMA conifers, hardwoods, and snag distribution; stream size; georegion; and harvest type (detailed in OAR 629-640-100). Sixty-eight of the Type F RMAs surveyed were harvested using this prescription, 62 of which were cruised for qualifying basal area retention under project time constraints. The basal area retention rates relative to the required standard target for all 62 of these RMAs are shown in Figure 8. The standard target was retained for 58 of these (93.5% compliance with rule 640-100 (6a)). The basal areas retained for the four noncompliant RMAs were 45%, 93%, 94%, and 95% of the standard target. The basal area measured in one of these four RMAs was within the range of measurement error reported in the *Quality Assurance and Quality Control* section on page 12 of this report.

  Twenty-two of these RMAs were on large and medium Type F streams, which have minimum tree count requirements in addition to basal area requirements (640-100 (5)). The minimum tree count was retained on 20 of these 21 RMAs, for a compliance rate of 95.2%. The retained tree count for the noncompliant RMA was 78% of required. The tree-count retention rates for these 22 RMAs are shown in Figure 9.

  Qualifying basal area retained in these 62 RMAs averaged 202% of the standard target. Tree counts for the 21 large and medium applicable RMAs averaged 258% of the requirements. For some RMAs, the basal area and tree count minimums were exceeded due to the compound requirements of these two rules and the 20-foot "no-cut" zone. In many of these RMAs, conditions were such that additional trees could have been harvested. Discussions with landowners revealed that requirements were exceeded because of a landowner's desire to provide additional stream protection and the election to retain unit wildlife trees within the RMA.

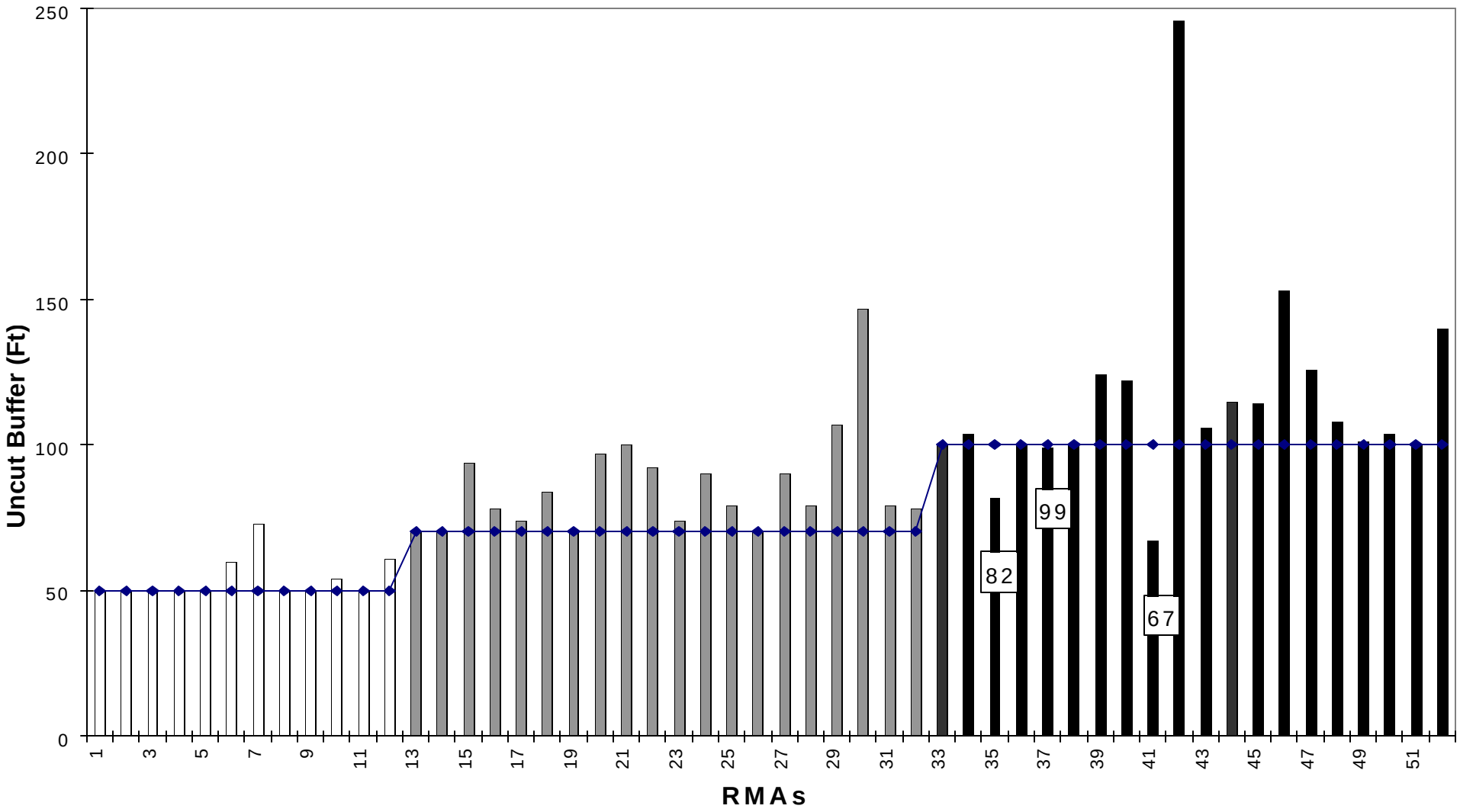

Figure 7. Buffer Retention for No-Harvest Prescription RMAs

Bars represent average distance of nearest cut tree to high water line for Type F RMAs with no-harvest prescriptions on clear cut units. White bars are small RMAs, grey bars are medium RMAs, and black bars are large RMAs. Dotted line represents the required uncut width (RMA width). Average width show for noncompliant RMAs.

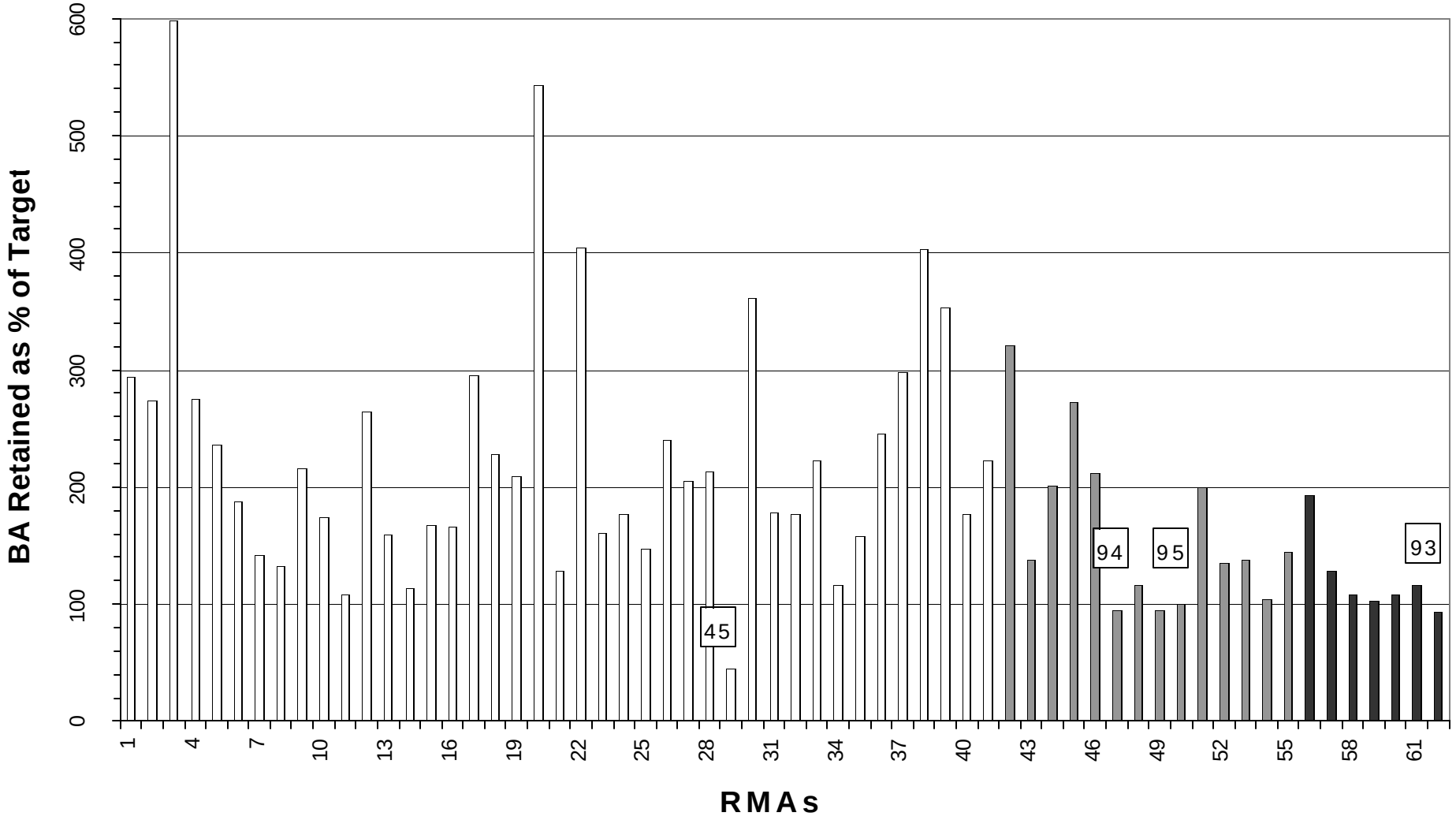

Figure 8. Relative Retention for Basal Area Prescription RMAs

Bars represent retained basal area for Type F RMAs as a percent of standard target. White bars are small RMAs, grey bars are medium RMAs, and black bars are large RMAs. Relative basal area retention is shown for noncompliant RMAs.

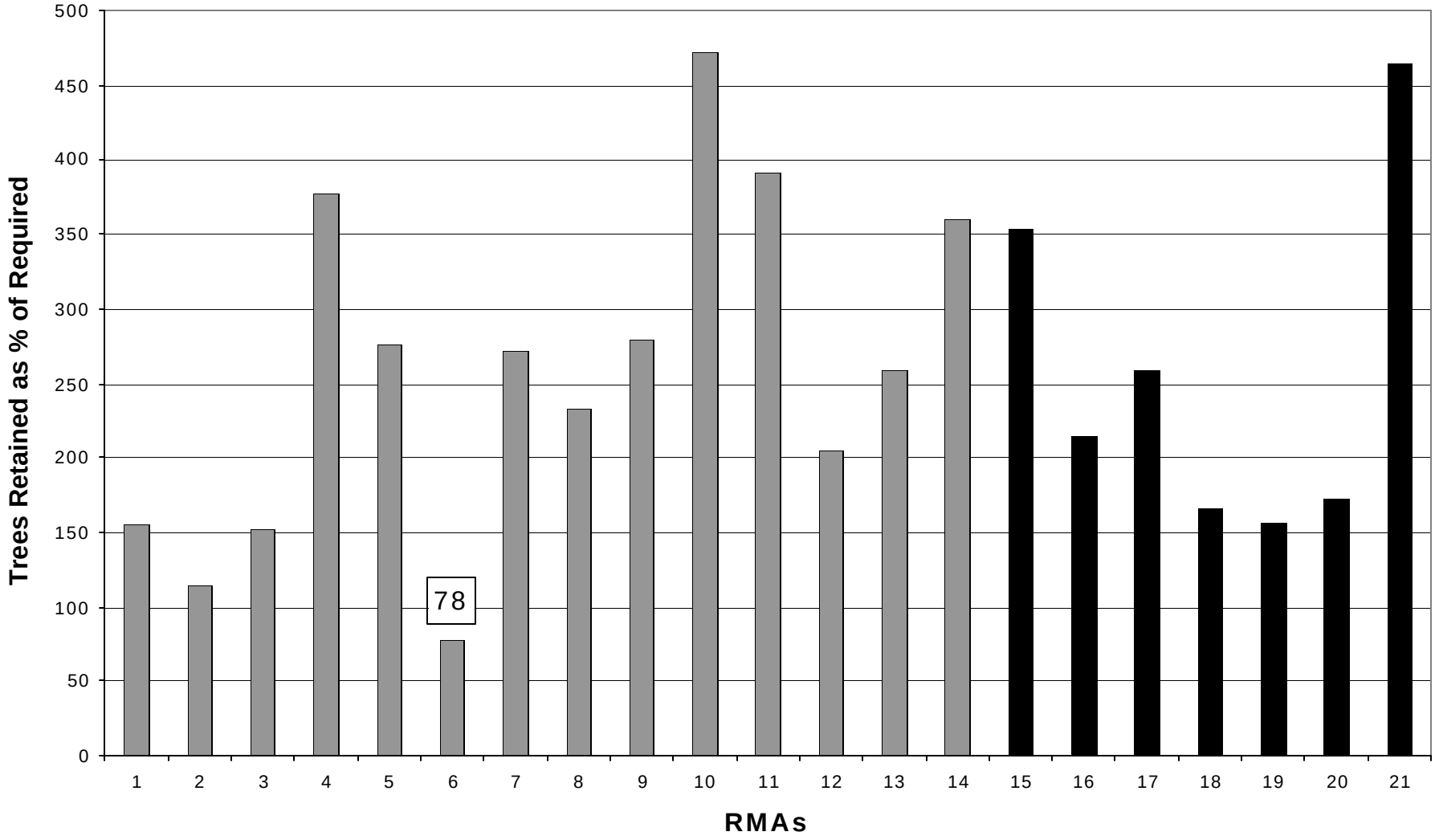

Figure 9. Tree Count Retention for Basal Area Prescription RMAs

Bars represent qualifying trees retained within each RMA as a percent of required. Rule applies only to medium (grey bars) and large (black bars) Type F RMAs. Relative tree count retention shown for noncompliant RMA.

- Conifer Restoration Alternate Prescription: This prescription consists of the application of conversion and retention blocks and is aimed at shifting alder-dominated near-stream areas into conifer stands with greater long-term stream benefits (detailed in OAR 629-640-300). This prescription was applied along one medium and five large Type F streams surveyed, with eight conversion blocks and six retention blocks in total. Operators may chose to apply this riparian conifer restoration (RCR) prescription when the stocking level along the entire stream length bordering the harvest unit is less than 50% of the standard target (640-300 (2)). There was enough retained basal area (> 50% of the standard target) in two of these six stream segments (66.7% compliance) to indicate that this prescription should not have been used. Conversion blocks must also be limited to less than half the total length of stream along the harvest unit (640-300 (4c.1)). This was compliant on four of the six (66.7%) applications of this prescription. The first noncompliance was for 420 feet of conversion block out of 780 feet of total stream length, and the second had 600 feet of conversion block out of 1150 feet of total stream length.

  Conversion blocks are alder-dominated RMA segments which can be harvested down to 10 feet from the high water line so that they may be replanted with conifer. Retention of all trees within this 10-foot zone (640-300 (4dA)) was complied with on all eight (100% compliance) of the conversion blocks surveyed. The requirement that conversion blocks be less than 500 feet long (640-300 (4c.2)) was complied with for six of eight blocks (75%). The two noncompliant conversion blocks were 530 and 600 feet long. The conversion blocks on the two surveyed stream segments with multiple conversion blocks were separated by the required 200 feet (640-300 (4c.3)) in both cases.

  Retention blocks are portions of these prescriptions with wider required buffers and are laid out adjacent to or between conversion blocks. These are designed to be the riparian segments with higher existing conifer stocking. Retention blocks have a required conifer no-cut width of 50, 30, and 20 feet from the high water line for large, medium, and small Type F streams, respectively. These widths were fully retained for four of the five retention blocks (80% compliance) on large streams (640-300 (4eA)) and not fully retained on the one retention block (0% compliance) on a medium stream (640-300 (4eB)).

  The ODF has conducted a variety of monitoring projects in recent years that have evaluated the application and effectiveness of the RCR prescription. Data now exists on compliance, stream temperature, riparian stand structure, and stream shade. A separate report is being developed to examine the interaction of these factors relative to resource protection for this prescription.

- Site-Specific Prescriptions: Operators may create a harvesting prescription which deviates from those outlined in the rules when it is better suited to the specifics of the RMA, will provide equal or greater immediate and long-term environmental benefits, and with approval of the ODF. Site-specific prescriptions were used for seven RMAs surveyed so that trees within an RMA that were hazards to roads, powerlines, or irrigation pipes could be removed. Because of the nature of these RMAs, compliance was evaluated only for the 10-foot “no-touch” and 20-foot “no-cut” buffers described at the beginning of this sub-section, and for the prior approval requirement reported in the “Administrative Requirements” section.

Vegetation Retention for Type N and D Streams. Compliance was 98.8% for all rule applications in this sub-section. There were 83 total applications of eight rules applying to six small Type D RMAs and 65

small Type N RMAs. (Table 37). These small Type N RMAs are those that meet the georegion-specific criteria of this rule division (see Table 5 of the *Oregon Forest Practice Rule and Statutes*).

Compliance with the vegetation protection requirement for qualifying small Type N streams was 98.5%. Operations along these 65 streams were required to retain all understory vegetation and non-merchantable conifer trees within 10 feet of the high water line (640-200 (6)). There was one noncompliant practice for this rule, where harvesting along a small Type N stream resulted in understory vegetation removal.

Compliance was 100% for the vegetation protection requirements surveyed in six Type D RMAs. The requirements for both Type D and N RMAs are similar to those for Type F streams. These rules required the retention of all vegetation within 10 feet of the high water line (640-200 (2a)), retention of all trees within 20 feet of the high water line (640-200 (2b)), and the retention of all conifers within the RMA when pre-harvest stocking is below the standard target (640-200 (7b)).

Table 37. Compliance Rates for Vegetation Retention Rules for Type N and D RMAs

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-640- 200 *2a*	Type D - Veg. within 10' of hwl Retained	6	100.0	0	0
629-640- 200 *2b*	Type D - Trees within 20' of hwl Retained	6	100.0	0	0
629-640- 200 *5*	Type D - Reqd. Live Trees/1000' Retained	0	-	-	-
629-640- 200 *6*	Small Type N - Veg. w/in 10' of hwl Retained	65	98.5	0	1
629-640- 200 *7a*	Type D/N - Standard Target BA Prescription	0	-	-	-
629-640- 200 *7b*	Type D - No-Harvest Buffer	6	100.0	0	0
629-640- 200 *7cB*	Type D/N - Default Prescription	0	-	-	-
629-640- 200 *13*	Type D/N - Island Tree Retention	0	-	-	-
Compliance of All Sub-Section Rule Applications		**83**	**98.8**	**0**	**1**

Protection Measures for Significant Wetlands (OAR 629-645)

Compliance with all rule applications in this division was 88.1%. There were 42 total applications of six rules outlining protection requirements for significant wetlands (those greater than 8 acres) and their RMAs within or adjacent to harvest units (Table 38). These rules are designed to minimize impacts to the vegetation and soils which could impair water quality, hydrologic function, and soil productivity. Seven significant wetlands and 15,350 total feet of RMA were surveyed.

The retention of 50% of RMA trees by size class and species (645-010 (1)) was compliant for six of the seven (85.7%) significant wetlands surveyed. No harvesting took place within five of these RMAs and limited harvesting on the sixth met this requirement. The noncompliant RMA had 50% of trees retained for only 1 of the 23 tree species and size classes present. Compliance was 100% for minimizing soil disturbance (645-030 (1)) and avoiding draining wetlands (645-030 (3)). Retention of significant wetland border trees (645-010 (2)) was complied with five times (71.4%). Minimization of understory vegetation disturbance (645-040 (2)) and retention of all snags and down wood (645-050 (1)) was compliant on six of the seven (85.7%) significant wetlands surveyed. All noncompliant practices were considered to have a resource impact due to vegetation damage or removal.

Table 38. Compliance Rates for Significant Wetland Protection Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-645- 010 *1*	Tree Retention - Tree Count Retained	7	85.7	0	1
629-645- 010 *2*	Tree Retention - Border Trees Retained	7	71.4	2	0
629-645- 030 *1*	General - Soil and Water Quality Protected	7	100.0	0	0
629-645- 030 *3*	Draining Avoided	7	100.0	0	0
629-645- 040 *2*	General - Understory Vegetation Retained	7	85.7	0	1
629-645- 050 *1*	General - Snags/Down Wood Retained	7	85.7	1	0
Compliance of All Sub-Section Rule Applications		**42**	**88.1**	**3**	**2**

Riparian Management Areas and Protection Measures for Lakes (OAR 629-650)

There were no lakes associated with any of the 189 units surveyed for BMP compliance. The rules described in this division are designed to protect the values and functions of lakes and include live tree retention (650-010), soil and hydrologic function (650-020), and understory vegetation retention (650-030).

Protection Measures for Other Wetlands (OAR 629-655)

Compliance was 69.8% for the one rule surveyed in this division (Table 39). As with streams and significant wetlands, "other" wetlands are afforded a level of protection by Oregon's Forest Practice Rules. Rules 655-000 (2a & 3) state that when harvesting along wetlands less than 8 acres in size, "operators shall protect soil and understory vegetation from disturbance that results in reduced water quality, hydrologic function, or soil productivity." These criteria were evaluated for 96 wetlands smaller than 8 acres. Activities around 19 of these wetlands were considered to have a potential resource impact, while activities around 10 others were deemed to have had an observable impact to the resource. Of these wetland impacts, two were adverse accumulations of slash, two were significant vegetation removal, and six were sedimentation from harvesting machinery alterations of wetland banks and soil.

Table 39. Compliance Rates for Other Wetland Protection Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-655- 000 *2a,3*	Soil and Water Quality Protected	96	69.8	19	10

Miscellaneous Water Protection Rules (OAR 629-660)

Compliance was 100% for the one rule surveyed in Division 629-660 (Table 40). This rule applied to the 186 surveyed units that had streams associated with them. The requirement of this rule (660-040 (2)) is that operators do not add or remove any soil or rock to/from streams, except as allowed for approved construction and improvement projects.

Table 40. Compliance Rates for Miscellaneous Water Protection Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Pot. Impact	NC: Impact
629-660- 040 *2*	Soil/Rock Stream Input or Removal Avoided	186	100.0	0	0

Administrative Requirements (From All Divisions)

Compliance was 83.0% for all rule applications related to ensuring proper rule application, documentation, and public record and review opportunities. There were 1,088 total applications of 28 rules in this section. These administrative requirements are located throughout nearly all rule divisions, but have been compiled

here so that administrative compliance can be reviewed collectively and separate from direct resource protection rules. Compliance with individual rules is discussed below in *Notification, Prior Approval*, and *Written Plan* sub-sections.

While these rules are associated with forest activities and features which may potentially impact water quality (road construction, RMA harvesting, etc), they deal only with the notification, prior approval, and written plan requirements of these activities. Noncompliance with any rule in this section is therefore considered a "procedural" or "administrative" infraction and does not speak to compliance or resource protection rates for those forest activities on the ground. Meeting requirements for prior approval or written plan documentation did not appear to be a significant indicator of whether or not practices were compliant in the field. Compliance and resource protection rates for forest activities (detailed in previous sections) were generally quite high, even when compliance with the administrative rule requirements for those activities was low.

Notification. Compliance was evaluated for two rules requiring notification for chemical applications within 100 feet of Type D streams. This activity occurred on two units and both rules applied to each (Table 41). The ODF notified downstream water-rights holders (ORS 527.670 (6)) for one of these two applications and the operator notified the community water manager (620-800 (3)) for both applications.

Table 41. Compliance Rates for Notification Rules

		# Rule	Percent	NC:
Rule Number	Rule Description	Applications	Compliant	Admin.
ORS 527.670 (6)	Type D - Downstream Holders Notified	2	50.0	1
629-620- 800 *3*	Type D - Community Water Manager Notified	2	100.0	0
Compliance of All Sub-Section Rule Applications		**4**	**75.0**	**1**

Prior Approval. Compliance was 90.2% for all rule applications in this sub-section. There were 491 total applications of 14 rules requiring written prior approval of the ODF for several harvest operation activities, described below (Table 42).

Three of these rules related to approval of planned operations. Compliance was 98.4% for notification at least 15 days before commencement of the operation (605-150 (1)), with three noncompliant practices on 189 units surveyed. Compliance was 95.9% for notification of activities within 100 feet of 216 Type F or D streams (605-170 (1a)), with nine noncompliant practices. Compliance was 62.5% for the notification of activities within 300 feet of significant wetlands (605-170 (1c)), with failure to notify on three of the eight applicable activities.

One prior approval rule related to reforestation and was 100% compliant. This rule required prior approval for exemptions from reforestation requirements because of land use changes (610-090 (1)) and applied to three units.

Table 42. Compliance Rates for Prior Approval Rules

Rule Number		Rule Description	# Rule Applications	Percent Compliant	NC: Admin.
629-605- 150	*1*	Planning - 15-Day Waiting Period	189	98.4	3
629-605- 170	*1a*	Planning - Activity w/in 100' Stream/Lake	216	95.9	9
629-605- 170	*1c*	Planning - Activity w/in 300' Significant Wetland	8	62.5	3
629-610- 090	*1*	Reforestation - Land Use Change Exemption	3	100.0	0
629-625- 100	*2b*	Road Construction - Machinery in Type F or D	12	75.0	3
629-625- 100	*2c*	Road Construction - RMA Road Construction	1	0.0	1
629-625- 100	*3*	Road Construction - High Risk Road Location	1	0.0	1
629-625- 100	*4*	Road Construction - Stream Crossing Fill >15'	3	66.7	1
629-625- 100	*5*	Road Construction - Stream Enhancement	4	100.0	0
629-630- 200	*3*	Harvesting - RMA Landings	8	37.5	5
629-630- 500	*1*	Harvesting - High Risk Site Harvest	29	48.3	15
629-630- 700	*3.2*	Harvesting - Type F Yarding Corridors	10	60.0	4
629-640- 110	*3*	Stream Veg. Retention - Active Management Rx	0	-	-
629-640- 400	*3*	Stream Veg. Retention - Site Specific Plans	7	57.1	3
Compliance of All Sub-Section Rule Applications			**491**	**90.2**	**48**

Five of the prior approval rules evaluated related to road construction activities. Prior approval for machine activity associated with road construction within Type F or D streams (625-100 (2b)) was obtained for 9 of 12 occurrences (75% compliance). The construction of new roads within an RMA (625-100 (2c)) and on high risk slopes (625-100 (3)) each occurred once, both without prior approval being obtained (0%). Four new stream crossings with fill greater than 15 feet deep (625-100 (4)) were also constructed, with required prior approval obtained for two of these three fills (66.7%). Prior approval was obtained for all four stream enhancement activities undertaken (625-100 (5)).

Prior approval was evaluated for three rules relating to harvesting practices. Prior approval was obtained for three of eight landings (37.5%) located within RMAs (630-200 (3)) and 14 of 29 operations (48.3%) on high risk sites (630-500 (1)). Six of 10 (60.0%) yarding corridors across Type F streams (630-700 (3.2)) had prior approval.

Prior approval was also obtained for four of the seven RMAs harvested with site-specific plans (640-400 (3)), for a compliance rate of 57.1%.

Written Plans. Compliance was 77.1% for all BMPs in this sub-section. There were 593 total applications of 12 written plan rules. These rules require operators to provide detailed information to the ODF in an approved written plan for a variety of harvesting activities which could potentially impact waters of the state, described below (Table 43). These rules address many of the same activities requiring prior approval, but differ in that they require specific details about vegetation and stream protection, feature design, construction methods, or sediment prevention rather than simple approval.

The first rule in this sub-section requires that operators comply with all provisions of a written plan once it has been approved (605-170 (5)), as these effectively become amended Forest Practice Rules governing the operation. Compliance with this rule was 79.3%, with all provisions being complied with for 88 of 111 operations with written plans.

For the planning of forest operations, written plans that describe three aspects of stream resource protection near harvesting activities must be submitted. The first is inclusion of detailed information on felling and

bucking activities in protected stream areas (605-170 (6)), and was 83.1% compliant. This rule applied to 219 Type F and D RMAs as well as felling across three Type N streams where the activity was deemed compliant but should have been documented in a written plan. The second is the inclusion of detailed information of the RMA prescriptions being applied (635-130 (1)), and was 77.3% compliant for 216 Type F and D RMAs. The third written plan requirement is the documentation of sediment prevention details for activities near Type D RMAs (635-130 (2)), and was done for four of the six Type D RMAs surveyed (66.7% compliance).

Table 43. Compliance Rates for Written Plan Rules

Rule Number	Rule Description	# Rule Applications	Percent Compliant	NC: Admin.
629-605- 170 *5*	Planning - Compliance with Approved WP	111	79.3	23
629-605- 170 *6*	Planning - Required Stream Protection Details	219	83.1	37
629-615- 300 *3*	Treatment of Slash - RMA Burning Details	0	-	-
629-625- 320 *1bB*	Road Const. - Stream Crossing Fill >15' Details	3	66.7	1
629-630- 500 *2*	Harvesting - High Risk Site Protection Details	29	41.4	17
629-630- 800 *4c*	Harvesting - Temporary Crossing Fill >8' Details	2	0.0	2
629-635- 130 *1*	Activities Near Listed WOS - RMA Prescription	216	77.3	49
629-635- 130 *2*	Type D Streams - Sediment Prevention Details	6	66.7	2
629-645- 030 *2a*	Significant Wetlands - Filling Details	0	-	-
629-645- 030 *2b*	Significant Wetlands - Machine Activity Details	0	-	-
629-645- 030 *2c*	Significant Wetlands - Road Construction Details	0	-	-
629-645- 040 *3*	Significant Wetlands - < 300' Site Prep. Details	7	28.6	5
Compliance of All Sub-Section Rule Applications		**593**	**77.1**	**136**

Road construction written plan details were required for the design and drainage of stream crossing fills greater than 15 feet deep (625-320 (1bB)). Three newly-constructed crossings were surveyed with fills 18, 20, and 22 feet deep, only two of which were addressed in a written plan (66.7% compliance).

Compliance was low for two written plan requirements related to harvesting practices. Written plan details on soil protection methods for harvesting on high risk slopes (630-500 (2)) were provided for only 12 out of 29 units with high risk site harvesting (41.4% compliance). The details of fill construction, design, and removal timing for temporary crossings with fill greater than 8 feet deep (630-800 (4c)) was not included in a written plan for either of the two crossings for which it was required (0% compliance).

The final written plan requirement reviewed was for details on soil protection methods for site preparation within 300 feet of significant wetlands (645-040 (3)). Compliance with this rule was only 28.6%, with written plan details provided for only three of seven significant wetlands.

FINDINGS

Monitoring Question 1: Compliance Rates. *How often did operators comply with BMPs described in the forest practice rules pertaining to water protection, road construction and maintenance, harvesting, and high risk sites?*

Unit-Level Compliance

Compliance rates for individual units ranged from 78.8% to 100% (Figure 10) and averaged 96.1%. The majority of units (76%) had at least one noncompliant practice of some sort, and 40% had at least one noncompliant practice that resulted in an impact to riparian and channel conditions.

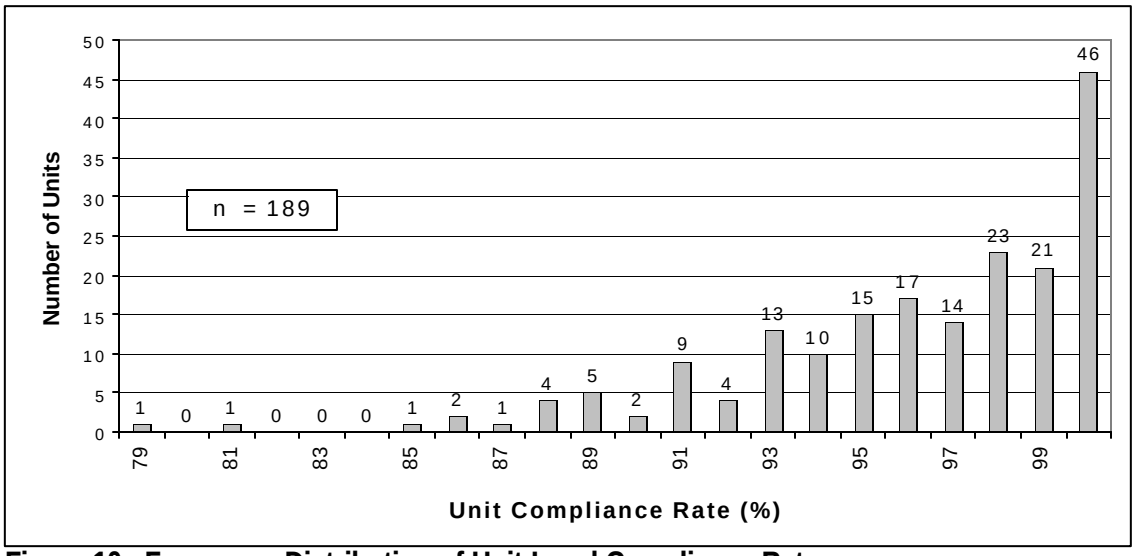

Figure 10. Frequency Distribution of Unit-Level Compliance Rates

The results of this project appear to compare favorably with those reported in other states, although they cannot be compared directly because state rule requirements differ and survey methodologies varied. Oregon's Forest Practice Rules are one of the most detailed and extensive sets of mandatory forestry BMPs in the nation. While it was common to find compliance issues when units were evaluated strictly, it would be an oversimplification to rate compliance solely on existence of a compliance issue of any kind on a unit. An accurate representation of compliance must account for the high numbers of BMPs applied to each unit (average of 71), the specific sources of noncompliance, and impacts to riparian and channel conditions (units had an average of 98.7% of practices with no impact).

Rule-Level Compliance

Compliance was 96.3% for all of the 13,506 BMP applications reviewed across all 189 units. Of the 502 total noncompliant practices surveyed, 185 (1.4%) were with administrative rules only, 147 (1.1% of all applications) were potential resource issues, and 170 (1.2%) had an impact to riparian or channel resources. These applications were broken into 11 rule sections (Table 44), with section compliance ranging from 69.8% for protection measures for other wetlands, to 100% for rules related to reforestation and operations near waters of the state (WOS).

Table 44. Compliance Rates for Rule Sections

Rule Division	Section Description	Compliance Rate
629-610	Reforestation (RMA reforestation only)	100.0
629-615	Treatment of Slash	98.2
629-620*	Chemicals and Petroleum Products	94.3
629-625	Road Construction and Maintenance	97.6
629-630	Harvesting	98.1
629-640	Vegetation Retention Along Streams	96.4
629-645	Protection Measures for Significant Wetlands	88.1
629-655	Protection Measures for Other Wetlands	69.8
629-650	Protection Measures for Lakes	N/A
629-660	Operations Near WOS	100.0
All	Administrative Requirements	83.0

*Includes rule 630-400 (3)

Monitoring Question 2: Stream Crossing Fish Passage and Peak Flow. *Have stream crossing structures on newly constructed and/or reconstructed roads been designed and installed according to ODF guidelines regarding fish passage and the 50-year peak stream flow event?*

These issues could not adequately be evaluated by the sampling design and survey constraints of this project. A supplemental study was implemented concurrently with this to more accurately address peak flow capacity and juvenile fish passage for newly constructed or reconstructed stream crossings. Results of this project are detailed in ODF Technical Report 14, *Compliance with Fish Passage and Peak Flow Requirements at Stream Crossings* (ODF, 2002[A]). This document can be found online at http://www.odf.state.or.us/FP/fpmp/default.htm.

Monitoring Question 3: Compliance Rates and FPF Inspections. *How do the statistical sample results compare with results based on forest practice foresters (FPF) inspections? Is there a correlation between number of FPF inspections and compliance rates? How statistically representative are the results of this project?*

Forest Practices Forester (FPF) Inspections

The Forest Activities Computerized Tracking System (FACTS) and a civil penalties database were queried for inspection and citation rates for the period of 1995 through 2001. These data are based on the number of citations issued relative to the number of operations that have been inspected by an FPF. Inspection compliance rates during this period showed little fluctuation, with 96.3 to 98.2% of annual operations inspected receiving a citation during this period (Figure 11). The power of these data is in the sheer number of operations assessed. For example, around half of the roughly 18,000 operations completed each year received at least one FPF inspection.

While these results provide a gage for the level of compliance during this period, they cannot be directly compared to compliance rates identified by this study for several reasons. The sample of operations inspected by an FPF consists of prioritized operations within significant time and resource limitations. Conversely, the sample for this project was completely randomly selected and stratified by stream and ownership classes, with an access denial rate of around 4%. FPF inspections also include all applicable forest practice rules, not just the water-related rules that were the focus of this project. It is also important to note that this project had three people collecting data to evaluate operations at a very strict and technical level of rule compliance. Many of the practices considered noncompliant may not have necessarily warranted a citation.

Although direct correlation between FPF inspections and findings from this project could not be measured with this data, the similar overall compliance rates support the effectiveness of FPF inspections relative to the findings of this study.

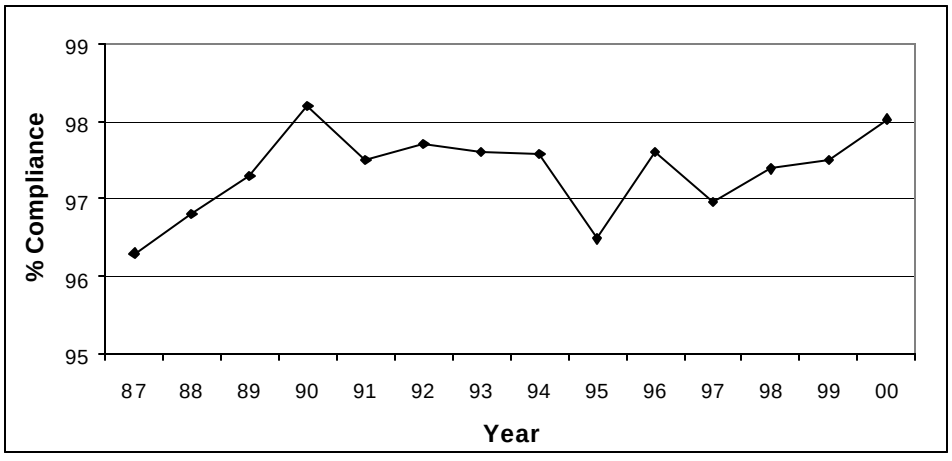

Figure 11. 1987-2000 Compliance Rates

(Rates are based on operations inspected and citations issued for 1987 through 2000.)

Statistical Representation

The precision level of the unit-level compliance results can now be calculated with the equation originally used to determine the needed sample size. Using sample size (n), population size (N), and unit-level compliance rate (P), the equation (Freese, 1962) can be solved to give the precision level (E) of these results:

$$n = \frac{1}{\frac{E^2}{(4)(P)(1-P)} + \frac{1}{N}} \quad \text{or} \quad E = ((1/n-1/N)*4*P*(1-P))^{\wedge 1/2}$$

With a sample size of 189 units surveyed, a population of 4,075 notifications, and an average unit-level compliance rate of 96.1% for the units sampled, the precision level is 0.028. The average compliance rate of the sampled units is therefore representative of the entire population with 97.2% confidence. This confidence level is actually somewhat higher than 97.2% because the identified population greatly overestimates the number of qualifying units. Qualified units were completed operations with a 1998 notification, harvested under the forest practice rules, and associated with some waters of the state. About one-half of the identified notifications reviewed during site selection either did not meet these criteria or did not actually occur.

As well as meeting these criteria, units were selected based on ownership class and stream type stratifications. These results are likely not representative of units selected with different criteria or stratifications. As well, confidence levels cannot be calculated for individual rules surveyed, as this site-selection process likely influenced the sampling rate and distribution of specific practices.

Monitoring Question 4: Areas of Highest and Lowest Compliance. *Are there particular rules that consistently have a higher or lower level of compliance? If the latter, can the guidance and/or rule language be modified to improve compliance? Are there educational and training opportunities/materials regarding those rules?*

Compliance and Sample Size

It is important to first note the role of sample size when assessing the significance of compliance rates for individual rules. It is difficult to assess the scope of a compliance issue in cases where a BMP was applied so few times that one or two noncompliant practices resulted in a low compliance rate. Closer examination shows that average compliance results were highly correlated to sample size, with average compliance much higher for those BMPs applied more often (Table 45). Rules with 1 to 10 total applications (37 rules) had an average rule compliance of 72%, while rules with 11 to 100 total applications (49 rules) had an average rule compliance of 94%, and rules with more than 100 total applications (43 rules) had an average rule compliance of 96%.

Table 45. Average Compliance Rates for Rules Based on Number of Times Applied

Number of Times Rule Applied	Number of Rules	Total Number of Rule Applications	Average Rule Compliance
1-10	37	194	72%
11-100	49	2,685	94%
>100	43	10,627	96%

This trend is encouraging for two reasons: the low compliance results for some rules with small sample sizes is possibly not representative of the larger population, and proper understanding, interpretation, and

administration of forest practice rules appears to improve the more they are conducted, as those practices most frequently applied to the landscape were generally most likely to meet BMP compliance.

Areas of Higher Compliance

Given the sample size considerations discussed above, these results still allow for the identification of areas of higher and lower compliance. There were 50 individual rules (39%) with 100% compliance and 72 rules (56%) with 98% or higher compliance. Because of these high numbers, high compliance is identified below for rule groups which have 98% or higher compliance.

- RMA Reforestation Timing (610-040): 100% compliance for two rules (36 applications)
- Chemical Applications (620-400): 98.4% compliance for three rules (129 applications)
- New Road Location (625-200): 100% compliance for three rules (240 applications)
- New Road Prism Design (625-310): 99.4% compliance for seven rules (320 applications)
- Rock Pits (625-500): 100% compliance for five rules (85 applications)
- General Yarding Practices (630-100): 99.5% compliance for three rules (407 applications)
- Cable Yarding near WOS (630-700): 99.7% compliance for five rules (376 applications)
- Landings (630-200): 99.8% compliance for four rules (3,472 applications)
- Vegetation Retention for Type N and D Streams (640-200): 98.8% compliance for eight rules (83 applications)

The general vegetation retention rules for Type F streams (640-100) are not listed above, but are worth mentioning here. Compliance was 97.1% for these six rules, however, the average rates of retention of RMA vegetation were quite high. All 41 no-harvest prescription Type F RMAs in partial cut units had at least 100% of the required buffer retained. The 52 Type F RMAs with this prescription in clear-cut units had an average of 117% of the required buffer retained. The 62 RMAs with a basal area prescription had an average of 202% of the standard target retained (although only a portion of the basal area above the standard target was likely harvestable; see page 32). These prescriptions made up 93% of the total length of Type F RMA surveyed.

Areas of Lower Compliance

There were also 10 specific BMPs identified as having the most significant compliance issues (less than 96% compliance and five or more noncompliant practices). These were: slash piling near WOS, removal of petroleum-related waste, stream crossing fill stability, road surface drainage, felling of trees into small Type N streams, skid trails near WOS, removal of temporary crossings, protection of other wetlands, prior approval requirements, and written plan requirements. These are detailed individually below in order of rule number. Opportunities to improve compliance (training, guidance language, enforcement, etc) are detailed in the *Recommendations* section, which follows.

- Mechanical Slash Piling near WOS (615-200 (4)). The placement of mechanically-piled slash in WOS or where it can enter WOS was an issue on 8 of the 77 applicable units (89.6% compliance). Five of these noncompliant practices were slash piled within or on the banks of small Type N streams and three were slash piled in "other" wetlands less than 8 acres in size. Discussions with operators over the course of implementing this project revealed that non-compliance resulted from two factors: operators did not realize that these protection requirements extended to small Type N streams and "other" wetlands, or operators had difficulty identifying small, ephemeral features during the dry season. Discussions of these results with ODF field staff, landowners, and operators have already begun to raise awareness of this issue.

- Stream Crossing Fill Stability (625-320 (1bC)). The design of new stream crossings so that fill and erosion to a channel are prevented was not achieved for 8 of the 51 new crossings surveyed (84.3% compliance). Fill erosion on those eight crossings was attributed to two design issues: over-steepened fills, which enter the channel through ravel or shallow failures, and drainage-caused rutting over ineffectively stabilized fill material.

- Road Surface Drainage (625-330 (1) and 625-600 (2)). Road surface drainage designs that effectively disperse runoff and minimize erosion and proper maintenance of that road surface drainage are critical for resource protection. Compliance with these rules was 86.5% (drainage design) and 94.2% (maintenance), with 31 total noncompliant practices on 171 units with roads. These two rules were considered together because distinguishing compliance issues between ineffective drainage designs and maintenance levels was often extremely difficult. Non-compliance was generally due to a combination of ineffectively designed drainage systems that broke down quickly and did not receive the subsequent required maintenance. These conditions resulted in routing of excessive runoff across the road surface for great distances, causing erosion and instability. There were 11 cases of sediment delivery attributed to poor drainage design and 10 attributed to a lack of maintenance.

- Removal of Petroleum-Related Waste (630-400 (3)). The removal of petroleum-related waste from the unit following completion of the operation was noncompliant on 34 of the 189 units surveyed (82.0% compliance). These materials (oil filters, grease tubes, and motor and bar oil containers) were generally located at landings, and while none were found to have delivered to WOS, they represent a possible risk to future soil and water quality. Noncompliance was considered to be the result of poor post-operation clean-up practices.

- Felling of Conifers into Small Type N Streams (630-600 (2)). Compliance for felling conifers away from streams and preventing damage to channels was 83.1% on 189 units. The 32 noncompliant practices surveyed were nearly all from the felling of conifers across or into small Type N channels or, to a lesser extent, felling into small wetlands. Fifteen of these resulted in significant slash in WOS, one to channel bed and bank disturbance, and one to sediment delivery to a WOS. Low compliance rates for limiting slash accumulations in Type N steams (630-600 (3b)) and leaving slash where it will not enter WOS (600-400 (1)) were considered to generally result from these noncompliant felling practices. Discussion with operators and ODF field staff while implementing this project revealed that noncompliance was generally associated with interpretation of this rule's application to small Type N streams and other wetlands, especially those which were dry during the time of harvest. Discussion of these results with ODF field staff, landowners, and operators has already begun to raise awareness of this issue.

- Removal of Temporary Crossings (630-800 (4e)). The removal of temporary crossing structures following completion of an operation and placement of fill material where it will not enter WOS was done properly for only 11 of 23 temporary crossings surveyed (47.8% compliance). Non-compliant practices include five crossings with fill not removed, two with fill only partially removed, and five with fill material removed but placed where it eroded back into the stream channel. Non-compliance was considered to be simply the result of poor post-operation clean-up practices.

- Skid Trails Near WOS (630-800 (8) and 630-800 (9)). Harvesting rules also require that skid trails on 106 units not be located within 35 feet of Type F streams (91.5% compliance) and be located so that stream water will not flow onto the skid trail (92.5% compliance). Noncompliant practices consisted of

nine units with skid trails located within 35 feet of a Type F stream and eight units with skid trails located within a length of a small Type N stream channel. These resulted in eight cases of channel bed or bank disturbance and six cases of sediment delivery to WOS. Discussion with operators indicated that noncompliance was generally the result of skid trail location rules not adhered to because of operational concerns.

- Protection of Other Wetlands (655-000 (2a & 3)). This rule required protection of soil and water quality for activities along 96 wetlands less than 8 acres ("other" wetlands), seeps, or springs. Compliance was 69.8%, with 29 noncompliant practices in the form of harvesting machinery driven through wetlands, wetlands used as landing areas, trees yarded through wetlands, and slash piled in wetlands. Discussion with landowners, operators, and ODF field staff over the course of implementing this project revealed that noncompliance was generally the result of interpretation of this rule's application to these small wetlands and their identification during the dry season. These discussions have already begun to raise awareness of this issue.

- Prior Approval Requirements. Compliance was evaluated for 13 rules in several divisions requiring department approval for a variety of specified activities (see Table 42). No written prior approval documentation was found for 48 of the 492 activities for which it was required (90.4% compliance). Noncompliance with these requirements was strictly an administrative issue and was not an indicator of compliance for related resource-protection rules. Discussions with landowners, operators, and ODF field staff revealed that the practices addressed by these rules were often considered or discussed with ODF personnel during the operation, with the compliance shortcoming simply being one of written documentation. Compliance also appears to be closely related to how familiar operators and landowners are with the requirements in question. The two most commonly applied prior approval rules averaged 203 applications each and 97.2% compliance. The remaining 11 rules averaged only eight applications each and 55% compliance.

- Written Plan Requirements. Compliance was evaluated for eight rules in several divisions requiring that detailed information be documented in a written plan for a variety of specified activities (see Table 43). Documentation of adequate information in a written plan was lacking for 136 of 593 total activities for which it was required (77.1%). Noncompliance with these requirements was strictly an administrative issue and not an indicator of compliance for related resource protection rules. Discussions with landowners, operators, and ODF field staff revealed that these requirements were often considered or discussed with the FPF during or before the operation, with the compliance shortcoming being one of written documentation. Noncompliance also occurred in many cases where a written plan was submitted but did not contain a sufficient level of detail to describe activities in question. Compliance issues generally appeared to be the result of a lack of clear understanding of what specific details are required to be in a written plan (This was especially true for providing fish passage (ODF, 2002[A])).

Monitoring Question 5: Resource Impacts of Noncompliance. *When BMP compliance is inadequate, to what extent are quality and function of riparian areas, stream channels and/or fish habitat compromised?*

Of the 502 total noncompliant practices surveyed, 185 (37%) were with administrative requirements not directly affecting riparian and channel conditions, 147 (29%) had the potential to impact riparian and channel conditions in the future, and 170 (34%) had an observed impact to riparian and channel conditions. The 170 observed impacts resulted from noncompliant practices associated with a range of forest practice rules

(Table 46). Each of these instances was categorized as one of four types: significant harvesting slash accumulations below a high water line, significant damage or removal of riparian vegetation, physical alterations of channel bed or banks without sediment delivery, or sediment delivered below a high water line.

Slash Accumulations

Fifty-three noncompliant harvesting slash accumulations were deemed significant enough to impair the water quality of a stream or wetland. These accumulations resulted from trees not felled directionally away from small Type N streams and small wetlands (40), slash on slopes above streams was not disposed of or placed to prevent it from entering the channel after harvest (7), or mechanically-piled slash was placed below a high water line (6). In all these cases, the loading of fine harvesting slash greatly exceeded natural levels.

Table 46. Riparian and Stream Channel Impacts of Noncompliant Practices

Slash = Significant accumulations below a high water line, Vegetation = significant damage or removal of riparian vegetation, Alteration = physical alterations of channel bed or banks without sediment delivery; Sediment Delivery to WOS numeric columns are categorical estimates of volume of sediment delivered in cubic yards.

				Sediment Delivery to WOS (yd3)			
Rule Sub-Section	Slash	Vegetation	Alteration	0-1	1-10	10-100	>100
Reforestation (RMAs only)							
Treatment of Slash	6				1	1	
Chemical and Other Petroleum Products							
Chemical Applications		2					
Petroleum Products							
Road Construction and Maintenance							
Road Location							
Road Prism Design					1		
Steam Crossing Design			2		8	2	
Road Drainage Design				4	7		
Road Waste and Stabilization				4			
Road Drainage Maintenance				5	4	1	
Road Vacating							
Rock Pits							
Harvesting							
General Yarding Practices						1	1
Felling and Harvesting Slash	38		1				
Cable Yarding Near WOS					1		
Ground Equipment Near WOS				2		1	
Harvesting Waste	7			2		3	
Landings							
Skid Trails			8	4	4	1	
Temporary Crossings				5	5	2	
Vegetation Retention Along Streams							
Vegetation Retention - Type F RMAs		23					
Veg. Retention - Type N and D RMAs		1					
Significant Wetlands		2					
Other Wetlands	2	2		2	3		1
Stream Channel Changes							
Total	53	30	11	28	34	12	2

The beneficial and detrimental effects of this material on water quality and channel dynamics is not yet fully understood or quantified. It is believed, however, that large accumulations of fine organic material in streams and wetlands can have the following potential impacts: elevated water temperatures due to artificially widened channels and slowed flows, reduced dissolved oxygen as material decomposes,

alteration of channel hydrology and increased erosion, reduced potential for vegetation establishment, short-term retention of sediment, and elevated debris torrent hazard. Research on clear-cut first- and second-order streams in western Washington (Jackson *et al*., 2001) found several significant short-term effects of heavy slash loading. These include large increases in the amount of fine sediment retained in these channels, shading of channels from direct solar radiation, and reduction of amphibian populations.

Riparian Vegetation Damage

Thirty of the noncompliant practices surveyed resulted in significant damage or removal of riparian vegetation that was required to be retained by the forest practice rules. The retention of vegetation along streams and wetlands is required to maintain water quality, fish and wildlife habitat, and bank stability. The majority of these (23) were failures to fully meet the vegetation retention requirements when harvesting in Type F RMAs. Other noncompliances were for aerial chemical applications to riparian vegetation (2) and with vegetation retention requirements when harvesting along significant wetlands (2), other wetlands (2), and a Type N RMA (1).

Alteration of Bed or Banks

Eleven noncompliant practices resulted in channel alterations with no observable sediment delivery to a stream or wetland. This physical alteration of channel beds or banks can result in immediate and long-term impacts to water quality through altered hydrology, soil compaction, and elevated erosion potential. Most were associated with machinery operated within a channel, either from ground skidding of logs (8) or excessive activity within a channel while constructing a stream crossing (2). The remaining alteration was the result of trees felled into a small Type N streambed.

Sediment Delivery

Seventy-six observations of sediment delivered to a stream or wetland resulted from a wide range of noncompliant practices (Figure 12). The impacts of sediment delivery vary greatly depending on the volume of delivery, stream size, channel morphology, and other site conditions, but in some cases can cause severe resource impacts. These situations can mean unstable slopes and the loss of forest soils, as well as impaired water quality through increased stream temperatures and lowered dissolved oxygen, hindered fish migration and feeding ability, mortality of aquatic invertebrates, and deposition of fine materials which can alter channel hydrology and bury spawning gravels.

Because these surveys were conducted during the dry season, observations of past sediment delivery and estimations of delivery volume were likely to be under-representative of actual erosion rates. The volume of sediment delivered to WOS was estimated within broad categories. Of the total (76), 28 were estimated to be less than 1 cubic yard, 34 were 1 to 10 cubic yards, 12 were 10 to 100 cubic yards, and two were greater than 100 cubic yards (Figure 13). The first of these two largest cases was from poor yarding practices on steep slopes that caused several large shallow failures. The second (on the same unit) was from improper ground skidding within a wetland.

It is important to note that the estimated volume of delivered sediment is not necessarily a measurement of the magnitude of impact that this delivery may have had on the stream channel. The degree to which a volume of delivered sediment will impact a channel can vary greatly depending on the presence of fish and other aquatic species, stream size, channel morphology, habitat conditions, delivery timing, and other factors. The two cases of sediment delivery of greater than 100 cubic yards, for example, were to a small Type N stream and a wetland of less than one acre. Neither of these streams had fish populations, however, such large amounts of sediment delivery to these small features have drastic hydrology and morphology impacts, such as long-term aggradation of the channel downstream.

The greatest source areas of sediment delivery were from 36 noncompliant road construction and maintenance practices. Specific sediment source areas were ineffective road drainage design (11), inadequate road drainage maintenance (10), eroding stream crossing fill (10), unstabilized road waste (4), and an unstable road prism design (1). The other main sources of sediment delivery were from 32 noncompliant harvesting practices. Specific source areas were poorly-removed temporary crossings (11), ineffectively drained skid trails near streams (9), unstablized harvesting waste (5), harvesting equipment operated in stream channels (3), yarding gouges on steep slopes (2), trees felled into a channel (1), and trees yarded through a stream channel (1). The remaining delivery observations were from infractions of small wetland protection requirements (6), and slash-piling machinery operated in WOS (2).

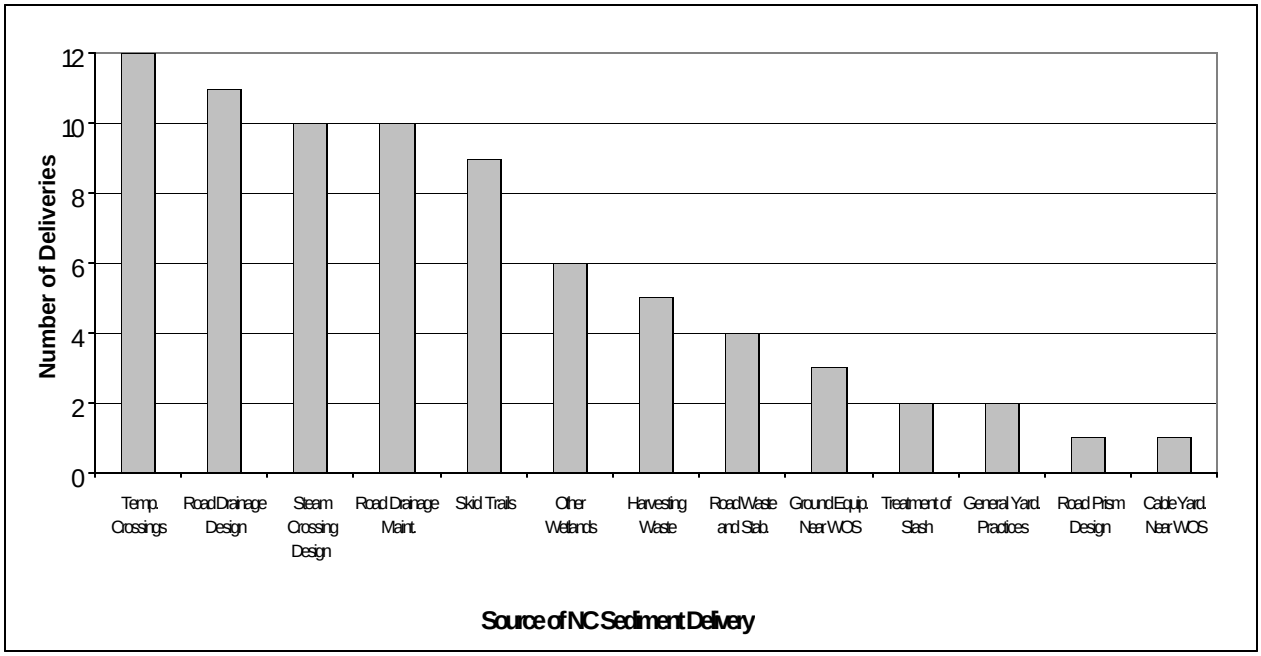

Figure 12. Distribution of Sediment Delivery Volumes from Noncompliant Practices

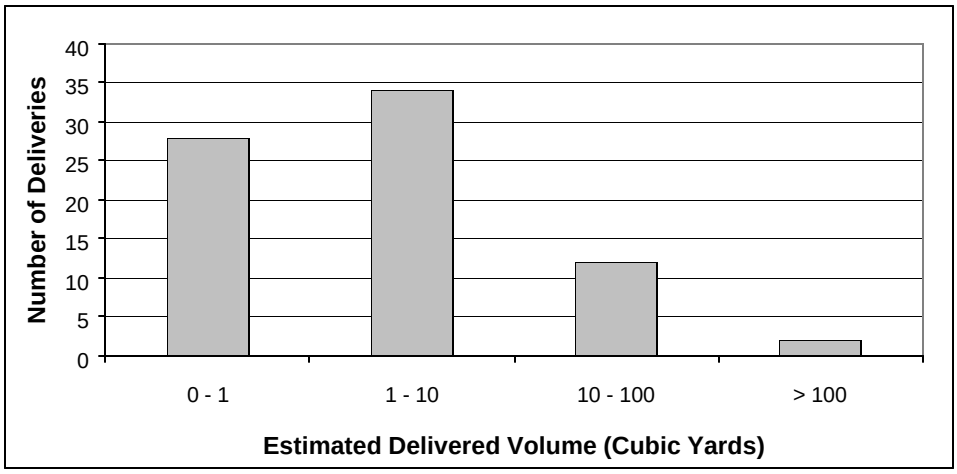

Figure 13. Distribution of Sediment Delivery Sources

RECOMMENDATIONS

Raise Awareness and Understanding of Key Findings

The results of this project demonstrate very encouraging rates of overall compliance with Forest Practice Rules related to water quality, as well as identify those areas of consistent compliance issues. Efforts to raise awareness of those areas of low compliance and greatest resource impact with landowners, operators, and ODF field staff are likely to greatly increase compliance and resource protection. Identification and discussion of many of these issues over the course of implementing this project have already begun to help clarify interpretations and applicability of some rules and lead to efforts by alert landowners to correct specific problems in the field.

This information should continue to be disseminated to forest operators, landowners, ODF staff and the public. Opportunities to raise awareness of findings in the near future include ODF Area Forest Practices conferences in the spring of 2002, Association of Oregon Loggers training workshops, the Oregon Logging Conference, Oregon Forest Industries Council meetings, and potential roads training seminars in the fall of 2002. Training should focus on the causes of compliance issues for the 10 areas of low compliance identified in the *Findings* section of this paper, especially those directly related to stream and wetland protection. Specific priorities for future training include (in no particular order):

- Although road construction and design practices have improved over time, there is still a need for training that addresses effective drainage design, maintenance, and road surface and stream crossing fill stability. These efforts should be based on the criteria described in the *Forest Practices Rule and Statute Guidance Manual* (ODF, 1997) and the *Forest Road Management Guidebook* (ODF, 2000[B]). Specific focus should be given to durable road surfacing, design and maintenance of frequent surface and ditch relief points, disconnection of road drainage from the stream network, drainage filtering or relief before stream crossing approaches, and effective stabilization of stream crossing fills. This training need is also identified in Recommendations F and L of the *Report of the Forest Practices Advisory Committee (FPAC)* (ODF, 2000[C]).

- Increased awareness and understanding of the protection requirements for small Type N streams is needed. A number of rules require that these streams be provided the same level of protection as fish-bearing streams relative to slash piling, felling, bucking, yarding, road drainage, and all machinery activities. Accumulations of felling slash in small Type N streams should be below "quantities that threaten water quality or increase the potential for mass debris movement." It is believed that improved compliance with felling and slash piling requirements would likely result in effective protection against such slash accumulations.

- Increased awareness and understanding of the protection requirements for "other" wetlands, seeps and springs is needed. A number of rules require that these features, when larger than one-quarter acre, be provided the same level of protection as fish-bearing streams relative to felling, bucking, yarding, road drainage, and all machinery activities. For wetlands of any size, the piling of slash is prohibited and accumulations of felling slash should be below "quantities that threaten water quality or increase the potential for mass debris movement." It is believed that compliance with felling and slash piling requirements would likely result in effective protection against such slash accumulations.

- The identification of small Type N streams and "other" wetlands appears to be a major cause for lack of protection of the features. Proper identification is made even more difficult by the fact that these features are often dry during the summer months when many forest activities occur. Training should be provided which focuses on identification of obligate plant species, soil characteristics, and geomorphic evidence of small channels and wetlands during dry periods.

- Increased awareness of the requirements for many activities that prior approval be obtained and/or written plan be approved by the ODF is needed. Low compliance rates generally appear to result from incomplete documentation or a lack of required detail. ODF staff should provide a complete list of all activities which require prior approval or a written plan, the level of detail required, and the need for written documentation of all required information.

Update Rules and Guidance

Some changes to the *Forest Practices Rule and Statute Guidance Manual* (ODF, 1997) can be identified which could help increase understanding of the rule goals and objectives, and ultimately increase proper rule implementation:

- Administrative compliance could be improved with the creation of uniform and detailed checklists of prior approval and written plan requirements. These forms could be located in the guidance for reference, in published ODF newsletters or updates, or included with notifications to assist operators, landowners, and FPFs in identifying and documenting all required information. Sample forms of required information are included in Appendix B.

- The rules or guidance should be revised to incorporate Recommendation F of the *Report of the FPAC*. This recommendation calls for language detailing the objectives and installation criteria for effective road surface drainage so that:
  1. Road surfaces are protected from erosion and water retention,
  2. Erosion of the roadside ditch is minimized,
  3. Ditch water is not discharged onto unstable slopes, and
  4. Ditch water (and associated sediment) discharging directly into a stream is minimized.

- The Forest Practice Rules or guidance should be updated as significant rule interpretations are clarified and future monitoring and research results identify areas for language, requirement, and methodology improvement.

Provide for Administration and Enforcement

Uniform administration and enforcement is a critical aspect of ensuring proper implementation of the Forest Practices Act. This role is filled by department staff and 52 forest practice foresters who perform unit inspections as well as work with landowners and operators in a more preventative role. The identification of these areas of consistent compliance and resource protection concerns will help FPFs and other ODF staff to prioritize their efforts accordingly.

Effective administration of forestry operations is greatly limited by workload and budgetary constraints at the current time. For example, FPFs were able to perform a site inspection on only 49% of the 107,488 forestry operations completed for the period of 1995 to 2000. The current extended vacancy of several FPF and Civil Penalties positions will likely reduce inspection rates and citation administration even further.

Maintenance of this program at the designed staffing level and beyond would help to better address those areas of concern. These include opportunities for FPFs to work with interested landowners before issues arise (e.g., RMA layout, stream crossing location, road drainage design, etc.), provide technical assistance to small landowners, pursue specific resource concerns, re-visit operations during phases or weather conditions when resource impacts are most likely, or inspect many operations.

Consider Related Monitoring

The results of this study suggest several areas where there is a need for related future monitoring efforts. The potential future monitoring topics identified below are specific areas for which supplemental compliance monitoring or effectiveness monitoring and research is needed. Supplemental compliance monitoring is needed for those rules with potential compliance and resource protection concern but which had relatively small sample sizes. Effectiveness monitoring and research is needed to fully understand and quantify the resource implications for those areas where sediment, slash, vegetation damage, or channel disturbance impacts to riparian and channel conditions were identified. These and other topics are currently being evaluated and prioritized in the *Forest Practices Monitoring Program Strategy* (ODF, 2002[B]), and as they relate to the recommendations in the *Report of the FPAC.*

- Roads and Chronic Erosion. While the focus of this study is on compliance, some data were provided on erosion and sediment delivery to streams. Noncompliance with road-related BMPs, especially drainage and maintenance, was identified as the largest source of sediment delivery to stream channels. Because these surveys were performed during the dry season, they also likely underestimated the number of sediment delivery sources and total eroded volume.

  Outside research results have also identified road drainage and maintenance issues as the major source of forestry-related sediment delivery to stream channels. Luce and Black (1999) found sediment production to be heavily correlated with road surface and unvegetated ditch and cutslope lengths draining to a channel. Skaugset and Allen (1998) identified the relief of road drainage at stream crossings as the most common source of sediment delivery in western Oregon. This study also found that 25% of surveyed road length delivered drainage and sediment directly to a stream channel. Many other recent studies in western Oregon have identified even higher levels of road drainage connectivity with the stream network, as well as other major factors which affect sediment production, such as surfacing material or traffic levels.

  More quantitative information is needed on the effectiveness of current policy in terms of the volume of chronic sediment being delivered to streams. Sediment production, delivery, and transport need to be monitored in the winter to determine the effectiveness of Forest Practice Rules in minimizing sediment impacts on streams. This need is also addressed by Recommendation K of the *Report of the FPAC*, and is identified as a top priority in the Forest Practices Monitoring Program Strategy. The ODF is currently implementing a project to evaluate the impacts of forest road surfacing materials and hauling rates on stream turbidity during wet weather, as per Recommendation G of the *Report of the FPAC*.

- Slash in Small Type N Streams and Wetlands. This study found slash accumulation in Type N streams and "other" wetlands a common result of some noncompliance practices. Improved compliance with felling and site preparation practices near all WOS will likely reduce occurrence of this issue, although some accumulation of slash within small Type N streams and wetlands will inevitably occur. Research is needed to identify the specific resource effects associated with these accumulations of organic

material of different sizes and, subsequently, the approaches to slash management which would provide the greatest protection to these resources.

- Oregon Plan Measures. While many Oregon Plan for Salmon and Watersheds measures include Forest Practices regulatory requirements, this project did not track the many volunteer efforts conducted in accordance with this plan (see Appendix D). Monitoring of the rate of landowner application of these measures and their effectiveness at achieving restoration and protection goals is a top priority in the Forest Practices Monitoring Program Strategy.

- Significant Wetlands. Seven of the units surveyed had activities within 300 feet of a significant wetland, but only two had activities within 100 feet. While compliance rates were generally low for significant wetland protection BMPs, further evaluation of activities near a larger sample of significant wetlands is needed to more fully evaluate compliance with these rules. This survey could be conducted along with an effectiveness evaluation of current standards for protecting wetland habitat and function. Both of these wetland monitoring needs are currently identified as high priorities in the Forest Practices Monitoring Program Strategy.

- High Risk Site (Landslide-Prone Locations) Activities. Sample sizes were low for BMPs related to activities on high risk sites and may have also been under-represented due to a site selection stratification that was biased towards units with Type F streams. This study found high compliance rates with harvesting BMPs on high risk sites and the Storm Impacts and Landslides of 1996 (ODF, 1999) study answered many questions about these areas. However, this remains an area of high concern for potential resource damage and public safety and new rules being adopted later this year. Further monitoring is needed to evaluate the effectiveness of these evolving BMPs at protecting soil productivity and slope stability. The need for this is also identified by Recommendation Q of the *Report of the FPAC*.

- Reforestation. Evaluation of reforestation rules dealt only with replanting within harvested portions of RMAs (34). Replanting and free-to-grow requirements on a unit-wide basis are topics for potential future monitoring because they were not addressed by this project. Reforestation issues were the source of 25% of the citations issued from 1990 to 1999 (ODF, 2000[D]), and current public opinion in Oregon is that effective reforestation following harvest does not occur (Davis and Hibbitts, Inc., 2001). A survey of reforestation compliance could be coupled with monitoring of units not reforested due to conversion to other land uses.

- Riparian Conifer Restorations. While compliance rates were generally low with rules relating to riparian conifer restorations, this small sample size made it difficult to draw reliable conclusions from these results. Although rarely used, this prescription has potentially very large and long-lasting effects on stream and riparian conditions and monitoring is needed on the effectiveness of meeting its intended goals. Over the past 5 years, the ODF has collected data on stream temperature, shade, compliance, and riparian structure for several stream reaches on which this prescription was applied. Plans are currently being developed to analyze these data collectively to provide effectiveness and compliance evaluation of this management option.

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APPENDIX A

Unit Compliance Data

Table A-1. Unit Compliance Data

Number of Rules Surveyed, Number of Rule Applications, and Compliance Rate for All Rule Applications for Each Unit. Also shown are the number of non-compliant rule applications by category: Admin. = infraction of administrative requirements, Pot. Impact = potential future impact to water quality, and Res. Impact = observed impact to water quality.

Site	# Rules Surveyed	# Applications Surveyed	% Applications Compliant	Non-Compliance Type:		
				Admin.	Pot. Impact	Res. Impact
1	44	70	97.1	1	0	1
2	61	101	95.0	0	2	3
3	42	47	95.7	0	1	1
4	49	71	97.2	2	0	0
5	44	44	100.0	0	0	0
6	34	34	100.0	0	0	0
7	38	66	97.0	0	0	2
8	33	33	78.8	0	1	6
9	56	56	94.6	0	0	3
10	67	112	95.5	0	2	3
11	68	83	97.6	0	1	1
12	48	55	96.4	2	0	0
13	36	41	92.7	0	1	2
14	21	21	100.0	0	0	0
15	41	41	100.0	0	0	0
16	17	17	100.0	0	0	0
17	76	99	99.0	0	1	0
18	40	40	100.0	0	0	0
19	66	152	98.7	0	1	1
20	35	60	98.3	0	1	0
21	59	64	87.5	4	1	3
22	45	60	98.3	1	0	0
23	45	47	97.9	0	0	1
24	64	107	94.4	4	1	1
25	55	70	91.4	1	2	3
26	67	89	94.4	3	1	1
27	40	60	100.0	0	0	0
28	29	29	96.6	0	0	1
29	50	55	100.0	0	0	0
30	39	46	91.3	2	0	2
31	42	42	97.6	1	0	0
32	37	57	94.7	0	2	1
33	38	41	100.0	0	0	0
34	41	56	98.2	1	0	0
35	43	63	98.4	1	0	0
36	23	23	100.0	0	0	0
37	42	43	86.0	4	1	1
38	54	64	100.0	0	0	0
39	57	82	93.9	0	1	4
40	30	40	100.0	0	0	0
41	40	40	97.5	0	1	0
42	45	62	85.5	5	1	3
43	37	37	91.9	3	0	0
44	54	63	93.7	2	2	0
45	47	87	98.9	0	1	0

Table A-1 Continued

Site	# Rules Surveyed	# Applications Surveyed	% Applications Compliant	Non-Compliance Type: Admin.	Pot. Impact	Res. Impact
46	45	65	96.9	0	1	1
47	43	43	100.0	0	0	0
48	53	88	93.2	2	2	2
49	34	34	100.0	0	0	0
50	67	73	97.3	0	0	2
51	46	85	96.5	2	1	0
52	53	53	92.5	3	1	0
53	48	48	97.9	1	0	0
54	55	92	98.9	0	1	0
55	32	37	94.6	2	0	0
56	72	104	99.0	0	1	0
57	60	145	97.9	0	1	2
58	37	42	100.0	0	0	0
59	26	26	88.5	0	2	1
60	29	29	100.0	0	0	0
61	43	63	87.3	2	3	3
62	44	44	88.6	2	1	2
63	64	99	94.9	3	1	1
64	53	78	100.0	0	0	0
65	48	58	94.8	0	0	3
66	53	84	88.1	1	2	7
67	24	24	100.0	0	0	0
68	37	37	89.2	0	3	1
69	28	33	90.9	2	1	0
70	58	76	92.1	1	2	3
71	55	79	88.6	0	7	2
72	41	41	100.0	0	0	0
73	59	110	99.1	0	1	0
74	41	53	92.5	3	0	1
75	66	123	88.6	8	6	0
76	52	62	95.2	0	0	3
77	50	65	90.8	0	3	3
78	65	106	99.1	0	1	0
79	79	118	95.8	0	3	2
80	62	81	96.3	0	2	1
81	61	108	90.7	3	3	4
82	52	74	98.6	0	1	0
83	63	100	97.0	1	0	2
84	45	45	97.8	0	1	0
85	73	95	92.6	3	2	2
86	35	40	100.0	0	0	0
87	44	44	93.2	0	1	2
88	62	88	94.3	3	0	2
89	65	123	98.4	0	0	2
90	80	112	94.6	4	0	2
91	55	60	100.0	0	0	0
92	63	150	97.3	3	0	1
93	30	35	97.1	0	1	0

Table A-1 Continued

Site	# Rules Surveyed	# Applications Surveyed	% Applications Compliant	Non-Compliance Type: Admin.	Pot. Impact	Res. Impact
94	43	55	100.0	0	0	0
95	61	90	100.0	0	0	0
96	59	87	97.7	2	0	0
97	68	148	94.6	4	4	0
98	26	33	100.0	0	0	0
99	51	75	98.7	0	1	0
100	58	76	89.5	0	3	5
101	27	27	96.3	1	0	0
102	55	104	88.5	3	3	6
103	39	69	98.6	0	0	1
104	54	69	88.4	1	5	2
105	50	70	100.0	0	0	0
106	49	49	89.8	1	0	4
107	65	148	100.0	0	0	0
108	41	66	100.0	0	0	0
109	35	35	100.0	0	0	0
110	44	59	100.0	0	0	0
111	55	78	100.0	0	0	0
112	44	54	92.6	0	4	0
113	60	90	98.9	0	1	0
114	65	95	95.8	1	3	0
115	26	26	80.8	5	0	0
116	51	81	93.8	0	3	2
117	53	68	95.6	2	1	0
118	47	62	98.4	0	1	0
119	37	47	95.7	2	0	0
120	56	56	96.4	1	0	1
121	56	89	91.0	8	0	0
122	56	61	98.4	0	1	0
123	39	51	94.1	3	0	0
124	60	77	100.0	0	0	0
125	53	65	98.5	0	1	0
126	45	50	94.0	0	2	1
127	67	72	100.0	0	0	0
128	53	64	98.4	0	1	0
129	50	58	94.8	0	0	3
130	45	78	96.2	0	1	2
131	41	76	97.4	0	0	2
132	49	54	92.6	0	0	4
133	36	41	100.0	0	0	0
134	45	70	98.6	1	0	0
135	59	69	98.6	0	1	0
136	56	88	92.0	6	1	0
137	68	81	96.3	0	3	0
138	48	58	93.1	2	0	2
139	64	99	92.9	0	4	3
140	36	46	100.0	0	0	0
141	37	57	100.0	0	0	0

Table A-1 Continued

Site	# Rules Surveyed	# Applications Surveyed	% Applications Compliant	Non-Compliance Type: Admin.	Pot. Impact	Res. Impact
142	37	44	95.5	2	0	0
143	62	72	100.0	0	0	0
144	54	81	100.0	0	0	0
145	59	84	94.0	5	0	0
146	56	59	98.3	1	0	0
147	44	44	97.7	1	0	0
148	50	50	100.0	0	0	0
149	44	419	99.8	0	1	0
150	30	35	100.0	0	0	0
151	45	115	100.0	0	0	0
152	30	60	98.3	0	0	1
153	60	85	95.3	3	1	0
154	56	98	94.9	0	1	4
155	48	78	98.7	0	0	1
156	41	131	100.0	0	0	0
157	51	61	98.4	0	1	0
158	71	109	97.2	0	1	2
159	46	61	93.4	2	0	2
160	62	138	99.3	0	1	0
161	26	26	100.0	0	0	0
162	59	97	97.9	0	0	2
163	73	96	94.8	2	1	2
164	67	112	96.4	2	0	2
165	65	91	98.9	0	1	0
166	46	78	98.7	0	1	0
167	67	107	98.1	1	1	0
168	60	94	96.8	0	0	3
169	56	66	93.9	1	0	3
170	40	55	92.7	4	0	0
171	52	72	97.2	0	2	0
172	21	21	90.5	2	0	0
173	46	71	98.6	1	0	0
174	46	66	98.5	1	0	0
175	47	57	91.2	2	1	2
176	49	69	95.7	3	0	0
177	42	97	97.9	2	0	0
178	42	42	95.2	2	0	0
179	44	74	93.2	2	2	1
180	43	54	96.3	2	0	0
181	28	28	92.9	1	1	0
182	46	92	85.9	11	2	0
183	48	55	96.4	0	1	1
184	42	42	95.2	0	1	1
185	48	53	100.0	0	0	0
186	55	85	100.0	0	0	0
187	37	112	100.0	0	0	0
188	37	197	100.0	0	0	0
189	49	110	90.9	3	5	2
Average Compliance Per Site			96.1	185	149	168

APPENDIX B

Sample Checklists of Administrative Rule Requirements Related to WOS

Written Prior Approval Required For:	Activity Associated with Notification?	
Activities within 100 feet of Type F or D stream or large lake	Yes	No
Activities within 300 feet of significant wetland	Yes	No
Request for land use change exemption to reforestation requirements	Yes	No
Machine activity conducted within a Type F or D stream, lake, or significant wetland	Yes	No
Road construction within riparian management area	Yes	No
Road construction on high risk site in northwest or southern Oregon areas	Yes	No
Construction of stream crossing fill over 15 feet deep	Yes	No
Placement of large wood or boulders in stream channels for enhancement	Yes	No
Location of landing within a riparian management area	Yes	No
Harvesting on high risk site in northwest or southern Oregon areas	Yes	No
Yarding across Type F or D streams, large or medium Type N streams, lakes, or significant wetlands	Yes	No
Placement of conifer logs or down trees in Type F streams for basal area credit	Yes	No
Site specific vegetation retention prescription for a riparian management area	Yes	No

Figure B-1. Draft Checklist for Activities Associated with WOS Requiring Prior Approval. The following activities related to protection of waters of the state require written prior approval with the Oregon Department of Forestry.

Detailed Information Required in an Approved Written Plan:	Activity Associated with Notification?	
Stream and riparian management area protection measures	Yes	No
RMA protection for burning within 100' of Type F or D stream, 100' of large lake, or 300' of significant wetland	Yes	No
Fill and drainage structure design for stream crossing fills over 15' deep	Yes	No
Minimization of impacts to soil and water resources when harvesting on high risk sites	Yes	No
Construction, passage of water, and duration for temporary crossing fills over 8' deep	Yes	No
Sediment protection of Type D streams for activities within 100'	Yes	No
Prescription used for harvest within or adjacent to a riparian management area	Yes	No
Filling within wetlands	Yes	No
Machine activity within wetlands	Yes	No
Road construction within wetlands	Yes	No
Protection of understory vegetation during harvest or site preparation within 300' of significant wetlands	Yes	No

Figure B-2. Draft Checklist for Activities Associated with WOS Requiring an Approved Written Plan. The following information for activities related to waters of the state is required in a written plan approved by the Oregon Department of Forestry.

APPENDIX C

Quality Assurance and Quality Control

Table C-1. Repeated Measurement of Road Location Classification

Site #	Location Category	1st Visit (Feet)	2nd Visit (Feet)	Difference (Feet)
1	Other	1100	900	200
2	>65% Slope	400	400	0
2	Other	2500	2400	100
3	Other	200	200	0

Table C-2. Repeated Measurement of Road Drainage Classification

Site #	Drainage Category	1st Visit (Feet)	2nd Visit (Feet)	Difference (Feet)
1	Outsloped	1100	900	200
2	Functional Ditch	2900	2800	100
3	Outsloped	200	200	0

Table C-3. Repeated Measurement of RMA Widths

RMA #	1st Visit (Avg. Width Feet)	2nd Visit (Avg. Width Feet)	Difference (Feet)
1	100	100	0
2	100	100	0
3	100	100	0
4	10	10	0
5	20	20	0
6	10	10	0
7	20	20	0
8	20	20	0
9	20	20	0
10	100	100	0

Table C-4. Repeated Measurement of RMA Tree Counts

Site #	1st Visit (# Trees)	2nd Visit (# Trees)	Difference (# Trees)
1	16	16	0
2	3	4	1
3	9	10	1
4	37	42	5

Table C-5. Repeated Measurement of RMA Retained Basal Area

Site #	1st Visit (Sq. Ft. BA)	2nd Visit (Sq. Ft. BA)	Difference (Sq. Ft. BA)
1	25.5	21.8	3.7
2	7.7	9.2	1.5
3	19.9	24.5	4.6
4	74.8	71.8	3.0

APPENDIX D

Oregon Plan for Salmon and Watersheds Voluntary Measures

OWEB Activity #	Voluntary Measure Description
ODF 1S	Road Erosion and Risk Project
ODF 8S	Conifer Restoration
ODF 19S	Additional Conifer Retention Along Fish-Bearing Streams
ODF 20S	Increased Riparian Management Area for Small Type N Steams
ODF 21S	Active Placement of Large Wood During Forest Operations
ODF 22S	25 Percent In-Unit Leave Tree Placement and Additional Voluntary Retention
ODF 62S	Voluntary No-Harvest Riparian Management Areas

Figure D-1. Oregon Plan Voluntary Measures. OWEB = Oregon Watershed Enhancement Board.