




July 21, 2014

MEMORANDUM

TO: Forest Practices Board

FROM: Walt Obermeyer, Compliance Monitoring Program Administrator

SUBJECT: 2012-2013 Biennial Report and current program status



Enclosed with this memo is the 2012-2013 Biennial compliance monitoring report for your review.

The program is in the process of completing field reviews and expects to be finished November 2014.

The program field coordinator, transferred to a different program in July. Interviews have been scheduled and we expect to fill the position by August.

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2012-2013 Biennium Forest Practices Compliance Monitoring Report

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July 2014



Acknowledgements

The contributions of the following were critical to the completion of this report:

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2012-2013 Biennium Forest Practices Compliance Monitoring Report

July 2014

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Executive Summary

The Compliance Monitoring Program (CMP) is a key component of the Washington State Department of Natural Resources' (DNR) Forest Practices Program (FP program). Compliance monitoring is linked to DNR's responsibility to ensure that operators and landowners are complying with the forest practices rules (FP rules) when conducting forest practices activities. Through monitoring, the CMP provides feedback to the FP program regarding the degree to which specific FP rules are being implemented correctly, and where there is a need for focus, training, or clarity.

The CMP reports on compliance of FP rules on-the-ground. The FP rules direct DNR to provide "statistically sound, biennial compliance audits and monitoring reports to the (Forest Practices) Board for consideration and support of rule and guidance analysis" ([WAC 222-08-160\(4\)](#)). Last July, the CMP published an interim report containing result for the 2012 CMP sample. This current report contains the entire results for the biennial sample assessing samples collected during the 2012-2013 field seasons.

The Compliance Monitoring Program currently evaluates compliance with those FP rules considered to have the greatest impact on the protection of aquatic and riparian species and their habitat. These are riparian and wetland rules, road construction rules and haul route rules.

Sample Design and Methodology

The population designated for sampling consists of forest practices applications (FPAs) that have forest practices activities such as timber harvest or road construction that include specific rules being monitored. FP rules are grouped into categories of similar rules called "prescriptions" for the purposes of monitoring and statistical analysis. Separate samples are selected for each prescription type being monitored. The list of FPAs that contain the prescriptions being monitored for that year constitutes the pool from which sample selections are drawn for each prescription. For the 2012-2103 report, samples from 301 forest practices applications (FPAs) were chosen from the total population of 8,109 FPAs.

Forest Practices rules monitored annually are referred to as the *Standard* Sample. In addition, certain rule groups are monitored periodically and these are known as an *Emphasis* Sample. The Standard Sample monitors the following rules:

- Riparian protection (WACs 222-16-031, 222-30-021 and -022)
- Wetland protection (WACs 222-16-035, 222-30-020(7), WAC 222-24-015(8) and (9) and WAC 222-24-015)
- Road construction, and abandonment (chapter 222-24 WAC)
- Haul routes for sediment delivery (chapter 222-24 WAC)

In addition, the physical criteria of waters (e.g., stream width, stream gradient, etc.) are observed to estimate the number of occurrences where water types are recorded on FPAs. The CMP review team compared them to determine differences between the water types submitted in FPAs and what is observed on-the-ground. Those waters observed by the CMP team are considered correct.

The reader should note that the CMP water-type review applies a subset of water typing methods in the Board Manual and rules which is discussed in Section 3.1 of this report.

In 2012, the CMP performed one emphasis sample that assessed rules pertaining to harvest within riparian management zones (RMZs) for exempt 20-acre parcels ([WAC 222-30-023](#)). There are different Forest Practices rules that only apply to the riparian management zones of small forest landowners who own less than 80 acres of forest land in Washington state and are harvesting on a parcel that totals 20 contiguous acres or less. Sampling of RMZs on exempt 20-acre parcels was included in the 2008-2009 biennial report, and was an emphasis sample in 2012 to determine if the compliance rates improved. The CMP conducted a census on the 2012 population because the total population size was small. Twenty-eight FPAs were reviewed where the operations were completed.

Changes

The CMP made significant changes in the 2012-2013 sample design to increase confidence in statistical estimates for each prescription type observed. Previously, the Standard Sample design was based on a random selection of FPAs stratified by the proportion of the population found in each DNR region. The sample size for each prescription was dependent on what was observed on the selected FPAs. The 2012-2013 sample design, instead, randomly selects instances of each sampled prescription type occurring in the population. A sample size is calculated for each prescription type which meets a desired confidence level and margin of error for a biennium sample. This change in selection design allows for control in the level of statistical confidence in results and provides a larger data set to help determine causes of non-compliance. It may allow flexibility in the future to add or remove different prescription types from the sample as needed, while still providing the desired confidence intervals for each prescription type.

The CMP has also made terminology changes beginning with the 2012 report. The terminology used to describe compliance has changed. In past CMP reports, prescriptions have been assessed as either “Compliant” or “Non-compliant”. Starting with the 2012 report, prescriptions are being assessed as “Compliant” or a “Deviation”. How the data is calculated has not changed, nor the methodology supporting the collection of the data. The CMP determined that a ‘Deviation’ assessment label was more accurate and descriptive than a ‘Non-compliant’ label, acknowledging that, while a prescription may have one or more rule deviations, other rule elements within the prescription may still be fully compliant.

Notable Aspects of CMP Samples:

- FPAs are randomly selected.
- Conclusions on compliance patterns are based on a two-year monitoring period. Samples are observed proportional to approved FPA population per year. Two years of FPAs are needed to obtain enough samples to attain the desired level of statistical precision.
- The CMP sets sample sizes based on an estimated 95% confidence level and a +/- 12% margin of error in order to produce the confidence intervals for compliance estimates. CMP results are reported separately for small forest landowners and industrial landowners and for all the landowners combined; however, the target confidence interval is set for the combined landowner groups.

- The “Compliant” percentages reported for all sampled prescriptions, except the haul route prescription, reflect the percentage of samples for a certain prescription type where there was compliance with every FP rule within the prescription. See Section 2.3 for more information.
- The haul route prescription type follows a different sample design, therefore, compliance percentages reported for the haul route prescription are overall rates of compliance with FP rules for haul routes (instead of percent sample compliant). See Section 4 for more information.
- When a prescription is assessed as a deviation, it is rated as either “minor, moderate, major, or indeterminate” to provide a sense of the severity of the deviation from the rule.
- When a landowner implements higher protection standards than required in FP rule, the prescription is assessed as compliant and rated as “exceeds rule requirements”.
- Compliance is determined for both the forest practice activity implementation with the FP rules, called “rule compliance” and for the forest practice activity implementation with what was stated on the FPA, called “FPA compliance”.

Compliance Monitoring Challenges

Four challenges faced by the CMP are discussed in the report.

1. Sampling errors occur when the forest practices rule or board manual guidance specifies that *average* values be used during the layout of a particular prescription type. For example, a stream width is determined by averaging measurements along the stream reach. It’s unlikely that the compliance monitoring field team will arrive at the same average width without knowing specifically where the landowner’s measurements were taken. Statistical analysis techniques, such as a sensitivity study to determine error tolerances, have not yet been pursued by the CMP to determine whether the differences in values are significant. To acknowledge the inability to determine statistical variability, the CMP currently allows for an absolute 5% measurement error tolerance in two situations, when determining: 1) Large versus small Type F stream widths (e.g., for a 10-foot-wide stream, the error tolerance would be 6 inches), or 2) buffer widths or floors within no-harvest RMZ areas.
2. Natural systems such as forests are highly variable and difficult to measure with precision, yet Forest Practices rules require precise measurements to implement forest practices activities. When precise measurements required in the FP rules are confounded by variable site conditions, the CMP follows the Forest Practices Operations section interpretation of the FP rules to determine compliance. This happens commonly when an observed stream reach exhibits some physical characteristics, per rule definitions, of both a Type Np stream and a Type F stream. The compliance monitoring team considers the stream to be Type F water unless there is documentation supporting the FPA stream type.

Findings

Complete findings from the 2012-2013 sampling seasons are reported in sections 3 and 4 of this report. The findings are summarized in Table A below showing average compliance rates and sample size.

Table A- Summary Riparian FP Rule Compliance Rates and Sample Size by Prescription Type

Western Washington					
	Fish Water				Non-fish water
	No Inner Zone Harvest	No Outer Zone harvest	DFC Option 1	DFC Option 2	Type Np
% compliant	67%	91%	52%	58%	76%
Sample size	58	32	33	48	25

Eastern Washington			
	Fish Water		Non-Fish Water
	No Inner Zone Harvest	No Outer Zone harvest	Type Np RMZ
% compliant	82%	79%	86%
Sample size	34	14	7

Statewide				
	Non-Fish Water			
	Type Ns Harvest	Type A Wetland	Type B Wetland	Forested Wetland
% compliant	96%	80%	94%	94%
Sample size	25	20	17	17

Exempt 20-acre Parcels

Findings from the 2012 Emphasis Sample of the exempt 20-acre parcels on the 28 applications available for review showed 57% of the samples assessed as compliant.

Road Construction and Abandonment

The statewide Road Construction and Abandonment rule compliance rate was 97% from a sample of 36 FPAs.

Haul Routes

The rate of compliance for haul routes in 2012-2013 was 94% from 48 observations.

Discussion

Standard Sample Results

Comparison of Standard Sample results with the previous biennium did not reveal statistically different results based on the comparison of means and confidence intervals. The 2010-2011 sample sizes were small for the less-frequently occurring prescription types resulting in confidence intervals so wide as to be uninformative. In two prescription types, No Outer Zone harvest and Type Np RMZs, changes in the assessment procedures between the biennia did not allow direct comparison of the statistics.

RMZ Exempt 20-acre Parcels

FPAs associated with RMZs for exempt 20-acre parcels comprise 2.1% of total FPAs submitted to DNR for the 2013 fiscal year. The low rate of compliance for the exempt 20-acre parcels RMZ prescriptions in 2008 led to the delineation of steps outlined in the 2011 Compliance Action Plan, to help increase the compliance rate for the exempt 20-acre parcels RMZ prescription types. Corrective steps included:

- Implementing an FPA condition for the applicant to notify DNR 48-hours prior to beginning harvest operations, and
- Requiring a minimum of two on-site forest practices evaluations by foresters during the active period of the FPA.

Participation in the notification condition was generally not successful; however some foresters successfully visited FPAs twice during their operations. Data from 2012 shows the compliance rate has not significantly changed statistically since 2008.

Changes Made Based on Previous CMP Feedback

One of the primary goals of the Compliance Monitoring Program is to provide feedback from compliance monitoring for the purposes of improving compliance with the FP rules. Following are some of the Forest Practices program changes made to address issues identified as a result of the 2010-2011 sample analysis:

Water Type Classification

The Water Type Classification Worksheet and the Water Type Modification Forms have been revised to provide better detail about the location of water type breaks and stream physical characteristics.

- Water Type and Bankfull Width Training was presented to all region Forest Practices Staff in 2013 to help provide consistent statewide interpretation and understanding about how water types and bankfull widths are determined.

- Regions provided a truncated version of the Water Type and Bankfull Width Training to their Timber, Fish and Wildlife stakeholders.

Future CMP analysis will determine if these measures are effective in improving compliance with water typing rules. The reader should note that program changes take at least three years before the CMP can field verify change in results because of the three year lifespan of FPAs.

Future Program Improvements

The CMP design implemented in 2012-2013 provided a marked improvement in the confidence intervals but proved to be too time consuming to maintain. The program was redesigned this last winter with implementation beginning with the 2014 sample. The design continues to observe compliance with individual rules but aggregates results differently. In the new method, the individual rules contribute to the measure of variability, allowing analysis of individual rules and improving the reliability of the estimates.

Because the fundamental observations of individual rules are unchanged, the program will be able to reanalyze previous data and provide results in the new design. This will allow comparison between past and future results. Additionally, the sample size will be smaller which may allow the program to consider including additional prescription types or emphasis samples.

1. Introduction



Photo by: Doug Couvelier

Compliance monitoring is an important component of the feedback loop for the Washington State Department of Natural Resources (DNR) Forest Practices program. This section provides a brief history leading up to the development of the compliance monitoring program, an

explanation of key factors and concepts related to compliance monitoring and an explanation of Forest Practices rules that are monitored.

1.1 History and Context

The 1974 Forest Practices Act (FP Act) declared that “forest land resources are among the most valuable of all resources in the state” ([Revised Code of Washington \(RCW\) Chapter 76.09](#)). This law and its corresponding forest practices rules (FP rules) ([Washington Administrative Code \(WAC\) chapter 222](#)) regulate forestry activities on state and private lands in Washington state and are designed to protect public resources on forestland and ensure that Washington continues to support a viable forest products industry. [Public resources](#) are defined as water, fish, wildlife, and capital improvements of the state or its political subdivision.

The FP Act created the Forest Practices Board (the Board), an independent state agency with 13 members. The Board, with input from members of the public, stakeholder groups and DNR, adopts FP rules and approves technical guidance ([Forest Practices Board Manual or “Board Manual”](#)) which assists applicants in implementing the FP rules. The FP rules are administered by DNR with input and consultation from other entities where directed in rule.

An adaptable Forest Practices program (FP program) was developed as the foundation to implement the FP Act and rules. Knowledge and understanding of natural systems evolve and technology and markets change forest practices over time. A flexible FP program is essential for meeting the intent of the FP Act in an arena where change is expected and ongoing. FP program components provide systematic feedback and facilitate change when needed and have been intentionally designed and incorporated into the FP program. These components include the Compliance Monitoring Program (CMP), the Adaptive Management Program (AMP) and the Forest Practices Training Program (FPTP). Other FP program components provide critical functions for implementing the FP Act and rules and also provide information to improve the FP program. These include [forest practices application \(FPA\)](#) review and FPA compliance and enforcement. When these components provide feedback that suggests change is needed to better meet the goals of the FP Act and rules, the Board can adopt new FP rules or guidance. Additionally, the FP program may adjust its operational practices within the bounds of the FP Act and rules to implement changes. Since promulgation of the FP Act in 1974, the FP program’s flexible design has facilitated many changes to the FP rules and Board Manual as well as to the FP program.

One such change was the incorporation of the Compliance Monitoring Program into the FP program. The CMP was not part of the original FP program established in 1974. The CMP was first formally proposed as an essential element in the [1999 Forests and Fish Report](#). This report is a multi-stakeholder agreement that delineated acceptable measures to protect water quality and habitat for federally listed aquatic species and other riparian-dependent species on private and state forestlands in Washington. The legislature enacted the Forests and Fish Report protection measures into law in 1999. As a result, compliance monitoring for forest practices became a legal requirement when the Forest Practices Board’s “Forests and Fish” rules became effective in 2001.

[WAC 222-08-160\(4\)](#) states: *The department shall conduct compliance monitoring that addresses the following key question: “Are forest practices being conducted in compliance with the rules?” The department shall provide statistically sound, biennial compliance audits and monitoring reports to the board for consideration and support of rule and guidance analysis. Compliance monitoring shall determine whether forest practices rules are being implemented on the ground. An infrastructure to support compliance will include adequate compliance monitoring, enforcement, training, education and budget.”*

When funding for the CMP was allocated by the legislature in 2006, DNR, along with other stakeholders, developed a Compliance Monitoring [program design](#) and implemented an initial sampling effort in the spring of 2006. The CMP has completed annual compliance monitoring sampling every year since 2006. Additionally, the program has produced biennial reports starting with the [2006-2007 CMP Biennium Report](#) showing results of field reviews, as directed by [WAC 222-08-160\(4\)](#), for consideration and support of rule and guidance analysis. All completed reports can be found on the compliance monitoring website: http://www.dnr.wa.gov/BusinessPermits-Topics-ComplianceandEnforcement-Pages-fp_cm_program.aspx.

The CMP is a key component of a feedback loop to improve compliance with the forest practices rules that protect public resources and maintain a viable forestry industry in Washington state. When sampling results provide sufficient information regarding a need for change, CMP reports include suggestions for potential changes that could help the FP program better achieve the goals of the FP Act and rules. See Section 9 for a list of recent changes that resulted from CMP feedback.

1.2 Compliance Monitoring Program

Program Staffing: The DNR Forest Practices Assistant Division Manager for Operations directs the CMP. The program staff includes a program manager and a field coordinator along with funded participation of one staff person each from the Washington State Departments of Ecology and Fish and Wildlife. Additional assistance is provided by tribal members and other forest practices region staff.

Reports: Field sampling of completed Forest Practices Applications (FPAs) occurs annually and findings are presented in a biennial report as required in WAC 222-08-160(4). In 2011, the Commissioner of Public Lands requested that the FP program also begin producing annual reports in the years that a biennial report is not required. The 2012 interim CMP report covered data samples collected during the 2012 field season and was published July 2013. Sample sizes in the annual report were too small to provide the designed statistical precision which is why the second half of the data obtained in the second year of the biennium cycle is critical. The data from the 2012 and 2013 field seasons have been combined to produce the desired precision for statistical estimates, comprehensive findings, conclusions, and recommendations found in this 2012-2013 biennial report.

Forest Practices Activities and Prescription Types:

Forest practices activities are individual operations such as timber harvest or forest road construction that are subject to the FP rules. Prescription types are groupings of similar rules that apply to a forest practices activity. FP rules are divided and grouped by similar topic per

application for monitoring purposes. For example, forest practices activities such as road construction and timber harvest near streams or wetlands are evaluated based on options available for implementing a particular activity, such as the many options available for harvest in the RMZ (DFC Option 1, DFC Option 2, etc.); and by function-feature being protected such as water quality and wetlands. In CMP reports these rule groupings are called “prescription types”. The CMP obtains data from samples and reports compliance monitoring findings by prescription type.

These prescription types allow for statistical estimation of compliance within specific rule groups rather than an overall forest practices compliance rate. This enhances the ability for the FP Program to determine where additional training, education or FP compliance efforts might be needed to increase compliance with FP rules. The CMP determines which prescription types will be sampled and estimates the number of samples required for statistical precision. This number is randomly selected from FPAs and then visited by the compliance monitoring field team for each prescription type.

Compliance: Each FPA is observed after completion of forest management activities for compliance. Two elements are used:

- Rule compliance – how well the activity fulfilled FP rules; and
- FPA compliance – whether the activities follow the FPA.

Deviation from rules on a particular FPA can occur in one of the following three ways:

- The conditions on the ground are in compliance with the FPA but have deviated from the FP rules. For example, an applicant incorrectly measures the width of the stream in the FPA area and states on the FPA that the stream falls into a smaller (incorrect) width category that requires less protection. Subsequently, if the applicant implements the forest practices activity using the incorrect stream width and associated protection measures, the forest practice has deviated from the FP rules but is not out of compliance with what the applicant stated on the FPA.
- The conditions on the ground are in compliance with the FP rules but not with the FPA. For example, an applicant states on the FPA that they are going to leave an RMZ along the entire 1000-foot length of the Np stream in the harvest area, but upon completion of harvest only left a buffer along 700 feet of the stream length. The 700-foot RMZ buffer is still in compliance with the FP rules because the FP rules do not require the entire length of an Np stream to be buffered. However, the 700 feet is not in compliance with what the applicant stated would be done on the FPA.
- The conditions on the ground deviate from both the FP rules and the FPA.

The intent of the CMP is to determine on-the-ground compliance with the forest practices rules or “rule compliance”. However, understanding deviation from the FPA or “FPA compliance” can help the FP Program determine whether improvements should be made in application forms, application instructions, landowner outreach, or education. Information regarding both types of deviation helps to advise the efforts of the FP program to improve compliance with the FP rules.

Compliance Monitoring Scope Limitations: Compliance monitoring is limited by mandate (WAC 222-08-160(4)), budget, and staffing, resulting in a focused program with a well-defined scope. Compliance monitoring does not:

- Focus on individual landowners and compliance specific to those landowners, but rather focuses on the two overall groups of small and large forest landowners;
- Conduct follow-up on FP rule violations – When field reviewers encounter rule violations, the appropriate DNR regional staff is notified; or
- Modify water types – Field reviewers do, however, record observed differences between water type documentation on FPAs and on-the-ground physical features. See Section 3.1.

1.3 Forest Practices Rules Observed by Compliance Monitoring

FP rules provide protection for many riparian and upland species and their forest habitat as well as protection for water quality. Compliance monitoring to date has focused on rules that protect aquatic and riparian species habitat including:

- Riparian buffers,
- Wetland protection,
- Water typing,
- Road construction and abandonment, and
- Haul routes.

The CMP prioritizes rule sampling based on [public resource protection](#). Budget and staffing preclude the ability to monitor all FP rules that might affect aquatic, riparian, and-or upland habitat with statistical precision. The CMP performed both Standard Samples and one Emphasis Sample in the 2012-2013 field seasons.

Standard Sample:

The Standard Sample is performed annually. It includes specific FP prescription types that occur with high frequency and are suitable to be analyzed on a biennial basis. The Standard Sample includes:

- Water typing: (WACs 222-16-031, 222-16-035)
- Riparian rules: Western Washington and eastern Washington riparian management zone rules ([WACs 222-30-021](#) and [-022](#),
- Road construction and abandonment rules ([WAC 222-24](#)),
- Wetland rules: ([WAC 222-30-020\(7\)](#);(8),(9) and WAC [222-24-015](#)), and
- Haul Routes ([WAC 222-24](#)) for sediment delivery.

Emphasis Sample:

Other FP rule groups are sampled in Emphasis Samples either because the prescription occurs infrequently and several years are necessary to get a large enough sample or more data is desired of a particular prescription. Emphasis Samples are performed as needed and budgets and staffing allow. The smaller population size usually leads to the CMP sampling a higher proportion of the total Emphasis Sample population than is sampled in Standard Samples.

There is one Emphasis Sample for the 2012-2013 reporting period – Riparian management zones (RMZ) for exempt 20-acre parcels ([WAC 222-30-023](#)).

2. Compliance Monitoring Design and Methodology



The compliance monitoring design was developed to be a consistent and repeatable field-based method to determine if forest practices are conducted in compliance with FP rules. Compliance monitoring design details are found in the document [Washington State Department of Natural Resources Forest Practices Compliance Monitoring Program design and Compliance Monitoring Protocols](#). Section 2.0 explains key design and methodology concepts used in the forest practices compliance monitoring program.

2.1 Population and Sample Selection

The population designated for sampling consists of completed forest practices activities from approved FPAs. Each application contains all of the forest practices activities the applicant intends to implement. This information allows the compliance monitoring field team to locate FPAs that list the particular FP rule prescriptions being sampled that year. The list of FPAs that contain the prescriptions being monitored that year constitutes the pool from which sample selections are drawn.

Landowner population groups

CMP reports provide riparian and road compliance findings separately for small forest landowners and industrial landowners in addition to the findings for all landowners combined. To date, sample sizes for small forest landowners have been too small to achieve sufficient

statistical precision for conclusions regarding small forest landowners as a separate landowner group. It is a goal of the CMP to eventually obtain sufficient data to draw conclusions for industrial landowners and small forest landowners separately, but sample size, budget and staffing currently preclude the ability to do so.

Sample Selection

There are thousands of active (not yet expired) FPAs every year because FPAs have multi-year life spans that vary. (There were approximately 10,000 active FPAs in fiscal year 2012). To ensure that all active FPAs have an opportunity to be selected, the CMP determines the population to be FPAs expiring between April 1 of the year the field work is taking place and March 31 of the following year. For the 2012-2013 sample this included 8,109 FPA’s (including FP notifications – see Glossary). Using the April 1 to March 31 window improves the likelihood that the forest practices operations are complete prior to the primary compliance monitoring sampling months, February through November. The CMP only samples FPAs where harvest and road activities have been completed.

FPAs from the sampling population are assigned a random number as a decimal fraction between 0 and 1, and then placed in numeric order to ensure randomness. The ordered FPAs are reviewed to determine which, if any, of the sample FP rule prescription types being sampled that year occur in each FPA. This selection process continues through the ordered list of FPAs until the target sample size is reached for each prescription type.

Standard Sample FP rule prescriptions monitored annually are shown in Table 1.

Table 1: Standard Sample Prescriptions Monitored in 2012-2013

	Sampled Statewide	W. WA only¹	E. WA only
Roads	Road Construction and Abandonment		
	Haul Route		
Harvest	RMZ -Type Ns Prescriptions		
	RMZ -Type Np Prescriptions		
	Wetlands	RMZ -Type F or S Inner Zone Harvest (DFC Option 1)	RMZ -Type F or S Inner Zone Harvest²
	RMZ – Type F or S No Outer Zone Harvest	RMZ -Type F or S Inner Zone Harvest (DFC Option 2)	
	RMZ – Type F or S No Inner Zone Harvest		

¹ Though The DFC options are available for high elevation forest types in eastern Washington, none have been encountered by CMP during the life of the program.

² No eastern Washington Inner Zone Harvest FPAs were found to have completed operations, so none were reviewed by CMP.

Emphasis Sample: FP rule prescriptions during the 2012 season were limited to Riparian Management Zones for exempt 20-acre parcels.

Sample Size and Confidence Values

Standard sample: The Standard Sample uses a conventional significance level of 95%. Associated with the 95% significance level, the CMP set a desired margin of error or confidence interval (CI) to be 12%. These choices reflect the program's intent to obtain the highest level of confidence that could be obtained within the timeframe allocated to the CMP. A 95% CI of width means that if we repeated the sample 20 times we would expect the population mean (the "true" compliance rate) to lie within the confidence interval 19 out of 20 times.

The CMP sets the sample size to provide an approximate +/- 12% margin of error at the 95% confidence level for the compliance rate of each prescription type for the biennium. This sample size is an estimate based on assuming the current compliance rate is similar to historical values. Because the population of FPAs in any given year is finite, the size of the population impacts the variance of compliance rates, and, by extension, the margin of error and the estimated sample sizes. Thus, infrequently occurring prescriptions need fewer samples to attain the desired precision levels. Estimated population sizes for each prescription are used in the sample size estimation to determine a "Finite Population Correction Factor". This means a smaller sample is required than would be required for an infinite population. See Appendix A for more information.

Standard Sample estimated population and sample sizes for each prescription type in 2012-2013 are shown in Table 2. Population sizes for each prescription type are estimated based on the proportion of the entire population viewed to reach the desired sample size.

Total population sizes for prescription types are estimated because it would consume more time than available for staff to review each of the 8,109 FPAs to find the exact population count for each prescription type. See Appendix A for more information.

Table 2: 2012-2013 Standard Sample Count by Prescription Type

Geographic Region	Prescription Type	Sample Count	Estimated Population of FPA s with the Prescription
Statewide	Road Construction and Abandonment	36	2049
	Haul Route	48	NA
	RMZ – Type Ns Prescriptions	25	1932
	RMZ – Type Np Prescriptions	32	1908
	Type A Wetlands	20	215
	Type B Wetlands	17	296
	Forested Wetlands	17	593
Western Washington	RMZ – Type F or S No Outer Zone Harvest	32	210
	RMZ – Type F or S No Inner Zone Harvest	58	753
	RMZ – Type F or S Desired Future Condition Option 1	33	140
	RMZ – Type F or S Desired Future Condition Option 2	48	369
Eastern Washington	RMZ – Type F or S No Outer Zone Harvest	14	75
	RMZ – Type F or S No Inner Zone Harvest	34	186

Table 2 shows the count of samples by prescription type during the 2012-2013 field seasons.

Emphasis Sample

The 2012 Emphasis Sample monitored exempt 20-acre parcel RMZs with a focus on harvest adjacent to Type F and Type Np waters. This is the second time since the initiation of the CMP that exempt 20-acre parcel RMZs have been in an emphasis sample. The first sampling was in 2007-2008. As mentioned previously, sampling designs for Emphasis Samples are different than designs for Standard Samples because the overall population size for an Emphasis Sample is far smaller.

Initially, the CMP made two decisions regarding sampling for exempt 20-acre parcel RMZs: first, to draw from the population of FPAs approved from June 2011 through June 2012, and second, to match the same sample size (45 samples) that was used in the 2008 RMZ exempt 20-acre parcel sample.

The beginning sample period of June 2011 was chosen to coincide with the start date of new FPA processing guidance which asked applicants to notify the DNR office within 48 hours prior to starting work on their RMZ exempt 20-acre exempt parcels.

The actual sample size for the Emphasis Sample was less than the original goal of 45. DNR receives, on average approximately 102 FPAs (2.2% of total FPAs submitted) associated with RMZ exempt 20-acre parcels per year, but the available population for 2012 began with 70 FPAs. The intent was to randomly select a sample of 45 from the 70 FPAs. However, upon examination only 28 of the 70 FPAs had completed their harvest activities. The CMP chose to do a census of all 28 of the completed RMZ exempt 20-acre parcel samples for the period. Since a census is not a sample, the compliance rate reflects the entire population. It has no confidence interval.

2.2 Field Review and Data Collection

The compliance monitoring field team uses two primary data collection methods, field observations and field measurements, to determine whether the applicant met the requirements of the forest practices rules while implementing forest practices activities. Field observations are recorded, providing answers to the questions asked on CMP [field forms](#). Specific measurements are taken to determine attributes such as tree-stump counts, RMZ length, RMZ width, and bankfull width. Examples of types of field observations and field measurements follow.

Riparian Harvest

- Observations:
 - Presence of alluvial fans, headwall seeps and springs
 - Location of uppermost point of perennial flow
 - Presence of unstable slopes

- Measurements:
 - Bankfull width (BFW) – Bankfull width is measured for Type S, F, and Np waters except streams that obviously exceed or fall below threshold width (i.e., under or over 10 feet in western Washington; under or over 15 feet in eastern Washington). The BFW is measured (using a tape measure) at even intervals along the stream reach within the boundaries of the FPA. The goal is to obtain a minimum of ten measurements. If the reach is 300 feet or less, a measurement interval of 25 feet is typically used.
 - Stream length – Stream length is measured using a hip chain. The length is used to determine the intervals for BFW measurements and RMZ width measurements. It is not used to establish RMZ area.
 - RMZ and wetland management zone (WMZ) width – RMZ width (and the three zones within the RMZ) and WMZ widths are measured using a laser hypsometer to ensure accurate horizontal distances. Laser hypsometers used in conjunction with reflectors are used to ensure measurement precision. RMZ and WMZ zone widths are marked with ribbon for visual reference.

Road Construction and Abandonment and Haul Route Assessment

The assessment of road construction and abandonment is based on answering a series of questions found on the CMP [Road field form](#). The questions address observed site conditions based on the required management practices in FP rule (WAC [222-24-010](#), [020](#), [030](#), and [040](#)). The assessment of haul routes is based on fulfillment of road rule requirements and professional judgment from CMP participants used to rate sediment delivery levels resulting from each haul route.

2.3 Compliance Assessment and Ratings

The compliance monitoring field team makes four determinations regarding each sample in a prescription type. The first determination is whether the sample is compliant or has a deviation from an FP rule. The second determination is the level of compliance or deviation which is referred to as a “rating”. The third and fourth determinations are whether it deviated from the conditions of the FPA and the rating of the deviation if one occurred.

Compliant/Deviation Determination:

The purpose of this section is to provide the reader with a more comprehensive understanding of compliance with the FP rules across the landscape and how that compliance is measured and reported by the CMP. Compliance percentages in CMP reports don’t represent a complete picture of compliance with the rules because there are varying levels of compliance that are difficult to summarize in a quantitative way. To recognize this, beginning with this report, the terminology used to describe compliance has changed.

Past CMP reports, described prescriptions as “Compliant” or “Non-compliant.” Beginning with the 2012 report, prescriptions are considered as “Compliant” or a “Deviation” from the rules. Estimation for the “Compliant” category is the same as in past CMP reports. The “Non-compliant” category has been relabeled to more accurately acknowledge that while a prescription implementation may deviate from one or more FP rules, compliance may be fully achieved on other FP rules that comprise the prescription. Section 1.2 explains that prescriptions are a grouping of FP rules. These rule groupings are used by the CMP for the purposes of estimating compliance. The following example illustrates this concept.

The DFC Option 2 (Leaving Trees Closest to the Water) prescription is not a single FP rule but rather a grouping of several rules, some of which are [listed](#) below:

- Core zone – “No timber harvest or construction is allowed in the core zone”,
- Inner zone – “Forest practices in the inner zone must be conducted in such a way as to meet or exceed stand requirements” (see Glossary),
- Inner zone – “Harvest is not permitted within 30 feet of the core zone for streams less than or equal to ten feet wide”,
- Inner zone – “Trees are selected for harvest starting from the outer most portion of the inner zone first”,
- Outer zone – “Timber harvest in the outer zone must leave twenty riparian leave trees per acre”,
- Outer zone – “Dispersal strategy-riparian leave trees, which means conifer species with a diameter measured at breast height (DBH) of twelve inches or greater, must be retained and dispersed evenly throughout the outer zone.”

These six rules are only a few of the FP rules that are part of the “DFC Option 2” prescription type. This report identifies compliance as a percent. The number refers to the sampled FPAs that are compliant with every FP rule included in the DFC Option 2 prescription type. The corresponding “Deviation” category includes any FPAs that deviated from at least one of the FP rules included in the prescription type.

It is important for the reader to keep in mind that the compliance percentages only represent the number of prescription samples that showed compliance with every FP rule in the prescription type. It does not represent the total compliance of all the relevant FP rules (with the exception of the haul route prescription type).

The program so far had not found a way to statistically combine all the separate rules which constitute compliance into a quantitative compliance statistic for a single application of a prescription (Option 1 above).

Nonetheless, it may be important for decision makers to understand the meaning and severity of deviation from FP rules. To aid in this understanding, compliant and deviation assessments are assigned a compliance rating. Compliant prescriptions are rated as those that are “compliant” and those that “exceed rule requirements”. Prescriptions that deviate from the FP rules are rated as “minor,” “moderate” or “major” or are called “indeterminate” when the compliance monitoring field team cannot determine how to rate the deviation. These ratings help the reader understand the severity of the deviations from FP rules.

Compliance Ratings Descriptions:

This section describes five compliance ratings that are applied after the compliant/deviation assessment is made. There are three ratings for a deviation assessment including “minor”, “moderate”, or “major”. There is also an “indeterminate” category as part of the deviation assessment. A compliant assessment can be rated “exceeds rule requirements” if extra protections meet a threshold.

Compliant Rating Determinations:

Compliant means that an FPA meets all relevant FP rule requirements in the prescription group and/or what was stated on the approved FPA. By signing and submitting an FPA, an applicant is conveying the intention to conduct specific forest practices activities on lands with specific site characteristics as described on the FPA. The applicant’s signature on the FPA is the acknowledgement that the applicant understands that FP activities must comply with the FP Act and rules.

- **Compliant Rating:**
The prescription type is completely compliant with all of the FP rules assessed for that particular prescription.
- **Exceeds Rule Requirement Rating:**
Applicants sometimes choose to provide more protection than is required in the FP rules while implementing their forest practices activities. The applicant often provides additional ecological function and protection for public resources. CMP acknowledges

those additional protection measures taken by the applicant. Currently the compliant rating of “Exceeds rule requirements” is limited to the following:

- For Type S or F Waters: Twice as many trees in the RMZ inner and outer zones were retained as were required by rule. For No Inner Zone Harvest this would be twice as many Outer Zone trees only.
- Type S, F, or Np Waters: RMZ width is consistently 20% wider than required by rule.
- Type Np Waters: No cut RMZ length is at least 20% longer or wider than required by rule.
- Road improvements were more protective than required by rule (i.e., 24-inch cross drains instead of 18-inch; paving portions of road; etc.).
- Road abandonment activities (i.e., mulching, distribution of trees and woody debris along road prism to deter off-road vehicle travel) were more protective than required by rule.

Deviation Rating Determinations:

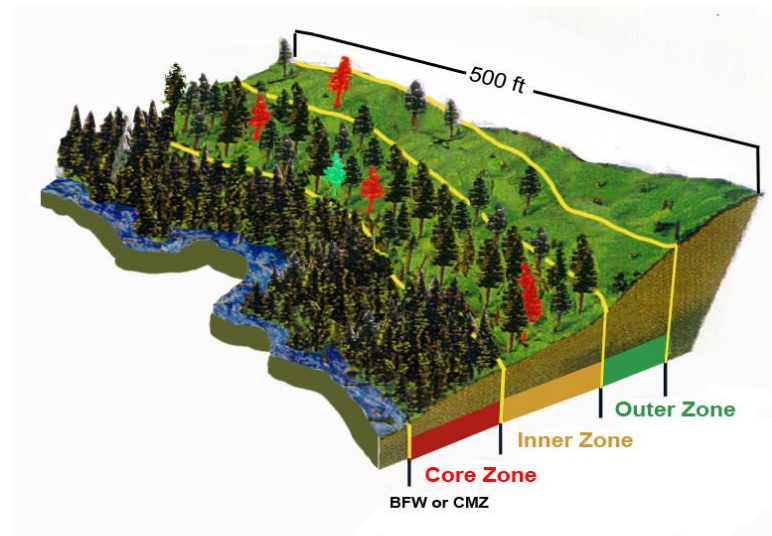
Deviation means that a prescription implementation does not meet at least one FP rule within the prescription type and/or what was stated on the approved FPA. Severity of the deviation provides a sense of where DNR might focus training efforts to improve compliance. The compliance monitoring field team uses professional judgment to rate noncompliant activities. There are three severity rating categories: minor, moderate, and major as well as an indeterminate call. The following guidelines are examples used to assist professional judgment when rating the magnitude of deviation in the field:

- Minor Deviation –Examples include:
 - A few trees harvested in the inner or outer zone of the RMZ of the same species and equal or lesser diameter as the remaining trees in the RMZ.
 - Evidence of slight sediment delivery that does not appear to be persistent.
- Moderate Deviation –Examples include:
 - The required outer zone trees are not retained.
 - More than a few required leave trees have been harvested from a no harvest inner zone.
 - Soil stabilization has not occurred on road cuts, fills or water crossings and there is potential for sediment delivery above background levels to typed water.
- Major Deviation –Examples include:
 - Significant harvest of the required leave trees in the inner zone.
 - Harvest in areas not delineated on the FPA.
 - Evidence of direct sediment delivery to typed water.
- Indeterminate – The prescription is out of compliance but the compliance monitoring field team cannot determine the level of non-compliance.

The following examples of deviation from FP rules illustrate that there is a level of compliance for many of the rules included in a prescription type even when they are assessed as “Deviation” and shows the process of assigning ratings to the deviation.

Figure 1 illustrates a DFC 1 riparian harvest using average data from the fifteen 2012-2013 samples of Type S and F waters assessed as a deviation rated as minor. A riparian zone harvest is subject to a number of complex FP rules. The following two scenarios illustrate the applicant followed multiple FP rules by typing the stream accurately and measuring the stream width correctly; correctly measuring the core, inner, and outer zone widths; correctly assessing the number of surplus trees according to the desired future condition (DFC) modeling; and leaving the core zone intact. Figure 1 – Inner Zone Harvest with Deviation rated as Minor (Scenario 1)

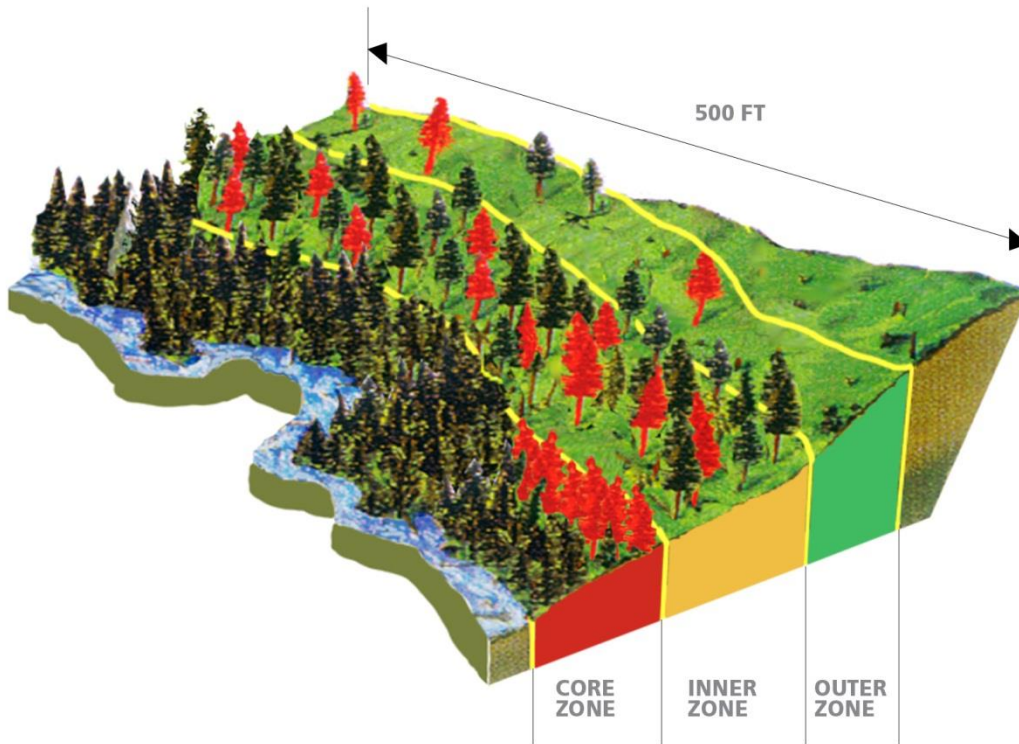
Figure 1



The red trees in Figure 1 represent trees which were required by rule to be left but were harvested. The figure shows one additional tree per 500 feet was taken out of the outer zone and three trees too many were harvested from the inner zone. The lime green tree represents an additional tree left in the inner zone.

Figure 2 uses average data from the two 2012 samples assessed as a deviation rated as major on fish bearing waters. In contrast, this scenario illustrates an example of inner zone harvest assessed as a major deviation. The applicant planned a riparian zone harvest and followed all of the same forest practices rules as noted in scenario 1, except that harvest rules were not followed completely in any of the three zones. Core zone trees, inner zone trees and outer zone trees were harvested that were required to be left.

Figure 2 – Inner Zone Harvest with Deviation rated as Major



In Figure 2, 11 trees are missing per 500 feet of Inner Zone and three trees are missing per 500 feet of outer zone. Additionally some harvest occurs in the core zone.

Of the two examples above, the scenario illustrated in Figure 2 with deviation rated as major is a more severe deviation from the rules. The scenario illustrated in Figure 1 with deviation rated as minor has much less probability of a measurable impact on riparian functions.

2.4 Design and Methodology Changes

Section 2.4 discusses changes made to compliance monitoring sampling design or methodologies. Changes occur when CMP participants discover ways to improve the system.

Sample Strategy in 2012-2013: The program made significant changes in the 2012 sample design to increase confidence in statistical estimates of each prescription type observed.

From 2006 through 2011 the Standard Sample design was based on random selection of FPAs stratified by each region's FPA population in proportion to the statewide population. One instance of each prescription type occurring on the FPA was observed. This strategy allowed combining statistics across prescription types so overall compliance rates for FP rules could be reported. This was initially considered important but the strategy had challenges. For example:

- A combined statistic can cause confusion because compliance monitoring does not sample all forest practices rules, as explained in Section 2.3 above. A reader might

incorrectly believe that the one combined statistic represented the compliance rate for all FP rules.

- The strategy also caused problems with sample sizes among prescription types. For example, more common prescriptions had larger sample sizes of approximately 70 while less common prescriptions had fewer than 10 samples. The confidence intervals of the means of the least used prescription type were very wide (which results in a lower confidence in the statistic) and the small sample sizes provided little information about the cause of the non-compliance.

A decision was made in 2011 to change the selection design to randomly select instances of each sampled prescription type occurring in the population. An estimated sample size is calculated for each prescription type which meets a desired confidence interval for a biennium sample. This change in selection design allows for both a higher statistical confidence in results and provides a larger information set to help determine causes for deviation from FP rules.

Drawbacks to the new selection design included significantly more time required for up-front preparation in the sample selection process and the need for the compliance monitoring field team to visit 1.5 to 2 times more FPAs to obtain enough samples to produce statistically precise data. A time savings offset to the increased workload was anticipated due to having fewer prescriptions to observe on each FPA. Staff capacity to handle the increased workload was considered possible because recent improvements to the compliance monitoring data entry and database management processes, and additional participation by region staff.

Operationally the offsets were not realized. The program was reviewed and resulted in design changes for the next biennium. The changes are presented in the discussion section.

Overall the change in selection design is viewed by the CMP as an improvement. It allows future flexibility to add or remove different prescription types from the sample as needed while still providing the desired confidence intervals for each prescription type. The effectiveness of this approach is presented in the discussion section (Section 6).

2.5 Compliance Monitoring Challenges

Challenges are not uncommon for any complex assessment program. This section reviews current challenges for the CMP.

Representation of Complete Compliance:

Accurately representing the complete picture of compliance has proven to be difficult. While prescription types have many different FP rules directing them, the program so far has not found a way to statistically combine all the separate rules which constitute compliance into a quantitative compliance statistic for a single application of a prescription. This also means a meaningful average percent compliant for a prescription cannot be provided. The CMP continues to work toward finding better ways to report a more complete picture of compliance.

Sample and Measurement error:

Sampling error occurs when rule or board manual guidance specifies that average values are used during the layout of a specific prescription type. Averages vary depending on where

measurements are taken. It is unlikely that the compliance monitoring field team can duplicate the exact same ten measurements made along a stream reach for calculating stream width as were measured by an applicant, unless the applicant marked these locations in the field. The result is that the compliance monitoring field team's average stream width value is likely different from the applicant's average stream width value. Statistical analysis techniques, such as a variability study to determine error tolerances have not yet been pursued by CMP to help determine if an applicant's average measurement, that is slightly different from the compliance monitoring field team's average measurement, is considered the same or not (statistically speaking "significantly different"). The CMP resolves the inability to determine statistical variability on average values by assigning an absolute 5% measurement error tolerance. This measurement error tolerance applies for only two specific measurements:

- Stream width threshold (for a western Washington Type F stream, it is 10 feet, so the allowed mean width is 10.5 feet or less to be accepted as a small stream), or,
- Buffer widths or floors within no-harvest RMZ areas. Harvested trees occurring inside 5% of the zone width are given tolerance and considered compliant.

Variation in Natural Conditions:

Natural systems such as forests are highly variable and difficult to measure with precision. Forest Practices rules necessitate precise measurements to implement forest practices activities.

Applying precise measurements becomes difficult for forest practice activity implementation as well as for FPA compliance and compliance monitoring. Precise measurements in the FP rules are confounded by variable site conditions; the CMP follows the most protective interpretation of the FP rules to determine compliance.

A frequent example of precise FP rules conflicting with imprecise on-site conditions occurs when a stream reach has FP rule-defined characteristics of both a Type Np stream and a Type F stream. Type Np streams are considered to be streams over 20% gradient that have a perennial flow and Type F streams that are defined as having a gradient equal to or less than 20%. Often, sections of stream reaches have gradients that are over 20% and sections less than 20%. When the compliance monitoring field team finds a stream reach that has a general gradient under 20% but also has small sections that are greater than 20%, the compliance monitoring field team considers the stream a Type F stream.

3. Forest Practices Rule Compliance for Water Types, and Riparian, Wetland, and Equipment Limitation Zones



Forest Practices rules are designed to protect aquatic resources and related habitat adjacent to typed waters and wetlands when forest practices activities are proposed. Riparian and wetland areas provide fish, amphibian, and wildlife habitat and protect water quality. A riparian management zone (RMZ) is the area that is adjacent to Types S, F or Np streams (see water types below) where trees are left unharvested to provide functions for aquatic and riparian species. A wetland management zone (WMZ) is the area located around the perimeter of a wetland where trees are left to provide shade and nutrients for the wetlands. Both RMZ and WMZ buffers filter runoff to minimize sediment entering water; provide long-term large woody debris recruitment and organic material crucial for fish and amphibian habitat; maintain shade to help regulate stream temperatures; and provide amphibian and wildlife habitat. Protection on Type Np and Ns streams also include an equipment limitation zone (ELZ). This is a 30-foot-wide zone adjacent to Type Np and Ns streams. There are limitations on equipment use within the zone and on-site mitigation measures are required if activities expose the soil on more than 10% of the zone.

FP rule timber harvest options within RMZs depend upon the water type (Type S, F, Np, Ns), width of the stream (bankfull width), and the site class (I, II, III, IV, V) of the RMZ. Wetland protection depends upon the type and size of the wetland.

Section 3.0 provides FP rule and on-site review descriptions, and compliance monitoring findings for:

The Standard Sample:

- Statewide water type observations,
- Western Washington RMZ,
- Eastern Washington RMZ, and
- Statewide wetlands.

And the Emphasis Sample which includes:

- RMZs for exempt 20-acre parcels.

3.1 Statewide Water Type Observations

In the initial years of compliance monitoring, compliance monitoring field team observations indicated that at times water types observed on-the-ground did not match water type classifications provided on submitted and approved FPAs. This led to a concern regarding consistency and accuracy of water type information on FPAs because the width and length of riparian buffers required under FP rules are directly linked to water type. In the FP rules, water is classified in specific stream and wetland categories or “types” based on several factors ([WAC 222-16-030](#), [031](#), [035](#)). Stream and wetland type classification is a fundamental aspect of determining which FP rules apply to forest management activities taking place adjacent to typed water. Specific FP rules apply to specific water types because different water types fulfill unique and cumulative functions for aquatic and riparian species and water quality. Waters of the state were initially classified by type using local knowledge and ortho-photos and represented on a set of water type maps. Currently, the public can find information about the water type assigned to a particular stream on the FPARS Mapping Site: <http://fortress.wa.gov-dnr-app1-fpars-index.htm> or on the Forest Practices site: http://www.dnr.wa.gov/BusinessPermits-Topics-ForestPracticesApplications-Pages-fp_watertyping.aspx. Because waters depicted on DNR water type maps were originally typed without a field visit, the maps can display incorrect water types and must be field verified prior to FPA approval.

FP Rules for Water Type

Forest Practices water typing rules define four types of streams (S, F, Np, and Ns) and three types of wetlands (forested, non-forested Type A, and non-forested Type B). In addition, wetlands with Type F streams flowing through them are considered Type F waters. The four types of streams are classified in a hierarchical manner based on stream function and level of protection required for the stream. Following are the stream types in hierarchical order starting with the highest level (requiring the most protection).

- Type S streams are at the highest level of classification and are considered fish bearing streams that are shorelines of the state as designated by the Washington Department of Ecology.

- Type F streams are the second highest level of classification and either have fish, presumed to have fish or specifically defined human uses or both.
- Type Np streams fall next in the stream hierarchy. These are non-fish bearing streams that have a perennial flow of water during a normal rainfall year. This includes intermittent dry portions of the perennial channel.
- Type Ns streams are the lowest level of classification for streams. These are seasonal non-fish bearing streams where surface flow is not present year round.

Wetlands are classified into two broad categories: forested and non-forested. Non-forested are further divided into Type A and Type B wetlands.

- Forested wetlands – Wetlands that have a 30% or more crown closure (see Glossary).
- Non-forested wetlands – Wetlands that have a less than 30% crown closure.
 - Type A wetlands – Are greater than 0.5 acre in size and are associated with at least 0.5 acre of ponded or standing open water present for at least 7 consecutive days between April 1 and October 1.
 - Type B wetlands – All other non-forested wetlands greater than 0.25 acre.

On-site Review for Water Types Statewide

Field observations sometimes indicate that water types depicted on water type maps are incorrect. Applicants may use existing DNR water type maps as a starting point for information; however, as they prepare their FPA for submittal applicants must verify water types located within the areas proposed for forest management activities and indicate the correct water types on the FPA and FPA map. Correct and accurate water typing is critical. When water is typed incorrectly, inadequate riparian protection measures may be applied which may ultimately impact public resources. Water type verification occurs through measurement of the water's physical characteristics as defined in [WAC 222-16-031](#) and [035](#), or through a protocol (fish) survey (to confirm fish presence/absence) as specified in [Forest Practices Board Manual 13](#). Applicants are encouraged but not required to complete water type classification worksheets, protocol surveys, or submit supporting documentation for the water types indicated on the FPA.

Changes to DNR water type maps can be made when data from field observations indicate the water type on the water type map is incorrect and/or if a stream is found on the ground in a different location than depicted on the map or not at all. To propose a permanent water type change from the water type indicated on the DNR water type map, an individual submits a [Water Type Modification Form](#) to DNR. The Water Type Modification Form goes through a concurrence review process which provides opportunity for evaluation by several stakeholder groups.

The compliance monitoring field team observes physical criteria (such as stream width, stream gradient, etc.) to determine if there are differences between water types recorded on FPAs and what is observed on-the-ground. These observations are made on randomly selected stream reaches and wetlands within the FPA areas that have been previously randomly selected for compliance monitoring for other rules that year. The reader should note that this water-type review applies different methods for water typing than are reflected in the Board Manual or rules, so we are not specifically conducting stream-typing compliance monitoring. Operationally, the information obtained by stream-typing professionals and landowners should include off-site

conditions, such as presence of downstream barriers, but the CMP remains within the footprint of the FPA, artificially narrowing the scope of this review. The compliance monitoring field team evaluates only the stream reach or wetland within the proposed boundary shown on the FPA, and therefore, the information is not sufficiently comprehensive to determine all water types depending on the length and location of the water within the FPA. Water types can sometimes only be determined by continuing to observe and measure beyond the unit boundary.

The CMP developed a form called the Supplemental Water Information Form (SWIF) that is used specifically for the purpose of recording potential water type discrepancies and other water related discrepancies observed during CMP field work. When potential inconsistencies are found by the compliance monitoring field team between on-the-ground measurements and observations and what is described in the FPA, a SWIF is completed and the information is reported in the compliance monitoring report. If an FP rule violation occurred because of the water type inaccuracy observed (i.e., the water did not receive enough riparian protection – buffer width and length), the FPA information is sent to the appropriate DNR region for follow up. The intent of using SWIFs is to obtain a sense of the overall magnitude of possible water typing discrepancies on the landscape and the incorrect application of riparian buffers designed to protect aquatic resources. The compliance monitoring field team does not engage in formal water typing (i.e., fish-presence protocol surveys paired with identification of downstream barriers, or measuring bankfull width, stream gradient, basin area, and identifying natural barriers) with the intent of changing water types because that action has a defined process beyond the scope of the compliance review. The burden is on the applicant to ensure that the water types on the FPA have in fact been field validated.

Findings for Water Types Statewide

Table 3 provides the total number of specific water types observed by the compliance monitoring field team and the number of those that were reported on a SWIF. Those recorded on a SWIF are further broken down into: waters correctly classified, under classified (should have a higher classification), over-classified (should have a lower classification) and indeterminate. The categories are defined as follows:

- SWIF # Waters Correctly Classified – These are waters that were placed on a SWIF because it was thought they might be classified incorrectly, however, it was found that the waters had been classified correctly on the FPA.
- Under-classified – Physical characteristics indicate that the water should have been typed on the FPA and protected on the ground at a higher level of the hierarchical water typing continuum. For example, the FPA depicts Type Np water on the FPA that is found to have Type F physical characteristics or observed fish.
- Over-classified – Physical characteristics indicate that the water should have been typed on the FPA and could have been protected on the ground at a lower level of the hierarchical water typing continuum. For example, the FPA depicts a Type F water that is found to be a Type Np water.
- Classified indeterminate – Waters where the compliance monitoring field team does not have enough information to make a water typing determination. For example, when the compliance monitoring field team visits a site in the wettest part of the year (winter) and cannot determine if the water would flow in the driest part of the year (summer). The

compliance monitoring field team cannot determine with certainty if the water is a type Np (perennial) or Ns (seasonal).

Table 3: Water Typing Observation Information for the 2012-2013 biennium

Water Type on FPA	# Waters in Standard Sample	Supplemental Water Information				
		# Waters Recorded on SWIF (had indications of misclassification)	# Waters Correctly Classified	# Waters Under-Classified	# Waters Over-Classified	# Waters Indeterminate
Ns	27	3	0	1	2	0
Np	32	8	2	4	1	1
F or S ³	173	13	2	3	8	0
Type A	20	6	0	3	3	0
Type B	18	3	1	0	0	2
Forested Wetland	17	0	0	0	0	0
Not Mapped or Type "N" on Hydro data and mapped streams crossed out on the FPA map	0 ⁴	4	2 ⁵	1	0	1
Total	288	37	7	12	14	4

During 2012-2013, the Compliance Monitoring Program evaluated 288 riparian related prescriptions involving typed water or wetlands. The number of typed waters or wetlands where the compliance monitoring field team found discrepancies was 37 or 12.8% of the total observed. These 37 were reported on SWIFs. The total number of typed waters on FPAs that were under-

³ Type F or S classification refers to whether the stream is in the large or small width category which determines RMZ width.

⁴ These features are discovered in the course of review and not part of the standard sample.

⁵ The features are considered correct when the CMP observation confirms the information on the FPA such as a stream crossed out the map that is observed not to be present.

classified was 12, (4.2%) while the number that was over-classified was 14, (4.9%). Of the 288 waters and wetlands observed statewide 94% were correctly classified or were over classified (erring in the direction of more resource protection). The next compliance monitoring report will provide analysis comparing SWIF observations across several years.

Type Np streams were under-classified for 12.5% of the Type Np sample due to the presence of Type F physical characteristics while 1 Np stream (3.7%) was over classified due to being seasonal and disconnected from a higher typed water. Type A wetlands were under-classified three times (25% of the sample).

Type F waters are classified as either small or large based on a bankfull width threshold. The threshold is ten feet for western Washington and 15 feet for eastern Washington. Required RMZ width varies on whether the stream is large or small. There were 13 Type F waters recorded on the SWIF, 7.5% of all Type F water in the sample, of these, 3 (1.7%) were under-classified, while 8 (4.6%) were over-classified.

The most common cause of over-classification occurred when a stream reach was disconnected (there was no overland flow) from a higher order water (e.g., a rule defined Type Np water ((over-classed as a Type F)) was disconnected from a Type F water).

3.2 Statewide Summary Table for FP Rule Compliance for RMZs, WMZs and ELZs

Section 3.2 provides a summary table (Table 5) showing overall statewide results for compliance with RMZ and WMZ forest practices rules. The data and findings for each individual prescription are discussed in Section 3.3 Western Washington RMZs, Section 3.4 Eastern Washington RMZs, and Section 3.5 Statewide WMZs below.

Table 4 lists the RMZ, WMZ, and equipment limitation zone (ELZ) prescriptions that were monitored during the 2012-2013 compliance sample.

Table 4: RMZ, WMZ and ELZ Prescriptions Sampled in 2012-2013

Western Washington	Eastern Washington ⁶	Statewide
RMZ – No Outer Zone Harvest	RMZ – No Outer Zone Harvest	WMZ –Wetlands
RMZ – No Inner Zone Harvest	RMZ – No Inner Zone Harvest	ELZ – Type Np and Ns
RMZ – Option 1–Thinning from Below	RMZ – Type Np RMZ	Activities
RMZ – Option 2– Leaving Trees Closest to Water		RMZ – 20-acre exempt parcels
RMZ – Type Np RMZ		

⁶ No eastern Washington Inner Zone Harvests were completed in 2012 2013.

Table 5 shows the status of FP rule compliance for RMZ prescriptions for stream types S, F, Np and Ns (including ELZs), as well as for wetlands. Each prescription has a unique set of timber harvest requirements, and includes the use of a corresponding set of protocols and questions to determine compliance status. Forest Practices rule prescriptions for Type F and Np streams are different for eastern and western Washington. Wetland and Type Ns water prescriptions are consistent across the state. The information is separated into three categories; small forest landowner, large forest landowner (industrial), and combined. Figure 3 provides a graph showing rule compliance and 95% confidence bars.

Figure 3 – Rule Compliance Means and Confidence intervals

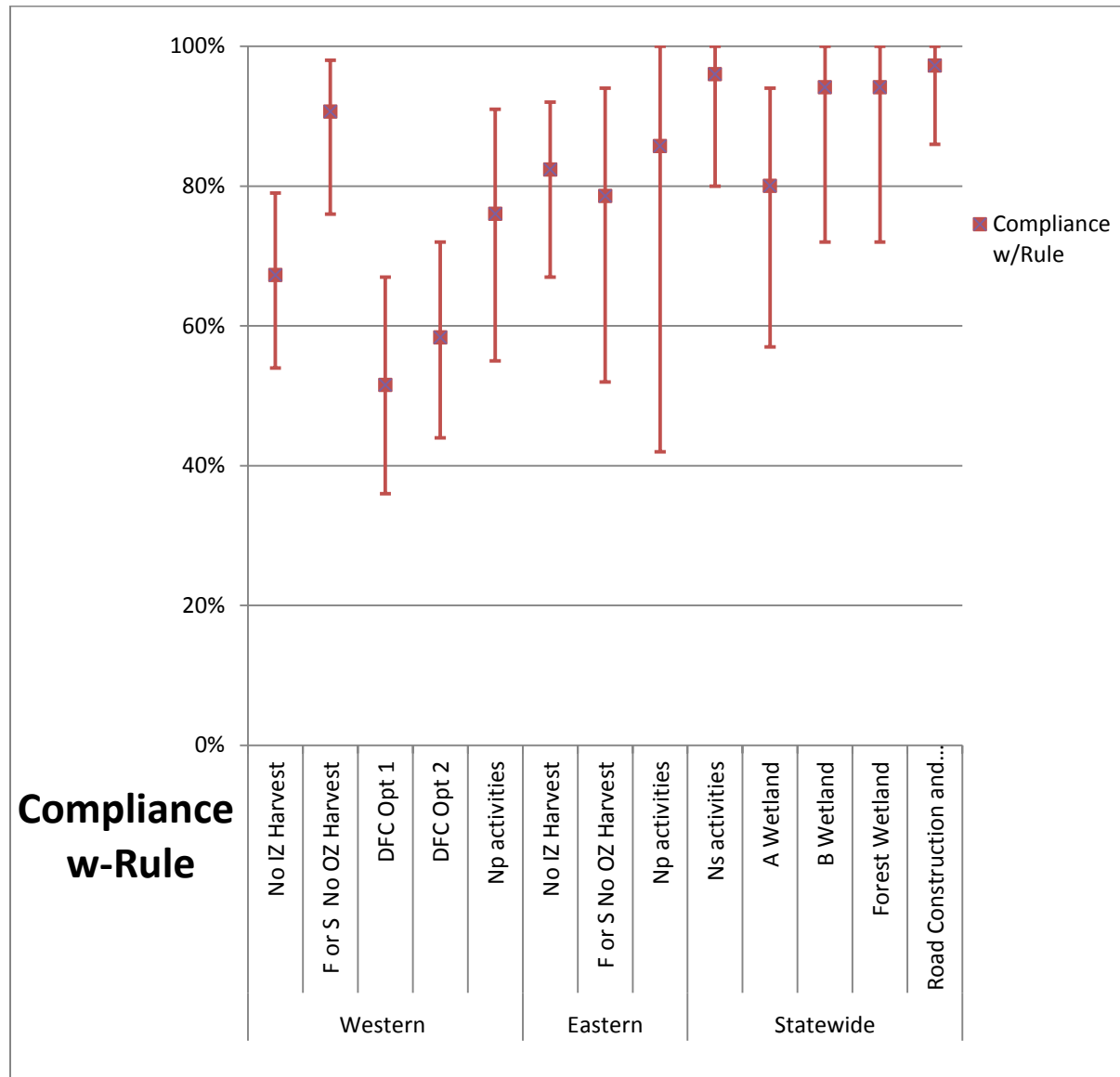


Table 5:2012 -2013 Compliance with Forest Practices Rules for Riparian and Wetland Harvest Prescriptions

Status of Compliance		Western Washington					Eastern Washington				Statewide			
		No Inner Zone Harvest	F or S No Outer Zone Harvest	DFC Option 1	DFC Option 2	Np Activities	No Inner Zone Harvest	F or S No Outer Zone Harvest	F or S Inner Zone Harvest	Np Activities	Ns Activities	Type A Wetland	Type B Wetland	Forested Wetland
Small Forest Landowners	# Compliant	4	9	0	1	1	7	2	0	0	3	6	3	3
	# with Deviation	7	2	0	0	0	1	1	0	0	1	3	1	0
	% of Sample Compliant	36%	82%	n/a	100%	100%	88%	67%	n/a	n/a	75%	67%	75%	100%
	Confidence Interval	(12, 68)	(55, 96)	n/a	n/a	n/a	(53, 99)	(23, 96)	n/a	n/a	(20, 99)	(32, 91)	(21, 99)	(30, 100)
	Assessed	11	11	0	1	1	8	3	0	0	4	9	4	3
Industrial Landowners	# Compliant	35	20	17	27	18	21	9	0	6	21	10	13	13
	# with Deviation	12	1	16	20	6	5	2	0	1	0	1	0	1
	% of Sample Compliant	74%	95%	52%	57%	75%	81%	82%	n/a	86%	100%	91%	100%	93%
	Confidence Interval	(60, 86)	(80, 100)	(38, 65)	(43, 71)	(54, 90)	(64, 92)	(58, 95)	n/a	(43, 100)	(84, 100)	(60, 100)	(76, 100)	(67, 100)
	Assessed	47	21	33	47	24	26	11	0	7	21	11	13	14
All Landowners	# Compliant	39	29	17	28	19	28	11	0	6	24	16	16	16
	# with Deviation	19	3	16	20	6	6	3	0	1	1	4	1	1
	% of Sample Compliant	67%	91%	52%	58%	76%	82%	79%	n/a	86%	96%	80%	94%	94%
	Confidence Interval	(54, 79)	(78, 97)	(38, 65)	(45, 71)	(55, 90)	(68, 92)	(58, 92)	n/a	(43, 100)	(80, 100)	(58, 94)	(72, 100)	(72, 100)
	Assessed	58	32	33	48	25	34	14	0	7	25	20	17	17
Population Size Estimate		753	210	140	369	1454	186	75	0	454	1932	215	296	593

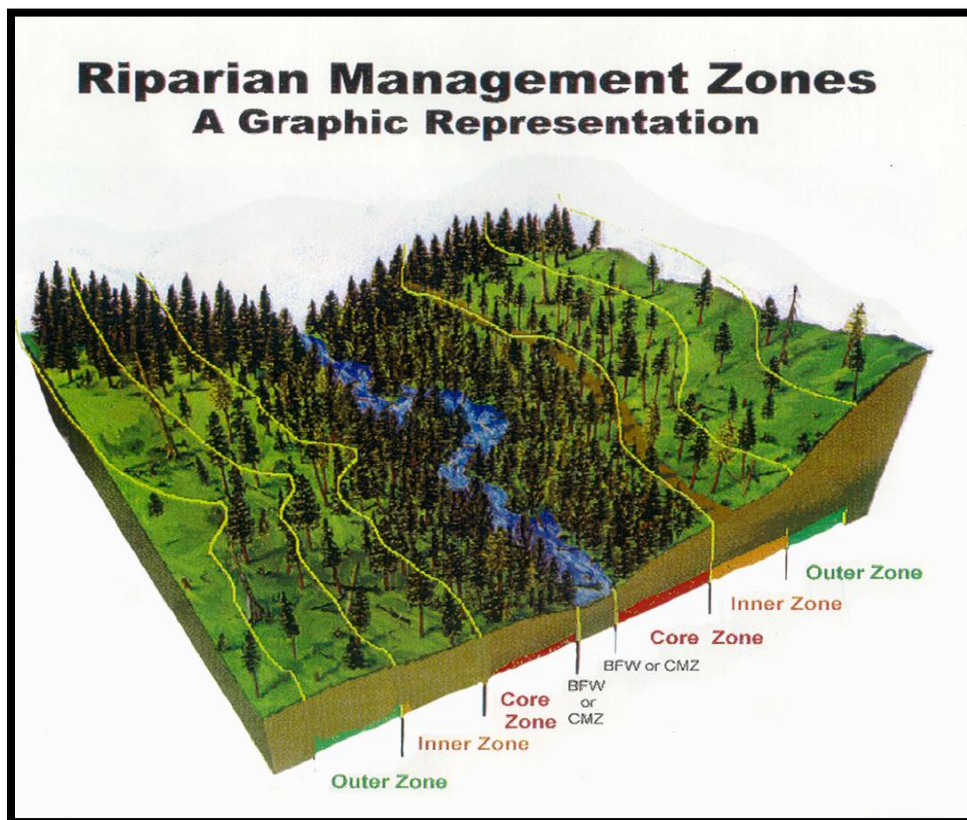
3.3 Western Washington RMZs and ELZs



Protection measures along typed water in western Washington include protecting channel migration zones; establishing riparian management zones along the full length of fish bearing waters and along portions of the length of perennial non-fish bearing waters; retaining no-harvest buffers adjacent to sensitive sites and establishing zones where equipment is limited along non-fish bearing waters.

RMZs adjacent to fish-bearing streams include a core zone, inner zone, and outer zone with differing prescriptions delineated in rule for inner and outer zones (see Figure 3). No timber harvest or road construction is allowed in the 50-foot core zone (zone closest to the water) except for the construction and maintenance of road crossings and the creation and use of yarding corridors. The inner zone (middle zone, not including core zone) ranges from 10 feet to 100 feet depending on width of the stream and site class (See Glossary) of the forested stand. Timber harvest of trees in the inner zone is only allowed if pre-determined stand requirements are met. The projected result is a mature riparian forest stand at 140 years of age (called “Desired Future Condition”) is 325 square feet of basal area. Timber harvest is allowed in the outer zone (adjacent to and outside the inner zone) with 20 riparian leave trees per acre retained following harvest.

Figure 4. Type S and F Water Riparian Management Zones



Protection along non-fish bearing waters in western Washington includes RMZs along at least 50% of the length of type Np waters and around sensitive sites and the establishment of equipment limitation zones for both Np and Ns waters. An equipment limitation zone is a 30-foot-wide area where equipment use is limited in order to minimize ground and soil disturbance. The equipment limitation zone protects stream bank integrity and vegetation which helps minimize sediment delivery to non-fish-bearing waters that could potentially be routed further downstream to fish-bearing waters.

Following is a description by prescription type of forest practices rules that regulate harvest within the RMZ of typed waters in western Washington; on-site review information where informative; and findings from the compliance monitoring field team observations.

3.3.1 Type S and F Waters in W. WA.

Section 3.3.1 addresses Type S and F riparian prescriptions including: no inner zone harvest, no outer zone harvest, DFC Option 1– thinning from below, and DFC Option 2 – leaving trees closest to the water.

On-Site Review for Type S and F Waters in W. WA.

During the compliance monitoring field review, there are questions on the [Western Washington Riparian Field Forms](#) that are common to all riparian harvest options for Type S and F waters, including:

- Is there any harvest within the core, inner, and outer zones?

- Is the site class (variable in determining inner zone width) consistent with DNR site class maps?
- Is the stream width (variable in determining inner zone width) the same as stated on the FPA? If not, does it impact the inner zone width?
- Are unstable slopes with the potential to deliver (sediment) bounded out of the harvest unit?

In addition to common questions relevant to all Type S and F water riparian prescriptions, specific western Washington riparian prescription questions are asked on the Western Washington Riparian Field Form that assesses the unique rules directed at individual harvest options.

3.3.1.1 Type S and F Water – Option 1, Thinning from Below in W. WA.

This option is available if desired future condition (DFC) growth modeling results show that there is surplus basal area available which allows for harvest to take place in the inner zone. DFC calculations indicate if a forest stand is on the trajectory to meet the desired future condition of 325 square feet of basal area per acre at a stand age of 140 years. Harvest is allowed when the model projects additional basal area is available among the smallest diameter trees. Harvest of progressively larger trees (also referred to as “thinning from below”) continue until the surplus basal area limit is reached. The leave trees in the inner zone can grow larger in a shorter time; achieving the desired large wood, fish habitat, and water quality functions more quickly. The width of the inner zone and outer zone varies depending upon the bankfull width of the stream and the site class. A minimum of 57 of the largest conifer trees per acre must be left in the inner zone. Twenty conifer trees per acre greater than 12 inches diameter at breast height (DBH) must be retained in the outer zone. The leave trees in the outer zone may be dispersed evenly throughout the zone or clumped around sensitive features such as seeps, springs, and forested wetlands.

Findings for Type S and F Water – Option 1, Thinning from Below in W. WA.

Desired Future Condition Option 1 is the most complex Type F prescription to implement in terms of the number of conditions to be met. It occurs relatively rarely in the population of FPAs. The estimated total population statewide is 71. There were 33 FPAs statewide in the 2012-2013 sample with DFC Option 1 chosen as the harvest option. Table 6 below displays the results for Desired Future Condition Option 1.

Table 6: 2012-2013 Compliance Ratings for Western Washington Type S and F Water – DFC Option 1, Thinning from Below

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
DFC Option 1 (Percent)	0	52%	36%	6%	6%	0%
DFC Option 1 (Count)	0	17	12	2	2	0

Sample Size = 33

Fifty-two percent of the samples were assessed as compliant for the DFC Option 1 prescription type. Of the 33 sites sampled 17 were compliant and 16 showed deviation from at least one FP rule in the prescription type.

No deviation occurred with the rules regarding CMZ's, and type F Stream widths. Deviations because of too few outer zone leave trees and incorrect inner zone trees occurred on 62% of DFC1 prescriptions having deviation. Harvest in the core zone occurred on 31% of these prescriptions. The primary species composition used to model DFC 1 was incorrect in 13%.

There were two instances of major deviation. One was missing 69% of its required outer zone trees and was also missing inner zone trees of the largest size classes. The other had core zone harvest, missing Inner Zone leave trees and missing 25% of the needed Outer Zone trees.

Of the two prescriptions with moderate severity, one was missing 65% of the outer zone trees and had one extra tree cut from the Inner Zone and one piece of cedar salvaged in the Core Zone. Six of the twelve prescriptions rated minor deviated because of one tree missing from one zone.

Deviation reasons

CMP records three classes of reasons for compliance deviation. The classes are administrative, layout, and operational. Administrative errors are caused by incorrect rule application in the initial planning, such as stream typing errors. Layout errors occur during the marking of field locations and boundaries. Operational errors occur during harvesting such as cutting beyond boundaries. For the 16 deviating DFC Option 1 prescriptions, one had an administrative issue which was that the large trees reported in the stand table were not within the FPA packet. The eleven layout reasons consisted largely of leave tree count and size classes not matching the table or zone measurement width differences. The nine operational reasons included leave trees cut when harvest lines were marked and harvested outer zone leave trees.

The two major deviations each had administrative, layout and operational reasons. The two moderate deviations had only layout causes.

3.3.1.2 Type S and F Water – Option 2, Leaving Trees Closest to the Water in W. WA.

This option only applies to RMZs for site class I, II, and III on streams that are less than or equal to ten feet wide or RMZs in site class I and II for streams greater than ten feet wide. For this option, DFC growth modeling results must show surplus basal area is available before the applicant is allowed to remove any trees from the inner zone. Trees are selected for harvest starting from the outer-most portion of the inner zone first and then progressively closer to the stream. Twenty conifer trees per acre must be left in the harvested area of the inner zone with a minimum DBH of 12 inches.

The width of the inner zone and outer zone varies depending upon the bankfull width of the stream and the site class. For site class I, II, and III on streams less than or equal to 10 feet, a 30-foot no-harvest extension (called the floor zone) is required beginning at the outer edge of the core zone. For site class I and II on streams greater than 10 feet, there is a 50 foot no-harvest beginning at the outer edge of the core zone. Twenty conifer trees per acre greater than 12 inches DBH (or hardwood and conifer trees over 8 inches DBH if located around sensitive features) must be retained after harvest in the outer zone unless there is a basal area exchange for excess floor zone BA or CMZ trees. Leave trees in the outer zone may be evenly dispersed throughout the zone or clumped around sensitive features.

Findings for Type S and F Water – Option 2, Leaving Trees Closest to the Water in W. WA

DFC Option 2 harvest is less complex to implement and is chosen more frequently than DFC Option 1. Forty-eight DFC Option 2 prescriptions were sampled from an estimated population of 273 FPAs. Table 7 below displays the results for Desired Future Condition Option 2.

Table 7: 2012-2013 Compliance Ratings for Western Washington Type S and F Water – DFC Option 2 – Leaving Trees Closest to the Water

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
DFC Option 2 (Percent)	4%	54%	29%	9%	2%	2%
DFC Option 2 (Count)	2	26	14	4	1	1

Sample Size = 48

Fifty-eight percent of the samples were assessed as compliant or exceeds rule requirements for the DFC Option 2 prescription type. Of the 48 sites sampled, 28 were compliant or exceeds and twenty showed deviation from at least one FP rule in the prescription type.

Fourteen of the samples were rated a minor deviation. Five samples had trees harvested in the no-cut floor zone, and nine samples had insufficient outer zone leave trees. One of these sites also lacked one leave tree in the harvested portion of the inner zone.

Four prescriptions were rated with a moderate deviation. Two because the streams, when measured, were larger (greater than 10 feet wide) than what was reported on the FPA, resulting in the RMZ width providing insufficient protection. One RMZ was missing all of the outer zone trees and the last had harvest of some floor zone trees along half the RMZ length.

One sample was rated major severity due to the assessment that it was ineligible for DFC Option 2. The FPA had been renewed but lacked adjustment for the new basal area rules. No harvest should have occurred within 128 feet from the edge of the Type F water but harvest took place within 102 feet of the Type F water. Outer zone trees were also harvested.

Deviation Reasons

For the 20 deviating DFC Option 2 prescriptions seven showed administrative issues. Layout reasons were the most common, 13 occurrences, with the most frequent reason being missing outer zone leave trees. The three operational reasons included leave trees cut in the floor zone and missing outer zone leave trees.

The one major deviation occurred because of an administrative reason. The FPA was approved without using the revised DFC model. The site was not eligible for DFC Option 2. Of the four with moderate severity, two were layout caused with the streams measured by CMP as large but reported by FPA applicants as small (less than 10 feet wide). The other two layout reasons were the lack of zone marking resulting in missing trees from floor and outer zones. The 14 with minor severity were predominately due to layout reasons, with insufficient outer zone leave trees.

3.3.1.3 Type S and F Water – No Inner Zone Harvest in W. WA

For this option, DFC results show that existing stands in the combined core and inner zone do not meet stand requirements and, therefore, no inner zone harvest can take place or sometimes the applicant elects not to harvest in the inner zone for operational or other forest management reasons.

Findings for Type S and F Water – No Inner Zone Harvest in W. WA

No inner zone harvest is the most frequently selected harvest strategy along fish bearing water. This harvest strategy occurs on an estimated 753 FPAs in the 2012-2013 population. Table 8 below displays the results for No Inner Zone Harvest.

Table 8: Compliance Ratings for Western Washington Type S and F Water – No Inner Zone Harvest

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
No Inner Zone Harvest (Percent)	5%	62%	28%	5%	0%	0%
No Inner Zone Harvest (Count)	3	36	16	3	0	0

Sample Size = 58

Sixty-seven percent of the samples were assessed as compliant or exceeds in the no inner zone harvest prescription type. Of the 58 sites sampled, 39 sites were compliant or exceeds, while 19 sites showed deviation from at least one forest practices rule in the prescription type.

The prescription type was rated as a minor deviation in 16 cases. Three received the rating solely for insufficient outer zone tree count, with the inner and core zones remaining intact, while five were for inner zone harvest. Eight others involved harvest along the outer edge of the inner zone and had insufficient outer zone leave trees.

Three sites sampled were rated with a moderate deviation: Two because of harvest in the inner zone and retention of less than half of the outer zone trees. One lacked two outer zone leave trees and eight trees from the largest diameter class were harvested from the inner zone.

Three compliant No Inner Zone Harvest prescriptions exceeded rule requirements. All three instances had twice the required amount of the needed outer zone leave trees.

No Inner Zone Harvest Deviation reasons

Two deviations resulted from administrative reasons. In one case, the site index within the RMZ was under-represented resulting in a wider RMZ needed. In the other, the Type F stream was assessed to be in the large category, not small (less than 10 feet wide) as reported on the FPA. Thirteen deviations had layout reasons, the most common issue being zone measurement differences. Seven operational reasons occurred where inner zone and outer zone trees were harvested even though the zones were appropriately marked. A prescription can have one or more rules that deviate.

The reasons for the three moderate severity ratings were layout and operational. One of the three included both. The 16 low severity reasons were predominantly layout (16) followed by Operational (five) and Administrative (two).

3.3.1.4 Type S and F Water – No Outer Zone Harvest in W. WA.

In this option, the Forest Practices Application states that no harvest will occur within any portion of the RMZ. Though this is not a rule, it is an option allowed in the FPA submission where the applicant elects not to enter any portion of the RMZ. The rule which applies is the “No Inner Zone Harvest”. This activity is assessed separately from the No Inner Zone Harvest because the applicant selects a more restrictive prescription. Rule compliance is assessed based on whether the RMZ meets the conditions required under the No Inner Zone Harvest prescription.

Findings for Type S and F Water – No Outer Zone Harvest in W. WA

There were an estimated 80 no outer zone harvests in the 2012-2013 FPA population. The CMP sampled 32.

Table 9: 2012-2013 Compliance Ratings for Western Washington Type S and F Water – No Outer Zone Harvest

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
No Outer Zone Harvest (Percent)	0%	91%	6%	0%	3%	0%
No Outer Zone Harvest (Count)	0	29	2	0	1	0

Sample Size = 32

Ninety-one percent of the samples were assessed as compliant in the no outer zone harvest prescription type. Of the 32 sites sampled, 29 sites were assessed as compliant while three showed deviation from at least one FP rule in the prescription type. The two deviations rated as minor resulted from trees being harvested along the outer edge of the inner zone. One deviation was rated major because of significant harvest in the inner and core zones and no outer zone leave trees.

No Outer Zone Harvest Deviation Reasons

No Outer Zone Harvest had three deviating prescriptions. One minor deviation had administrative reasons with RMZ location. The other minor deviation had no cause recorded.

The one major deviation had both layout and operational reasons. The RMZ was not marked and trees were cut in the core, inner and outer zones.

3.3.2 Type Np Water in W. WA

Type Np streams and sensitive sites contribute to the quality of water and fish habitat in downstream Type S and/or F streams. They also provide habitat to some wildlife.

Fifty-foot-wide RMZs are required along portions (and specified locations) of Type Np streams. For example, a 50-foot-wide no harvest RMZ is required for at least 300 feet above a confluence with a Type F or S stream, 500 feet where the length of the type Np reach is 1000 feet or greater.

The total distance of the 50-foot buffer required along an Np stream varies and depends upon the length of the Type Np stream from the confluence with the Type S or F stream. At least 50% of a Type Np waters' length must be protected by buffers on both sides of the stream (2-sided buffers). If the Type Np Water on the FPA is located more than 500 feet upstream from the confluence of a Type S or F Water and if the Type Np Water is more than 1000 feet in length, then the minimum percent of length of Type Np water to be buffered varies as per the table in [WAC 222-30-021\(2 \(b\)\(vii\)\)](#).

Sensitive sites associated with Np streams must also be protected with buffers or harvest restrictions. These include headwater springs or the upper most point of perennial flow; the intersection of two or more Type Np waters; perennially saturated side-slope seeps; perennially saturated headwall seeps; and alluvial fans. No harvest is allowed within alluvial fans.

Type Np streams also require a 30-foot-wide equipment limitation zone (ELZ) along un-buffered portions of the reach. Equipment use and other forest practices are specifically limited and mitigation may be required if activities expose the soil on more than 10% of the ELZ length.

On-Site Review for Type Np Waters in W. WA

Questions asked on the Western Washington Riparian Field Form for Np streams differ from Type S and F fish bearing streams. Examples include

- Is there evidence of equipment entry into the 30-foot ELZ? If so, was less than 10% of the soil with the ELZ exposed due to activities?
- Was the appropriate length of 50-foot no-harvest zone left on the given stream segment?

Findings for Type Np Waters in W. WA

Type Np streams commonly occur with an estimated 1454 western Washington FPAs having one or more Np streams within their harvest boundaries.

Table 10: Compliance Ratings for Western Washington Type Np Water

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
Np Water (Percent)	0%	76%	12%	0%	4%	8%
Np Water (Count)	0	19	3	0	1	2

Sample Size =25

Seventy-six percent of the samples were assessed as compliant for the Np water prescription type. Of the 25 sites sampled, 19 were compliant and six showed deviation from at least one FP rule in the prescription type.

Three samples were rated as a minor deviation. Two because of trees harvested in the buffer of the uppermost point of perennial flow. The other had insufficient buffer length.

One type Np segment was assessed with a major severity rating. The record shows that the stream had harvested trees within the 50 foot buffer. The stream also met Type F physical characteristics. The remaining 2 samples were rated as an indeterminate deviation because a portion of the Np streams met Type F physical characteristics, but most of the stream met Type Np characteristics.

Type Np Prescription Deviation Reasons

Of the six Type Np RMZ deviations the most common cause was layout (3), because Type F physicals were present on two and the third because of applicant confusion about required RMZ length. Operational reasons accounted for two more and administrative reasons accounted for the last because of misinterpretation of the required RMZ length table.

3.3.3 Type Ns Waters in W. WA

Buffers are not required for Type Ns streams. There is a 30-foot equipment limitation zone (ELZ) and mitigation measures are required if more than 10% of the soil in the ELZ is exposed.

Findings for Type Ns Waters in W. WA

Type Ns waters are common, occurring in an estimated 1,232 FPAs in the western Washington population for the 2012-2013 sample.

Table 11: 2012-2013 Compliance Ratings for Western Washington Type Ns Water

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
Ns Water (Percent)	0%	94%	0%	0%	6%	0%
Ns Water (Count)	0	17	0	0	1	0

Sample Size = 18

Ninety-four percent of the samples were assessed as compliant in the Ns water prescription type. The sample that was rated as a major deviation had an Ns water with Type F physical characteristics for gradient and width.

Type Ns Prescription Deviation reasons

The one deviation was of major severity with an administrative cause for not correctly determining water type.

3.4 Eastern Washington RMZs and ELZs



In eastern Washington, riparian management is intended to result in stand conditions that vary over time. Management is designed to mimic eastside disturbance (such as wildfire) regimes in a way that protects riparian function conditions and maintains general forest health. Harvest adjacent to a Type S, F or Np stream is based upon the DNR site class map, timber habitat type (see Section 3.4.3 below), basal area, and shade requirements needed to protect the stream. Habitat types include Ponderosa Pine, Mixed Conifer, and High Elevation. The no harvest core zone along type S and F waters is 30 feet. Harvest units within the bull trout overlay must leave all available shade within 75 feet of the bankfull width or CMZ, whichever is greater. Np and Ns waters have an equipment limitation zone (ELZ) of 30 feet.

Following is a description by prescription type of forest practices rules that regulate harvest within the RMZ of typed waters in eastern Washington, and on-site review information and findings from compliance monitoring field team observations.

On-Site Review of Timber Harvest Adjacent to Type S and F Waters in E. WA

During field review, there are questions on the [Eastern Washington Riparian Field Form](#) that are common to all the riparian harvest options, such as:

- Is there any harvest within the core, inner, and outer zones?
- Is the site class (variable in determining outer zone width) consistent with DNR site class maps?

- Is the stream width (variable in determining inner and outer zone widths) the same as stated on the FPA? If not, does it impact the inner zone width?
- Are unstable slopes with the potential to deliver (sediment and debris) bounded out of the harvest unit?

In addition to common questions relevant to all Type S and F water riparian prescriptions, specific eastern Washington riparian prescription questions are asked on the Eastern Washington Riparian Field Form that assesses the unique rules directed at individual harvest options.

3.4.1 Type S and F Water – No Inner Zone Harvest in E. WA

In this option, no harvest occurs in the inner zone because the forest stand does not meet certain basal area requirements based on timber habitat type (see Section 3.4.3) or sometimes the applicant elects not to harvest in the inner zone for operational or other reasons. Outer zone leave tree requirements are also based on timber habitat type.

Findings for Type S and F Water – No Inner Zone Harvest in E. WA

No Inner Zone Harvests are the most common eastern Washington fish bearing water prescription used with an estimated 186 occurrences in the 2012-2013 population.

Table 12: Compliance Ratings for Eastern Washington Type S and F Water – No Inner Zone Harvest

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
No Inner Zone Harvest (Percent)	15%	67%	15%	3%	0%	0%
No Inner Zone Harvest (Count)	5	23	5	1	0	0

Sample Size =34

Eighty-two percent of samples were assessed as compliant or exceeds in the no inner zone prescription type. Of the 34 FPAs sampled, 28 were assessed as compliant and six showed deviation from at least one FP rule in the prescription type.

Five sites assessed as a deviation were rated as minor and in all cases two or fewer trees were harvested from the inner zone.

One instance was rated moderate having some trees cut in the core zone along 265 feet of the 6000 foot reach and 12 trees harvested in the inner zone along the entire 6000 foot reach.

Eastern Washington No Inner Zone Harvest Deviation Cause

The operations issue was a minor deviation due to inner zone trees cut behind a flagged line. The one layout caused deviation was minor with the marked zone line too close to the stream. Three other minor deviations did not have as cause recorded. The one moderate deviation was due to combined administrative and layout issues with harvest in the inner and core zones.

3.4.2 Type S and F Water – No Outer Zone Harvest in E. WA

In this option, the Forest Practices Application states that no harvest is occurring within any portion of the RMZ. Though this is not a Forest Practices rule, it is an option allowed in the FPA submission where the applicant elects not to enter any portion of the RMZ. The rule which applies is the “No Inner Zone Harvest”. This activity is assessed separately from the No Inner Zone Harvest because the applicant selects a more restrictive prescription. Rule compliance is assessed based on whether the RMZ meets the conditions required under the No Inner Zone Harvest prescription.

Findings for Type S and F Water – No Outer Zone Harvest in E. WA

“No Outer Zone Harvest” prescriptions occurred on an estimated 75 FPAs in eastern Washington in 2012-2013.

Table 13: 2012-2013 Compliance Ratings for Eastern Washington Type S and F Water – No Outer Zone Harvest

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
No Outer Zone Harvest (Percent)	14 %	65%	14%	0%	7%	0%
No Outer Zone Harvest (Count)	2	9	2	0	1	0

Sample Size = 14

Seventy-nine percent of the samples were assessed as compliant in the no outer zone prescription type. Of the 14 sites sampled, two were assessed as exceeding FP rule requirements due to wider RMZs than required. Two were assessed as minor deviations and one as a major deviation.

One of the samples was assessed as a major deviation from FP rule due to a Type F stream that was protected as if it were a Type Np stream. The stream reach length was over 2,600 feet with a required two sided buffer. Over 1,000 feet of inner zone on each side was harvested where there should have been no harvest. Additionally, a skid trail was constructed in the inner zone on one side of the stream for 1,000 feet.

Eastern Washington No Outer Zone Harvest Prescription Deviation Cause

One minor deviation was an administrative issue that was due to not including a Type F RMZ in the FPA resulting in five trees harvested from an inner zone 1300 feet long. Another minor deviation had no cause recorded. Administrative and layout causes affected two of the three deviations. One was major where the administrative issue was failure to apply the correct water type determined by a pre-harvest WTMF and a layout issue with RMZ boundary markings too close to the stream to allow proper zone width..

3.4.3 Type S and F Water – Inner Zone Harvest (All Habitat Types) in E. WA

If an applicant is allowed to harvest within the inner zone (all basal area requirements are met – see below), then the leave tree and minimum basal area per acre requirements are based upon habitat type and site index:

Ponderosa Pine Habitat Type (elevation at or below 2500 feet) – [WAC 222-30-022 \(1\)\(b\)\(i\)](#)

In stands with a high basal area in the inner zone (greater than 110 square feet ((sq. ft.)) per acre for conifer and hardwood trees equal to or greater than 6 inches DBH), harvest is permitted in the inner zone. The harvest must leave at least 50 trees per acre (TPA) and a minimum leave tree basal area of at least 60 sq. ft. per acre.

In stands with low basal area and high density, thinning is permitted if the basal area of all species is less than 60 square feet per acre and there are more than 100 trees per acre. The thinning must leave a minimum of 100 trees per acre. There are requirements about which type of trees should be left.

Ten dominant or co-dominant trees per acre are required to be left in the outer zone.

Mixed Conifer Habitat Type (elevation from 2501 to 5000 feet) – [WAC 222-30-022 \(1\)\(b\)\(ii\)](#)

Harvest is allowed in stands with a high basal area (greater than a certain square feet per acre depending on the site index). Harvest must leave at least 50 trees per acre and a minimum total leave tree basal area.

Thinning is permitted in stands with a low basal area and high density if the basal area of all species is less than the minimum requirements for the site index.

Fifteen dominant or co-dominant trees per acre are required to be left in the outer zone.

High Elevation Habitat Type (elevations above 5000 feet) – [WAC 222-30-022 \(1\)\(b\)\(iii\)](#)

Desired future condition growth modeling determines if there is surplus basal area available in order for harvest to take place in the inner zone. Leave tree requirements are the same as those for Type S or F waters in western Washington. Twenty dominant or co-dominant trees per acre are required to be left in the outer zone.

On-Site Review for Type S and F Water – Inner Zone Harvest (All Habitat Types) in E. WA

The following describes how assessments are made by the compliance monitoring field team:

- In stands with high basal area, the compliance monitoring field team evaluates whether the harvest left the required number and size of trees per acre and minimum basal area per acre appropriate for the forest habitat type and site index.
- In stands with low basal area, the compliance monitoring field team assesses whether the minimum number of trees per acre are left standing, based on the forest habitat type.
- The outer zone is also assessed for the correct number of dominant and co-dominant trees per acre according to the forest habitat type.
- Stream adjacent parallel roads in the inner zone were also evaluated for compliance with the rules. See [Eastern Washington Compliance Monitoring Field Form #6](#) for details on the information collected when a stream adjacent parallel road was present in the inner zone.

Findings for Type S and F Water – Inner Zone Harvest (All Habitat Types) in E. WA

No completed inner zone harvest strategies were found for the 2012-2013 eastern Washington sample. In previous sample biennia, very few (2-4) occurred.

3.4.4 Type Np Water in E. WA.

Type Np streams require a 50-foot-wide RMZ which includes a 30-foot-wide equipment limitation zone. Harvest may be allowed within the 50-foot buffer if certain basal area requirements and tree counts are met. Two harvest strategies are available:

- **Partial Cut Strategy:** This strategy is a thinning of the RMZ and has thresholds for residual basal area and tree counts.
- **Clearcut Strategy:** This strategy has no-harvest areas which must meet the basal area and tree count thresholds while allowing certain parts of the RMZ to be clearcut. The applicant designates a no harvest buffer along the stream reach in the harvest unit that is equal in total length to the clearcut portion of the stream reach in the harvest unit, and meets the upper end of basal area requirements for each respective timber habitat type. The streamside boundary of all clear-cuts must not exceed in total 30% of the length of the stream reach in the harvest unit and not exceed 300 continuous feet in length. The clearcut boundary must not be located within 500 feet of the intersection of Type S or F waters and not occur within 50 feet of sensitive sites.

On-Site Review for Type Np Water in E. WA

The harvest strategy within the RMZ is confirmed: no cut, partial cut or clearcut; tree count and basal area thresholds are met; and the required leave trees retained. For the clear-cut strategy, the clearcut RMZ length is determined, along with its distance from all Type F or S waters and sensitive sites.

The review also includes evaluation to determine if equipment entered the 30-foot ELZ and if so, what percent of soil exposure occurred as a result. If more than 10% of the soil is disturbed, the compliance monitoring field team assesses whether mitigation measures for the disturbance have been completed.

Findings for Type Np Water in E. WA

In 2012-2013, eastern Washington Np waters were estimated to occur on 454 FPAs.

Table 14: Compliance Ratings for Eastern Washington Type Np Water

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
Np Water (Percent)	14%	72%	14%	0%	0%	0%
Np Water (Count)	1	5	1	0	0	0

Sample Size = 7

Eighty-six percent of the samples were assessed as compliant for the Np samples with 14 percent rated as exceeds due to a buffer of over 100 feet (twice the required width), around an Np spring.

One minor deviation was due to trees harvested in the buffer of the uppermost point of perennial flow (UMPPF) and three trees taken from the buffer along the stream reach.

Eastern Washington Type Np Harvest Prescription Deviation Cause

The one Type Np RMZ deviation was minor and recorded as an operational cause with trees harvested in the UMPPF buffer and in the no-cut RMZ.

3.4.5 Type Ns Water E. WA

In 2012-2013, eastern Washington Ns waters were estimated to occur on 396 FPAs. Buffers are not required for type Ns streams. There is a 30-foot-wide equipment limitation zone (ELZ) and mitigation measures required if more than 10% of the soil within the ELZ is exposed.

Findings for Type Ns Water E. WA

Table 18: 2012-2013 Compliance Ratings for Eastern Washington Type Ns Water

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
Ns (Percent)	0%	100%	0%	0%	0%	0%
Ns (Count)	0	7	0	0	0	0

Sample Size = 7

One-hundred percent of the samples were assessed as compliant for the Ns stream prescription type.

3.5 Statewide Wetland Management Zones (WMZs) Rules and Findings



Forest Practices wetland rules are nearly the same for western and eastern Washington. Wetland Management Zones (WMZ) have variable widths based on the size and type of wetland. Type A Wetlands greater than 5 acres have a minimum 50-foot WMZ width. Type A and Type B Wetlands 0.5 to 5 acres have a minimum 25-foot width WMZ, while Type B Wetlands less than 0.5 acre and Forested Wetlands have no WMZ required. There are leave trees required (by size and number) within the WMZ. There are also restrictions regarding the maximum width of openings created by harvesting within the WMZ. In addition, ground based harvesting systems shall not be used within the minimum WMZ width without written approval from DNR.

Following is a description by prescription type of forest practices rules that regulate wetlands statewide; on-site review information where informative; and findings from the compliance monitoring field team observations.

On-Site Review for Wetlands Statewide

Protection measures for wetlands depend upon the size and type of wetland. The information collected by the compliance monitoring field team on-site varies depending upon the type of wetland. Some of the questions answered by the team are applicable to all wetlands:

- Were the wetlands typed and sized appropriately on the ground, and consistent with the FPA?
- Is the variable buffer width appropriate relative to the WMZ table in the rules?
- If operations were conducted within the WMZ, were the openings less than 100-feet wide?

- If operations were conducted within the WMZ, were the openings no closer than 200-feet from each other?

In addition, for Type A and Type B wetlands, the compliance monitoring field team evaluate the following:

- Leave trees in the WMZ for species, number, and size;
- Approval by DNR for use of ground based harvesting systems within the minimum WMZ and for any timber that was felled into or cable yarded across the wetland;
- Protections applied when a WMZ overlaps an RMZ; and
- For particular leave tree requirements if the harvest within the WMZ is greater than or less than 10%.of the total harvest unit.

If harvest occurs within a forested wetland, the compliance monitoring field team determines whether the harvest method is limited to low impact harvest or cable systems; and whether the wetland boundaries (if greater than 3 acres within the harvest unit) are delineated correctly and shown on the activity map by the applicant.

3.5.1 Type A Wetland Management Zones Statewide

Findings for Type A Wetland Management Zones Statewide

Type A wetlands are estimated to occur on 139 FPAs statewide in the 2012-2013 population. Findings are displayed in Table 19.

Table 19: Compliance Ratings for Statewide Type A Wetland Management Zones

WMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
Type A (Percent)	0%	80%	10%	5%	0%	5%
Type A (Count)	0	16	2	1	0	1

Sample Size = 20

Eighty percent of the samples were assessed as compliant for the Type A WMZs prescription. Of the 20 sites sampled, 16 were compliant and four showed deviation from at least one FP rule in the prescription type.

Two were rated with a minor deviation, one for accessibility to fish for a portion of the wetland perimeter, which changed the WMZ to an RMZ for that portion of the wetland. The other minor rating was for three too many trees harvested.

One site was rated with a moderate deviation because trees were missing in all size classes. This was a known FP violation with a note attached that said the violation was found and mitigation enforced prior to its inclusion in the sample.

One deviation was rated indeterminate because Type F stream physical characteristics were observed, but it was unknown if fish were present.

Type A Wetland Management Zones Harvest Prescription Deviation Cause

Three of four deviating Type A wetland harvests had causes recorded. Administrative issues of Type F water presence caused two deviations rated minor and indeterminate. The one moderate deviation had both layout and operational causes because of the zone marking location and too many harvested trees.

3.5.2 Type B Wetland Management Zones Statewide

Findings for Type B Wetland Management Zones Statewide

There were approximately 174 FPAs statewide that contained Type B wetlands in the 2012-2013 sample population.

Table 20: 2012-2013 Compliance Ratings for Statewide Type B Wetland Management Zones

WMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
Type B (Percent)	0%	94%	0%	6%	0%	0%
Type B (Count)	0	16	0	1	0	0

Sample Size = 17

Ninety-four percent of the sites were assessed as compliant for Type B wetlands.

Of the 17 sites sampled, one deviation was rated moderate. No marking was present to indicate the buffer. Buffer measurement showed that nine trees of the largest diameter were removed within the minimum width and the remaining stocking did not meet the 25 trees per acre with DBH requirements of 12 inches and greater. This deviation was previously discovered and documented by the region through enforcement action.

Type B Wetland Management Zones Harvest Prescription Deviation Cause

The one deviating type B Wetland management zone was of moderate severity. The record showed both layout and operational causes. No marked buffer was found and larger trees than allowed to be harvested were removed.

3.5.3 Forested Wetlands Statewide

Findings for Forested Wetlands Statewide

There were approximately 251 FPAs statewide that contained forested wetlands in the 2012-2013 sample population. There are no leave tree requirements for forested wetlands.

Table 21: Compliance Ratings for Statewide Forested Wetlands

WMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
Forested (Percent)	0%	94%	6%	0%	0%	0%
Forested (Count)	0	16	1	0	0	0

Sample Size =17

Ninety-four percent of the sites were assessed as compliant for forested wetlands. The one deviating sample received a minor severity rating because the size exceeded 3 acres and the forested wetland was not represented as required (WAC 222-16-035) on the FPA map (all forested wetlands 3 acres and greater).

Forested Wetland Management Zones Harvest Prescription Deviation Cause

The one minor deviation was due to an administrative issue. The wetland, which was larger than three acres, was not mapped on the FPA.

3.6 Emphasis Sample



The one prescription type chosen to be sampled as an Emphasis Sample in 2012 – 2013 biennium was exempt 20-acre parcels which was sampled in 2012. This RMZ exempt 20-acre parcel prescription type was also selected as an Emphasis Sample in 2008, which allowed for a comparison to be made in this report between the two sample years.

Forest Practices rules for Exempt 20-acre parcels RMZs

Highlights for FP rules in western and eastern Washington for RMZ exempt 20-acre parcels are listed below.

S and F streams Western Washington

In western Washington, the RMZ boundary is determined by tree count, shade requirements, and physical features of the landscape. RMZ requirements include:

- Shade must be maintained as required by WAC 222-30-023(c),
- The riparian buffer width cannot be less than 29 feet,
- The width is expanded where necessary to include wetlands or ponds adjacent to the stream,
- Leave tree requirements include: an RMZ maximum width, minimum size of leave trees, and ratio of conifer to deciduous trees depending upon the width of the Type S or F water and the composition of the stream bed (gravel/cobble vs. boulder/bedrock).

S and F streams Eastern Washington:

- Maintain sufficient shade as required by WAC 222-30-040,

- 50% or more of the trees shall be live and undamaged on completion of harvest and randomly distributed where feasible,
- RMZ width is based on the adjacent harvest type. If the adjacent unit harvest type is “partial cutting”, then the RMZ width is a minimum of 35 feet to a maximum of 58 feet on each side of the stream. For clearcut harvesting, the RMZ averages 58 feet in width with a minimum width of 35 feet and a maximum width of 345 feet on each side of the stream.
- RMZ leave tree requirements include the need to leave all wildlife reserve trees and all trees with a DBH of 12 inches or less. There are size, number, and species requirements (conifer or deciduous) for leave trees and minimum leave tree requirements based upon stream bed composition (boulder/bedrock or gravel/cobble).

Np Streams (Statewide):

Leave trees are left along Type Np waters as necessary to protect public resources. At least 29 conifer or deciduous trees (6 inches in DBH or larger) are left on each side of every 1,000 feet of stream length within 29 feet of the stream where necessary.

On-Site Review for Statewide RMZs for exempt 20-acre parcels

In order to determine compliance for RMZ exempt 20-acre parcels, the compliance monitoring field team uses the Riparian Management Zones for Exempt 20-acre Parcels Field Form for Western Washington or the Riparian Management Zones for Exempt 20-acre Parcels Field Form for Eastern Washington to record information on-site. Examples of questions asked on the forms include:

Type S and F Western Washington

- Did the applicant harvest within the maximum RMZ widths? If so, did the applicant leave the required number of trees/1000 feet each side?
- If (there was) harvest in the RMZ, did the applicant avoid disturbing brush and live trees and stumps and root systems embedded in the bank and did they leave high stumps to prevent felled and bucked timber from entering the water?
- Did the applicant leave an average of 5 undisturbed and uncut wildlife trees per acre in the RMZ at a conifer to deciduous ratio of 1:1 equal to the largest existing tree of those species?

Type S and F Eastern Washington

- Upon completion of harvest, were 50% or more of the leave trees live and undamaged?
- If 10% or more of the harvest unit lies within any combination of an RMZ of a Type S, F or WMZ, did the applicant leave not less than 50% of the trees required in the rule?

Type Np (Statewide)

- Leave at least 29 conifer or deciduous trees, 6 inches or larger DBH, on each side of every 1000 feet of stream length within 29 feet of the stream?

Findings for RMZ Exempt 20-acre Parcels Statewide

Table 22: 2012 Compliance Ratings for Statewide Emphasis Sample RMZ Exempt 20-Acre Parcels

RMZ Prescription	Forest Practices Rule Compliance Ratings					
	Compliant Ratings		Deviation Ratings			
	Exceeds	Compliant	Minor	Moderate	Major	Indeterminate
20-acre exempt Harvest (Percent)	0%	57%	14%	14%	11%	4%
20-acre exempt Harvest (Count)	0	16	4	4	3	1

Sample Size = 28

The 2012 emphasis sample for RMZ exempt 20-acre parcels is a census of the population because it included all completed RMZ exempt 20 acre parcel FPAs in the population. Fifty-seven percent of the samples were assessed as compliant. Of the 28 sites, 16 were compliant and 12 showed deviation from at least one forest practices rule in the prescription type. The samples assessed as a deviation included twelve RMZs. In eight of the 12 RMZs, the applicant cut too many trees. Two of the RMZs had stream widths reported on the FPA as less than 5 feet, when they were actually greater than 5 feet wide. This caused the stream to receive less protection than required per rule. In one sample, the applicant needed 3 additional wildlife trees.

Statistically speaking, the 2012 samples assessed as compliant (57%) is not significantly different from the 2008 findings in which 62% of samples were assessed as compliant. This indicates that the compliance rating has not detectably changed.

4. Forest Practices Rule Compliance for Roads and Haul Routes



This section of the report provides rule and on-site review descriptions, and compliance monitoring findings regarding the standard sample for road construction and abandonment, and haul routes statewide.

Road sampling follows the same design as riparian sampling. Haul route sampling is designed differently. Haul route sampling assesses each 0.1 mile segment of forest road for correct design, construction or maintenance of roads to protect typed waters from sediment delivery. This strategy allows for determining the rate of compliance for the entire haul route of the FPA.

4.1 Forest Practices Road Rules Assessment:

A well-designed, located, constructed, and maintained system of forest roads is essential to both forest management and protection of public resources. Forest practices rules include road construction, maintenance and abandonment, and “best management practices”. The FP rules are designed to help ensure that forest roads are constructed, maintained, and abandoned to:

- Provide for fish passage at all life stages,
- Prevent mass wasting,
- Limit delivery of sediment and surface runoff to all typed waters,
- Avoid capture and redirection of surface or ground water,
- Divert road runoff to the forest floor,

- Provide for the passage of some woody debris,
- Protect stream bank stability,
- Minimize construction of new roads, and
- Assure no net loss of wetland function.

Forest practices rules provide direction for landowners on how to accomplish these goals through proper location, design, construction, maintenance and abandonment of forest roads, landings, and stream crossings.

The Compliance Monitoring Program collects data annually on sites where there has been:

- Road construction,
- Landing construction,
- Type N stream road crossing construction, including fords,
- Road abandonment, and
- Haul routes (forest roads used to transport logs to mills).

The following section describes the forest practices rules that regulate statewide road construction, landing construction, type N stream road crossing construction, road abandonment and haul routes, and provides an on-site review description and the compliance monitoring field team findings.

FP Rules for Roads and Haul Routes Statewide

FP rules for road construction, landing construction, Type N stream road crossing, road abandonment and haul routes are explained below.

Forest Road Construction:

Road construction is composed of three components: road location, road design, and actual construction. The road rules require specific standards for road location, design, and construction which are reflected in the questions found in the compliance monitoring [Roads Field Form](#) (see on-site review section below).

- 1) Road Location: FP rules require that roads are located to fit the topography and minimize alteration of natural features ([WAC 222-24-020](#)). Examples include minimizing the number of stream crossings and not locating roads in bogs or within natural drainage channels (except for crossings).
- 2) Road Design: FP rules include road design standards which address construction techniques and water management ([WAC 222-24-020](#)). For example, new road construction on side slopes exceeding 60% which have the potential to deliver sediment to any typed water or wetland need to utilize full bench construction techniques ([WAC 222-24-020\(8\)](#)).
- 3) Road Construction: Road construction requirements focus on maintaining stable road prisms and water crossing structures, and minimizing sediment delivery to surface waters and wetlands ([WAC 222-24-030](#)). For example, erodible soil disturbed during road construction needs to be seeded with non-invasive plant species, unless the soil is located where it could not reasonably be expected to enter the stream network.

Landing location and construction:

Landings are subject to several FP rules. They must not be located within specific areas such as natural drainage channels, RMZs, or WMZs. Landings must be constructed so that they are sloped to minimize

accumulation of water on the landing. Excavation material shall not be sidecast where there is high potential for material to enter wetland management zones or within the bankfull width of any stream or within the 100-year flood level of any typed water. ([WAC 222-24-035](#)).

Type N Stream Crossings:

Installation, maintenance, and removal of bridges, culverts, and temporary water crossings are subject to several FP rules. For example, culvert placement must be designed so that the alignment and slope of the culvert parallels the natural flow of the stream and it does not cause scouring of the streambed and erosion of the stream banks in the vicinity of the project. Additionally, bridges must not constrict clearly defined channels, and temporary water crossings must be constructed to facilitate abandonment ([WAC 222-24-040](#)).

Road Abandonment:

Landowners have the option to abandon forest roads, with the exception that in some watersheds landowners are required to abandon roads to keep the road ratio at a certain level. When a landowner chooses to abandon a forest road, specific standards delineated in the FP rules and Board Manual Section 3 must be followed. For example, abandoned roads must be out-sloped, water barred, or otherwise left in a condition suitable to control erosion and maintain water movement within wetlands and natural drainages. An abandoned road must be blocked so that four-wheeled highway vehicles cannot pass the point of closure at the time of abandonment and water crossing structures must be removed ([WAC 222-24-052](#) (3)).

Haul Routes:

FP rule states that roads must be maintained in a condition that prevents potential or actual damage to public resources ([WAC 222-24-051](#) (12)). The compliance monitoring field team observes and records observations for haul routes regarding level of sediment delivery.

On-site Review for Roads and Haul Routes Statewide

In order to determine road compliance, the compliance monitoring field team visits FPA units with forest road construction, landing construction, Type N stream road crossings, abandoned roads and haul routes. The compliance monitoring field team uses the Roads Field Form and the Haul Route Field Form to record information on-site. The data recorded on the Roads Field Form and the Haul Route Field Form help the compliance monitoring field team determine road compliance on each FPA sampled.

Roads Field Form:

The compliance monitoring field team uses the Roads Field Form to record data observed for forest road construction, forest road landing construction, Type N stream road crossings, and abandoned roads. The initial series of questions on the Roads Field Form assess road surface conditions, drainage structure placement and stabilization, routing of drainage water to the forest floor and potential delivery of sidecast. Stream crossing questions assess stream crossing placement, frequency, culvert sizing, positioning and stabilization. Other questions address wetland crossings, road location, wetland replacement, abandonment and stabilization of temporary roads, road abandonment, and proper construction and drainage for forest road landings.

Following are examples of questions found on the Roads Field Form:

- Road location: “Does new road construction minimize stream crossings?” [WAC 222-24-020\(5\)](#).

- Road design: “Where the potential for sediment delivery existed, was full bench construction utilized for roads built on slopes greater than 60%?” [WAC 222-24-020\(8\)](#).
- Road construction: “Were erodible soils disturbed during construction stabilized to prevent the potential to deliver to typed waters?” [WAC 222-24-030\(4\)](#).
- Road landing location and construction: “Was the landing sloped to minimize accumulation of water on the landing?” [WAC 222-24-035](#) (Western WA only).
- Type N stream crossings: “Are the alignment and slope of all culverts on grade with the natural streambed?” [WAC 222-24-040\(2\)\(3\)\(4\)\(5\)](#).
- Road Abandonment: “Was the road blocked so that four-wheel highway vehicles cannot pass the point of closure at the time of abandonment?” [WAC 222-24-052](#).

Haul Route Field Form:

The compliance monitoring field team uses the Haul Route Field Form to assess haul routes. The sampling method provides information to report the proportion of compliance/deviance, the level of sediment delivery (table 20), and the cause of the noncompliance (table 21).

Table 20: describes the five levels of sediment delivery: No delivery, De minimus, Low, Medium, and High used by the compliance monitoring field team for rating levels of sediment delivery as well as one decision type (No consensus).

Table 23: Haul Route Sediment Delivery Level Categories

Delivery Level	Delivery Level Description
No Delivery	Complete disconnection of sediment delivery to typed water. Considered compliant.
De minimus	Overland flow from roads reaches typed waters, but sediment delivery is indeterminable from background levels of turbidity. Considered compliant.
Low	Low or temporary delivery. Effects are observable at the site of entry (distance downstream less than one channel width) only, and not expected to magnify over time given the existing activity.
Medium	Measurable but non-critical levels of delivery. Visual plume at the reach scale.
High	Extensive or critical levels of delivery. Substantial violations of turbidity criteria or significant visual plumes that occupy the channel and goes beyond the reach scale (for example, around multiple bends in a stream).
No Consensus	The observers do not agree on the classification. Comments are essential to determine the scope of the difference, recording each observer’s classification and the basis of disagreement.

It is helpful to determine, to the extent possible, causes for sediment delivery. The compliance monitoring field team observes and records both primary and secondary causes of sediment delivery. Table 21 provides descriptions of potential sediment delivery causes.

Table 24: Potential Causes of Sediment Delivery

Potential Causes of Sediment Delivery	Cause Description
Faulty cross drainage	Inadequate frequency of or non-functioning drainage structures that carry road prism runoff or seepage, allowing sediment delivery to typed water.
Inadequate water crossing structures	Absence of or non-functioning structures designed to pass typed water across a forest road resulting in sediment delivery.
Obstructed or bermed ditch line	Features of the road surface or ditch that divert water normally serviced by the ditch causing sedimentation of typed water.
Intercepted water	Water intercepted by road features and diverted to a channel other than its channel of origin prior to the road construction.
Contaminated ditchwater	Ditchwater containing suspended sediment that flows into typed water.
Ruts - inadequate crown	Perturbations of the road surface contributing sediment to runoff reaching typed water.
Driving in ditch line	Vehicular disturbance of stabilized ditches resulting in sediment reaching typed water.
Haul on native surface or inadequate rock	Road haul on a running surface containing fine particles that are captured by runoff and contributed as sediment to typed water.
Water channeled to eroded-failing slopes	Water flow or runoff across un-stabilized road features that contributes sediment to typed water.
Road fill failure	Sediment resulting from the effects of gravity on the fill (slumps, raveling, etc.) being deposited in or carried by runoff to typed water.
Cut slope failure	Sediment resulting from the effects of gravity on the cut slope (slumps, raveling, etc.) being carried by ditch flow to typed water.

Findings for Roads and Haul Routes Statewide

This section summarizes data from both the Roads Field Forms and Haul Route Field Forms. The findings are separated into two categories.

Roads Findings

Road construction or abandonment occurred on an estimated 2049 FPAs in the 2012-2013 population. The sample consisted of 35 instances, of which 83% were industrial landowners. Table 25 provides statewide compliance information for road construction and abandonment activities by landowner type.

Table 25: FP Rule Compliance for 2012-2013 Road Activities

Statewide Road Activities for 2012-2013		
	Status of Compliance	Road Activities Rule Compliance
Small Forest Land-owners	# Compliant	6
	# with Deviation	1
	% Samples Compliant	86%
	95% Confidence Interval	(42, 100)
	Activity Totals	7
Industrial Land-owners	# Compliant	29
	# with Deviation	0
	% Samples Compliant	100%
	95% Confidence Interval	(88, 100)
	Activity Totals	29
All Land-owner Types	# Compliant	35
	# with Deviation	1
	% Samples Compliant	97%
	95% Confidence Interval	(86, 100)
	Grand Totals	36

*CI is confidence interval at the 95% confidence level.

In 2012-2013, road construction and abandonment activities were assessed as compliant on 35 of the 36 sites sampled. The one road with minor rule deviation was found with an 8” diameter relief culvert instead of the required 18” diameter culvert.

Haul Route Findings

The haul route sample included an inspection of the entire haul route between the FPA site to public access roads. In each sample, the entire road was observed if it was less than five miles long. If the entire road was over five miles then up to five miles of road segments were observed. Within each half mile, every 0.1 mile segment was recorded as to its actual or potential delivery of sediment to typed water and the primary and secondary causes for the delivery (see Table 21) were recorded. The compliance monitoring field team recorded compliance information for haul routes in general and also specifically for haul routes categorized by side slopes less than or greater than 60%. The side slope percent data provide information needed to fulfill requirements for Clean Water Act assurances (For more information see: [2009 Clean Water Act Assurances Review of Washington’s Forest Practices Program](#)). For the calculation method see appendix B – ratio proportions.

Table 26 summarizes the delivery level and compliance rates for overall haul route compliance. Forty-eight haul routes were assessed in the biennium.

Table 26: 2012-2013 Haul Route Compliance Summary

Compliant		Deviation		
94% (86, 100)CI*		6.3%(0, 14)CI		
No Delivery	De minimus	Low	Medium	High
76% (63, 89)CI	18% (6.2, 29)CI	5 % (0,13)CI	1 % (0, 3.2)CI	0%

*CI is confidence interval at the 95% confidence level, plus or minus a 12% margin of error.

Table 27 summarizes the primary and secondary causes for delivery of sediment along haul routes observed.

Table 27: 2012-2013 Percent of Haul Route Deviation by Cause

Primary Cause	Percent of deviation with this primary cause
Inadequate water crossing structures	24%
Sediment from stream adjacent parallel road	22%
Other (describe in comments)	17%
Road fill failure	15%
Contaminated ditchwater	10%
Haul on native surface or inadequate rock	10%
Water channeled to eroding/failing slopes	2%

*Over 60% of inadequate water crossings also exhibited road surface ruts or inadequate crowns that contributed to sediment delivery.

Table 27 shows that inadequate crossing structures for typed water (water crossings) and faulty relief drainage crossings accounted for 24% of the non-compliance followed closely by sedimentation from stream adjacent parallel roads, accounting for another 22%. For efficiency reasons, haul routes were observed on FPAs which had been selected for the harvest prescription sample. Since this is not an independent selection, there is some possibility of bias.

Tables 28 and 29 summarize haul route compliance by percent side-slope categories for haul route miles and by percent of total length.

Table 28: Haul Route Miles by Side Slope Category

Slope Category	No Delivery	De minimus	Compliant	Low	Medium	High	Deviation	Grand Total
Slope <60%	70.5	14.5	85.0	3.4	0.2	0.0	3.6	88.6
Slope >60%	1.0	0.0	1.0	0.0	0.5	0.0	0.5	1.5
Grand Total	71.5	14.5	86.0	3.4	0.7	0.0	4.1	90.1

Table 29: Haul Route Percent Compliance by Side Slope Category

Slope Category	No Delivery	De minimus	Compliant	Low	Medium	High	All Deviation
Slope <60%	80%	16%	96%	3.8%	0.23%	0%	4.1%
Slope >60%	67%	0%	67%	0%	33%	0%	33.3%

Overall Road Construction and Abandonment Comparison with the 2010-2011 Biennium

The overall 2012-2013 haul route compliance rate of 94% appears slightly lower than the 2011 rate of 96%; however, statistically they are considered to be the same. 2011 was the first season of the haul route prescription type sample.

5. Forest Practices Application Compliance



Section 5.0 of the report addresses compliance with the Forest Practice Application (FPA). The results for FPA compliance are displayed in Table 30.

Overall FPA compliance generally mirrors forest practices rule compliance on individual FPAs; however, occasionally one may be compliant while the other is not. When the prescription deviates from the FP rules, but is compliant with the FPA, there are typically mistakes in the layout and/or approval process. When the FPA is compliant with FP rules but deviates from the FPA specifications, typically the applicant proposed activities that were more conservative than what was implemented.

Table 30:2012 Compliance with the Forest Practices Application for Riparian and Wetland Harvest Prescriptions

Status of Compliance	Western Washington					Eastern Washington				Statewide				
	No Inner Zone Harvest	F or S No Outer Zone Harvest	DFC Option 1	DFC Option 2	Np Activities	No Inner Zone Harvest	F or S No Outer Zone Harvest	F or S Inner Zone Harvest	Np Activities	Ns Activities	Type A Wetland	Type B Wetland	Forested Wetland	
Small Forest Landowners	# Compliant	5	5	0	1	1	7	2	0	0	4	8	3	3
	# with Deviation	6	6	0	0	1	1	1	0	0	0	2	1	0
	% of Sample Compliant	45%	45%	n/a	100%	50%	88%	67%	n/a	n/a	100%	80%	75%	100%
	Confidence Interval	(18, 76)	(22, 71)	n/a	n/a	n/a	(53, 98)	(23, 89)	n/a	n/a	(40, 100)	(46, 88)	(21, 94)	(30, 100)
	Assessed	11	11	0	1	2	8	3	0	0	4	10	4	3
Industrial Landowners	# Compliant	35	14	17	30	16	21	8	0	6	21	11	13	13
	# with Deviation	12	7	16	17	8	5	3	0	1	0	0	0	1
	% of Sample Compliant	74%	67%	52%	64%	67%	81%	73%	n/a	86%	100%	100%	100%	93%
	Confidence Interval	(60, 86)	(48, 82)	(38, 65)	(50, 76)	(45, 84)	(64, 92)	(49, 89)	n/a	(42, 100)	(84, 100)	(73, 100)	(76, 100)	(67, 100)
	Assessed	47	21	33	47	24	26	11	0	7	21	11	13	14
All Landowners	# Compliant	40	19	17	31	17	28	10	0	6	25	19	16	16
	# with Deviation	18	13	16	17	9	6	4	0	1	0	2	1	1
	% of Sample Compliant	69%	59%	52%	65%	65%	82%	71%	n/a	86%	100%	90%	94%	94%
	Confidence Interval	(56, 80)	(45, 73)	(38, 65)	(51, 77)	(45, 83)	(68, 92)	(51, 87)	n/a	(42, 100)	(86, 100)	(71, 99)	(72, 100)	(72, 100)
	Assessed	58	32	33	48	26	34	14	0	7	25	21	17	17

Table 31 displays the count of prescription types and those instances where the assessment for FPA and rule are the same and when different, how they differ.

Table 31: Comparison between FPA and Rule Compliance Assessments by Count

	RMZ Prescription	Sample size	FPA & Rule are Assessed the Same	Deviates from FPA but Rule Compliant	FPA Compliant but Deviates from Rule	Deviates from FPA but Rule Indeterminate	FPA Compliant but Rule Indeterminate
Statewide	RMZ – Type Ns Prescriptions	26	25	0	1	0	0
	RMZ – Type Np Prescriptions	33	26	4	2	0	1
	WMZ – Type A Wetlands	21	18	2	0	0	1
	WMZ – Type B Wetlands	18	18	0	0	0	0
	WMZ – Type Forested Wetlands	17	17	0	0	0	0
Western Washington	RMZ – Type F or S No Outer Zone Harvest	32	22	10	0	0	0
	RMZ – Type F or S No Inner Zone Harvest	58	57	0	1	0	0
	RMZ – Type F or S Desired Future Condition Option 1	33	33	0	0	0	0
	RMZ – Type F or S Desired Future Condition Option 2	48	45	0	3	0	0
Eastern Washington	RMZ – Type F or S No Outer Zone Harvest	14	13	1	0	0	0
	RMZ – Type F or S No Inner Zone Harvest	34	34	0	0	0	0
	RMZ – Type F or S Inner Zone Harvest	0	0	0	0	0	0

Findings for FPA/Forest Practices Rule Compliance Differences

Differences between FPA compliance and FP rule compliance are few. Differences were found in the statewide Np Water, statewide Ns Water, Western and Eastern Washington No Outer Zone Harvest, W. WA. No Inner Zone Harvest, W. Washington DFC Option 2, and statewide Type A Wetland prescriptions.

- W. WA. No Outer Zone harvest prescription – The applicant was in compliance with the rules. The RMZ may have had some harvest in the outer zone but tree retention patterns still met the No Inner Zone harvest rules. This prescription has the highest count of differences between FPA and rule compliance. The difference is typically because the applicant harvested some trees from the outer zone while stating none would be harvested on the FPA. These are rule compliant because sufficient outer zone trees are left to meet the Outer Zone Harvest rules.
- Statewide Type Np prescription –The majority of the difference occurred as a deviation from the FPA. Applicants were in compliance with the FP rule; however, stated on the FPA that they were going to leave more length of buffer along the stream than they actually did upon completion of harvest.
- W. WA. DFC Option 2 prescription – There was one instance where the buffer was compliant with the FPA while deviating from the FP rule. The stream was measured over 10 feet wide, the stream was recorded less than 10 feet wide on the FPA. This resulted in incorrect protections being applied. The second DFC Option 2, the compliance monitoring field team found that the RMZ was longer than was stated on the FPA resulting in insufficient buffer length.
- Statewide Type A Wetlands prescription – In two cases of FPA/FP rule difference, Type F physical characteristics or fish were observed on the feature. The third difference was recorded as rule indeterminate.
- Indeterminate – The two indeterminate calls for an Np and a Type A wetland resulted from undetermined connectivity of water and Type A wetland because of possible physical characteristics of a Type F stream.
- Statewide Ns Prescription – This prescription had one instance assessed differently, the rule assessment deviated, and the FPA assessment did not.

6. Report Discussion

This section includes: an overview of compliance by prescription type in descending order of occurrence frequency; discussion of the final results for the Exempt 20-acre parcel Emphasis Sample; and assessment of compliance monitoring program changes to address challenges, including those instituted in 2012-2013 and program adaptations to be established in 2014.

6.1 Common Reasons Contributing to Compliance Deviation

The most frequent reason for deviation on Type F or S RMZ's was the understocking of the outer zone leave trees. This issue occurred in all Type F or S prescription types. The most frequent causes attributed to the missing outer zone trees are layout errors or operator errors. Layout reasons would be if zone boundaries are not well marked. Operator reasons occur individual trees are harvested that were intended to be left. From the field reviewers' point of view the issue would be much less common if the outer zone leave trees were individually marked in the layout process.

The desired future conditions options experienced some problems with the inner zone harvest. The DFC option ones with inner zone deviation typically had insufficient trees in some diameter classes. The DFC option 2 inner zone deviations were most commonly attributed to harvest in the floor zone.

The most common reason for type Np deviation was trees harvested in the 50 foot no cut buffer. Other reasons were misclassification of the water type and incorrect length of the no cut buffer.

6.2 Compliance with Forest Practices Rules for Riparian and Wetland Harvest Prescriptions Proportioned Across the Population

This section is intended to provide the reader with a sense of compliance across the landscape. Table 32 shows the estimated population size of each prescription together with the compliance rate of the prescription. The population sizes are listed in decreasing order. Prescriptions with zero occurrences are not shown.

Table 32 –Estimated Population Sizes and Associated FP Rule Compliance

Prescription Type	Estimated Population of FPAs with the Prescription	% Samples Compliant
RMZ – Type Ns Prescriptions Statewide	1932	96%
RMZ – Type Np Prescriptions Statewide	1908	78%
Western Washington RMZ – Type F or S No Inner Zone Harvest	753	67%
Type Forested Wetlands Statewide	593	94%
Western Washington RMZ – Type F or S Desired Future Condition Option 2	369	58%
Type B Wetlands Statewide	296	94%
Type A Wetlands Statewide	215	80%
Western Washington RMZ – Type F or S No Outer Zone Harvest	210	91%
Eastern Washington RMZ – Type F or S No Inner Zone Harvest	186	82%
Western Washington RMZ – Type F or S Desired Future Condition Option 1	140	52%
Eastern Washington RMZ – Type F or S No Outer Zone Harvest	75	79%

The most commonly applied prescriptions are Type Np riparian harvests and Type Ns activities (ELZ required). These are followed by Western Washington Type F or S No Inner Zone Harvest and DFC Option 2. Eastern Washington Type F or S Inner Zone Harvest occurs very rarely (see Table 5). This prescription did not occur at all during the 2012-2013 sample and will be removed from the standard sample in the future. It may be considered for an emphasis sample.

6.3 Emphasis Sample: RMZ exempt 20-acre parcels

This section discusses the Emphasis Sample of RMZ exempt 20-acre parcels completed in 2012. The FPAs in this emphasis population were from June 2011 through June 2012. There is no change in this section from the 2012 interim report.

The RMZ exempt 20-acre parcels prescription type showed 57% of the population was compliant with all FP rules in the prescription type. The 28 sites sampled represented a census of the population. The 2008 compliance rate was 62% with a 95% confidence interval of (54, 68). Because the 2012 compliance rate of 57% lies within the 2008 confidence interval, the 2012 compliance rate is not significantly different from the 2008 compliance rate for RMZ exempt 20 acre parcels. This means that the compliance rate in 2008 and the compliance rate in 2012 are statistically the same and there has been no change in compliance for RMZ exempt 20-acre parcels since 2008.

The FP Program wrote a Compliance Action Plan in May 2011 which delineated steps to help improve compliance for specific prescription types, including RMZ exempt 20-acre parcels. The Compliance Action Plan requested that the following actions occur for RMZ exempt 20-acre parcel FPAs:

- The applicant was requested to notify the forest practices program 48 hours prior to beginning harvest operations;
- Forest practices foresters will make a minimum of two on-site evaluations during the active period of the FPA; and
- Continue compliance monitoring surveys of RMZ exempt 20-acre parcel harvests.

The Regions reported that very few RMZ exempt 20-acre parcel landowners notified the DNR prior to beginning harvest operations and that the forest practices foresters visited some of the FPAs, typically post-harvest.

The FP program will continue to pursue options that address and improve compliance such as educational opportunities for RMZ exempt 20-acre parcel landowners and operators through media and meeting events, and training opportunities in collaboration with stakeholders that represent the landowner, consultant, and operator communities.

6.4 CMP Program Changes to Address Challenges

The CMP continuously seeks to improve its program design and techniques. This section describes program changes instituted in 2012-2013 and their effects; and design changes to be implemented in the 2014-2015 biennium.

6.4.1 Implementation of 2012-2013 sampling changes

In late 2011, the program reviewed the CMP sampling strategy with the intent of improving statistical confidence of future estimates over those of previous biennia estimates. The design that was chosen for improvement purposes used sample size estimation for each prescription type with a target of a 12% margin of error at a 95% confidence level. The design change resulted in the need for a larger sample size but the compliance workload per FPA appeared, initially, to be less.

6.4.2 Results of Design changes implemented 2012-2013

The sampling changes implemented (as described in 6.3.1) equated to improved confidence intervals in 2012-2013 over previous biennia, particularly for the less frequently occurring prescription types. However, the improved confidence intervals came at a higher cost than anticipated.

Once the improved confidence intervals were implemented, the program found the following:

- The advance work required to screen FPAs increased substantially, requiring more staff time than expected.
- The revised on-the-ground sampling required substantially more field and travel time. The 2013 field season ran from the last week in January into late November. In previous years, the season ran from mid-February to mid-November.
- Region FP staff participation increased more than anticipated.
- Overall, the changes drove program costs up due to more staff time required to accomplish the workload.

DNR staff determined during the summer of 2013 that the revised program design was not sustainable for long-term implementation. The impact on program resources was too great. This determination led to an intensive program review.

6.4.3 Intensive Program Review

CMP staff performed an intensive monitoring program review beginning fall of 2013, with the results of the review intended to be part of the 2014 field sampling season. The review was conducted in two stages; first, a review of other states' monitoring programs, and second, a comparison and analysis of Washington State's monitoring program and recommended changes. Stage one of the review included a survey of all existing states' programs, including: the southeastern states, northeast states, upper Midwest, Montana, Idaho, Oregon and California. Stage two was to be directed by significant findings, if any, discovered during stage one of the intensive review.

Results:

The results from stage one of the intensive program review showed similarities among the other states' monitoring programs. Key similarities include the following:

- Monitoring evaluations are based on assessments of individual rules or "Best Management Practices".
- The monitoring program data is analyzed at statewide levels providing statewide averages.
- The precision of assessment is typically less rigorous than required in Washington. For example, where Washington State uses instrument measurements another state might rely on ocular estimates.
- Observations are recorded and agreed to by the observation teams.

The results from stage one of the intensive program review provided a comparison to Washington's CMP sampling methods. CMP staff concluded it might be possible to improve current sampling methods. The staff requested approval to move to stage two where analysis of new possibilities could

move forward. Stage two of the intensive program review was approved by DNR’s Executive Management indicating that stage two was to include the following:

- Maintain or improve current statistical confidence in reported compliance figures for commonly used prescriptions, and improve confidence in rarely used prescriptions;
- Provide improved utility and accuracy for rate-of-compliance figures for riparian management zone prescriptions, and other prescriptions if possible and warranted;
- Provide a statistically acceptable method of accounting for measurement and sample error tolerances;
- Improve detection of changes in compliance trends and their underlying causes over time; and
- Inform options for reapportioning resource focus to enable additional emphasis sampling, subsampling for noncompliance investigations, and training.

In order to address Executive Management’s five requirements for program improvement, CMP staff consulted with a contract statistician and developed several options for consideration.

Executive Management reviewed the proposals and approved a design change that assesses all the rules directed at a particular prescription individually, with each rule contributing to the average compliance rate of the prescription. Previously, any one rule deviation caused the entire prescription to be non-compliant. The detailed design revision is found in the Compliance Monitoring Program Description and will be implemented in the 2014 field sampling season

Comparison of Current and New Methods using DFC Option 1:

This section provides an example of DFC Option 1, assessed first using current assessment processes and second using the approved design change. The following list shows the individual rules that can apply and are assessed by CMP under DFC Option 1 prescription type.

1. Species composition on the FPA is consistent with that observed by CMP.
2. Site class on the FPA is consistent with CMP determination using approved data.
3. Type F stream size is not larger than the threshold reported.
4. Unstable slopes, if present, are bounded out of the harvested area.
5. Harvest has not occurred in the core zone.
6. Inner zone harvest left the modeled number and size of trees.
7. No harvest occurs among the 57 largest inner zone trees per acre.
8. No CMZ was observed to be present that was not reported on the FPA.
9. The correct number of outer zone leave trees were observed to be left.

Table 33 uses the current data form (2012-2013) and obtains the results generated by the ratio proportion binomial assessment. This method was used for results in this and previous reports. If any one of the nine rules above deviated from compliance, the entire prescription type was assessed as a deviation.

Table 33 DFC 1 Compliance Using Ratio Proportion Binomial Assessment

DFC Option 1 Binomial ratio estimation	Compliant prescriptions	Sample size (Number of Prescriptions)	Confidence interval half- width (margin of error)
(Count)	17	33	
(Percent)	52%		13.5%

Table 34 uses the same data that Table 1 uses and finds different results using the mean or average compliance. The variance of the mean is calculated according to the rules of estimation for cluster samples. The mean compliance for a prescription is the ratio of the number of compliant rule applications divided by the total number of rule applications across all FPAs in the sample.

Table 34 DFC 1 Compliance Using Cluster Analysis Method

DFC Option 1 Ratio of compliant rule applications	Compliant rule applications	Sample size (Number of Prescriptions)	Confidence interval half- width (margin of error)
(Count)	232	33	
(Percent)	86.6%		4.6%

The difference in these compliance rates shows that almost half of the FPAs have at least one rule that is not

compliant, but, on average, 87% of the DFC Option 1 rules were complied with.

Benefits to Changing Compliance Metrics:

While each compliance percentage uses a different metric, the latter method has some distinct advantages.

- The method will require a smaller sample of FPAs which lowers program costs and allows more flexibility for possible emphasis samples or sampling upland prescriptions. The revised estimate observes the same prescriptions assessed in the 2012-2013 report, which will not require substantial changes in field procedures.
- The program will be able to use the data from previous biennia and produce results using the cluster sampling ratio method which will allow a comprehensive comparison.

The higher precision of the estimate in the new sampling method will improve results when determining trends.

6.4.4 Changes in Sample and Measurement Error

Changes are being made regarding the use of a 5% measurement error in two instances. First, the CMP has addressed the inability to determine statistical variability on average values by assigning a standard absolute 5% measurement error tolerance for two specific measurements; stream widths and buffer widths or floors within no-harvest RMZ areas. Second, the compliance monitoring field team has been using a 5% measurement error tolerance to assess no cut zones such as Type Np buffers and Type F and S core zones. In both cases, when an applicant’s estimate is within 5% of the compliance monitoring field team’s measurements, the values are considered the same. If the applicant’s estimate varies more than 5%, the compliance monitoring field team estimate will be considered correct and the applicant’s average estimate as incorrect.

Measurement Error Involving Averages:

Measurement methods involving averages such as stream width continue to be contentious because of the application of the absolute error value of 5%. This is problematic when the stream width average is close to the threshold width (ex. 9.8 feet vs. 10 feet). CMP reviewed statistical approaches using the measurement data to assess the probability of meeting bankfull width threshold values.

The requirement of the rule is that the applicant takes 10 measurements, averages them, and then uses the result to represent the width of the stream or buffer. There is no way to determine with certainty whether this rule was followed, but we can assess the probability it was followed, by assuming the applicant's measurement and sampling error are similar to the CMP's measurement and sampling error.

The CMP would sample more than 10 systematic locations on the stream unless the reach is shorter than 250 feet. The mean and variance of these samples is used as an estimate of the mean and variance in the population of all possible samples. From this distributional assumption, we can estimate the probability that a sample mean from a sample of size 10 would be as different (or more different) from the CMP mean as the observed difference. If this probability is less than 20%, the CMP would note a deviation from the rule.

As a test, this revised method was used to evaluate reaches sampled in 2012-2013 that were judged to be deviations due to falling outside of the 5% tolerance range for the measurement. The sample included three Type F and three Type Np waters. Of these six samples, there was one Type F stream which would be assumed compliant using the new method. For this stream, the CMP estimated a mean bankfull width of 11 feet, but there was considerable variability in the measurements. Using the new method, the probability that a mean of 10 samples from a population with mean width of 11 feet and the observed variance would be 10 feet or less is 31%. Because this probability is >20%, the new procedure would not label this application as having a rule deviation. There is a reasonable probability that the rule was followed and the applicant sampled 10 locations and found an average bankfull width of 10 feet or less.

Buffer or Zone Width Measurement Error:

The compliance monitoring field team has been using a 5% measurement error tolerance to assess no cut zones such as Type Np buffers and Type F and S core zones. This biennium, the sample size was larger than previous biennia for DFC Options 1 and 2. This helped facilitate the field team discovery that measurement error needs to be transferred to the adjacent zones such as the inner and outer zones.

For instance, the CMP field team found that particularly where streams are highly sinuous, core zone measurement error also affected the inner and outer zone tree counts. If the applicant's core zone extended landward from the CMP teams measurement, the applicant's core zone trees were counted in the inner zone count. The effect is compounded through the zones and applicant's inner zone trees were counted in the outer zone. It is possible that some applicant's outer zone trees were not counted because the distance from the bankfull width stream edge was greater than the prescribed outer zone distance.

To avoid this in the future, the CMP will apply a 5% measurement tolerance to all adjacent zones.

7. Conclusions

The Compliance Monitoring program provides a systematic, unbiased approach to determine forest practices compliance. The process is built on a biennial cycle with two field seasons (years) of collecting data to obtain required sample sizes.

The Emphasis Sample, RMZ exempt 20-acre parcels, showed 57% of samples were assessed as compliant with all the FP rules included in the prescription type. Statistically, this indicates that

compliance has not changed for this prescription type since 2008 (62%) when the prescription type was initially sampled.

Challenges remain to improve compliance goals in the outer and inner zones of Type F harvest prescriptions.

Haul route compliance rates continue to meet standards.

Changes in sampling design resulted in improved confidence intervals in 2012-2013 over previous biennia, but are not sustainable for long-term implementation.

Anticipated design changes to sampling methods that assesses all the forest practices rules associated with a riparian harvest prescription individually will be more efficient and allow the program to reassess previous data to determine trends over time.

8. Recommendations

RMZ exempt 20-acre parcels

The FP program should continue to pursue options that can help to increase compliance for this prescription type.

Haul Routes

Landowners and the FP Program should continue to follow the current successful process for maintaining and complying haul routes as well as continue to work toward increasing compliance rates.

Outer Zone Leave Trees

The FP program needs to communicate to the applicant community the problem with insufficient outer zone leave trees on Type F RMZs. Consider requesting applicants to count and mark outer zone trees to ensure the correct number of leave trees remain after harvest.

Marking Stream Reach Measurements

The CMP encourages applicants to mark bankfull width measurement points and the beginning and end of stream reaches. If those measurement points are well marked to be found by the CMP review team, those measurement points will be used by the CMP team improving consistency with the land owners results.

9. FP Program and FP Rule Changes Based on Compliance Monitoring Feedback

While no Forest Practices rule changes were made as a result of the CMP 2010-2011 biennium report findings, the Forest Practices program has responded with a number of actions to address issues detected through compliance monitoring.

Development of Water Type Modification Form

Water Typing problems were illuminated in the 2010-2011 CMP report. In response, the agency took two actions. The Water Type Modification Form was revised in 2013 to provide better detail about the location of water type breaks and stream physical characteristics, and the Water Type Classification Worksheet was revised to require applicants to review the reach upstream to assess if Type F water physical characteristics are present.

Administrative Changes regarding Shade Rule Documentation

CMP review of the shade rule discovered that there was no requirement for applicants to document their shade assessment when harvesting adjacent to a Type S or F stream within 75 feet of bankfull width, except for FPAs associated with exempt 20-acre parcels. In response, the FP program revised the FPA form. This revision in question 21 directs all applicants to “*Include stream shade analysis calculation if you are harvesting within 75 feet of S or F waters.*” This direction will provide a record in the FPA documenting the assessment results. See Appendix B for information from 2012. The FP Operations section reinstated the shade documentation form within the FPA instructions on June 1, 2014. Those FPAs using the new instructions will be selectable in the 2017 Sample.

Water Type-Bankfull Width Training

In response to the need to improve water classification skills, the FP program developed Water Type and Bankfull Width training which is being presented to all DNR region FP staff. This will provide the basis for consistent interpretation statewide. The Timber-Fish-Wildlife (TFW) stakeholder community was also trained during TFW meetings in each region in 2012 and 2013. The FP Operations program continues to train the TFW stakeholder community twice a year, every year, at Washington Contract Loggers Association Training.

10. Glossary

Bankfull Width –

- (a) For streams – The measurement of the horizontal extent of the water surface elevation perpendicular to the channel at bankfull depth. In cases where multiple channels exist, bankfull width is the sum of the individual channel widths along the cross-section (see board manual Section 2).
- (b) For lakes, ponds, and impoundments – Line of mean high water.
- (c) For tidal water – Line of mean high tide.
- (d) For periodically inundated areas of associated wetlands – Line of periodic inundation, which will be found by examining the edge of inundation to ascertain where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland.

Basal Area – The area in square feet of the cross section of a tree bole measured at 4 1/2 feet above the ground.

Bull Trout Habitat Overlay – Portions of eastern Washington streams containing bull trout habitat as identified on the department of fish and wildlife's bull trout map.

Channel Migration Zone – Area where the active channel of a stream is prone to move and this results in a potential near-term loss of riparian function and associated habitat adjacent to the stream, except as modified by a permanent levee or dike. For this purpose, near-term means the time scale required to grow a mature forest. (See board manual Section 2 for descriptions and illustrations of CMZs and delineation guidelines.)

Clearcut – Harvest method in which the entire stand of trees is removed in one timber harvesting operation (except for trees required by rule or law to be left uncut).

Confidence Interval (or margin of error) – Describes the amount of uncertainty associated with the statistic, in this case the rule compliance means. Confidence intervals consist of a range of values (interval) of a sample statistic that is likely, at a given level of confidence (e.g., 95%), to contain the true population parameter, (in this case, the true compliance mean).

Confidence Level – The likelihood that another sample will provide the same results. It is a measure of how confident we are in a given margin of error, or confidence interval. The 95% confidence level was used in this study.

Crown closure – Percent of canopy overlying the forest floor.

Desired Future Condition (DFC) –DFC means the stand conditions of a mature riparian forest at 140 years of age, the midpoint between 80 and 200 years. Where basal area is the only stand attribute used to describe 140-year old stands, these are referred to as the “Target Basal Area.”

Diameter Breast Height (DBH) – the diameter of a tree at 4-1/2 feet above the ground measured from the uphill side.

Dominant and Co-dominant Trees –

- Dominant – Trees or shrubs with crowns receiving full light from above and partly from the side; usually larger than the average trees or shrubs in the stand, with crowns that extend above the general level of the canopy and that are well developed but possibly somewhat crowded on the sides.
- Co-dominant – A tree that extends its crown into the canopy and receives direct sunlight from above but limited sunlight from the sides. One or more sides of a co-dominant tree are crowded by the crowns of dominant trees.

Equipment Limitation Zone – A 30-foot-wide zone measured horizontally from the outer edge of the bankfull width of a Type Np or Ns Water. It applies to all perennial and seasonal non-fish bearing streams.

Finite population correction factor – The finite population correction factor is a formula often used in statistics and probability. This formula allows you to adjust a population from bigger to smaller or to indicate no change in the population. The result of the formula's calculation is called the z-factor.

Flood level – 100 year – A calculated flood event flow based on an engineering computation of flood magnitude that has a 1 percent chance of occurring in any given year.

Forest Practices Application-Notification (FPA-N) – Form used by forest landowners to notify DNR they are conducting a Class II forest practice or to apply for approval of forest practices for a Class III or Class IV forest practice.

- An FPN is a notification to DNR that a Class II forest practice will take place. Class II forest practices have been determined to have less than ordinary potential to damage a public resource.
- An FPA is an application for a permit to conduct a Class III or Class IV forest practice. Class III and Class IV forest practices have a higher potential to impact a public resource than does a Class II forest practice.

End hauling – Removal and transportation of excavated material, pit or quarry overburden, or landing or road cut material from the excavation site to a deposit site not adjacent to the point of removal.

Forest road – Ways, lanes, roads, or driveways on forest land used since 1974 for forest practices. "Forest road" does not include skid trails, highways, or local government roads except where the local governmental entity is a forest landowner. For road maintenance and abandonment planning purposes only, "forest road" does not include forest roads used exclusively for residential access located on a small forest landowner's forest land.

Full bench road – Road constructed on a side hill without using any of the material removed from the hillside as a part of the road. This construction technique is usually used on steep or unstable slopes.

Laser hypsometer – Instrument that measures distances to the top and bottom of objects, and the angle between the lines from the observer to each to calculate height of the object.

Margin of error (or confidence interval) – Expresses the amount of error in the sample at a certain confidence level, which is 95% in this study. It is basically half the width of the confidence interval. A 12% margin of error was used in this study.

Partial Cut strategy – The removal of a portion of the merchantable volume in a stand of timber so as to leave an uneven-aged stand of well-distributed residual, healthy trees that will reasonably utilize the productivity of the soil.

Public Resources – Water, fish, and wildlife and in addition means capital improvements of the state or its political subdivisions.

Riparian function – Includes bank stability, the recruitment of woody debris, leaf litter fall, nutrients, sediment filtering, shade, and other riparian features that are important to both riparian forest and aquatic system conditions.

Riparian Management Zone – A Riparian Management Zone (RMZ) is the area that is located on each side of a Type S, F or N stream where trees are left to provide protection from disturbance when forest practices activities such as timber harvest are conducted.

Sensitive sites – Areas near or adjacent to Type Np Water and have one or more of the following:

- **Headwall seep** is a seep located at the toe of a cliff or other steep topographical feature and at the head of a Type Np Water which connects to the stream channel network via overland flow, and is characterized by loose substrate and-or fractured bedrock with perennial water at or near the surface throughout the year.
- **Side-slope seep** is a seep within 100 feet of a Type Np Water located on side-slopes which are greater than 20 percent, connected to the stream channel network via overland flow, and characterized by loose substrate and fractured bedrock, excluding muck with perennial water at or near the surface throughout the year. Water delivery to the Type Np channel is visible by someone standing in or near the stream.
- **Type Np intersection** is the intersection of two or more Type Np Waters.
- **Headwater spring** means a permanent spring at the head of a perennial channel. Where a headwater spring can be found, it will coincide with the uppermost extent of Type Np Water.
- **Alluvial fan** means a depositional land form consisting of cone-shaped deposit of water-borne, often coarse-sized sediments.

Sidecast – Act of moving excavated material to the side and depositing such material within the limits of construction or dumping over the side and outside the limits of construction.

Significance level – A fixed probability of wrongly rejecting the null hypothesis H_0 , when the hypothesis is in fact true. The smaller the significance level the better the protection for the null hypothesis and prevent, as far as possible, the investigator from inadvertently making false claims.

Site Class – The site class is a growth potential rating for trees within a given area based upon soil surveys. The designated site class along type S or F streams will determine the width of the RMZ.

Site Index: An index based on ranges of site classes. For example:

50-year site index range

(state soil survey)

I	137+
II	119-136
III	97-118
IV	76-96
V	<75

Stand Requirement – A number of trees per acre, the basal area and the proportion of conifer in the combined core and inner zone so that the growth of the trees would meet desired future condition.

Stream Adjacent Parallel Roads – Roads (including associated right of way clearing) in a riparian management zone on a property that have an alignment that is parallel to the general alignment of the stream, including roads used by others under easements or cooperative road agreements. Also included are stream crossings where the alignment of the road continues to parallel the stream for more than 250 feet on either side of the stream. Not included are federal, state, county or municipal roads that are not subject to forest practices rules, or roads of another adjacent landowner.

Temporary road – A forest road that is constructed and intended for use during the life of an approved forest practices application-notification.

Uppermost point of perennial flow – The point in the stream where stream water begins to flow perennially (year round) downstream.

Wetland Management zone – Area located around the perimeter of a wetland where trees are left to provide protection from disturbance, as well as shade and nutrients for the wetlands.

Yarding Corridor – A narrow, linear path through an RMZ to allow suspended cables necessary to support cable logging methods or suspended or partially suspended logs to be transported through these areas by cable logging methods.

11. Appendix

Appendix A

Statistical Methods

Methods for Confidence Intervals

There are two types of compliance proportions estimated in this report, simple proportions and ratio proportions. Estimation for both types is described below with examples.

Simple Proportions

Most compliance proportions estimated in this document are simple proportions. FPAs containing individual prescriptions are sampled until the target sample size is reached. One prescription is evaluated for each FPA, so the compliance proportion is simply the number of compliant FPAs divided by the total sampled for each prescription. This is a binomial proportion, and 95 percent confidence intervals were estimated using the F-distribution as described in Zar (1996; p524):

$$LCL = \frac{X}{X + (n - X + 1) * F_{\alpha(2), \nu_1, \nu_2}},$$

$$UCL = \frac{(X + 1) * F_{\alpha(2), \varpi_1, \varpi_2}}{n - X + (X + 1) * F_{\alpha(2), \varpi_1, \varpi_2}},$$

Where

LCL = Lower Confidence Limit

UCL = Upper Confidence Limit

X = the number of compliant activities

n = the total number of activities,

F = the F-distribution critical value for the given alpha and degrees of freedom,
 $\nu_1 = 2(n - X + 1)$

$$\nu_2 = 2X$$

$$\varpi_1 = 2(X + 1)$$

$$\varpi_2 = 2(n - X)$$

These binomial confidence intervals are not symmetric.

Because there is a finite population of FPAs, we correct the confidence intervals using the finite population correction factor. The overall population size for each prescription (i.e., the number of completed FPAs containing the prescription) is not known, but can be estimated based on the number of FPAs that were opened

and were found to be part of the population containing the given prescription. We estimate N for an individual prescription as follows:

$$\hat{N} = \frac{n_1 \times F_1}{f_1},$$

Where

F_1 = the total number of FPAs approved in Year 1,

f_1 = the number of FPAs evaluated for membership in the population (“opened”) in Year 1,

n_1 = the number of FPAs opened that contained road/riparian prescriptions in Year 1,

The finite population correction factor (FPCF) is $1 - \frac{n}{\hat{N}}$.

To correct the confidence intervals for the finite population, we follow the equation in Zar (1996, p 527) as follows:

$$LCL_c = \frac{X - 0.5}{n} - \left(\frac{X - 0.5}{n} - LCL \right) \times \sqrt{1 - \frac{n}{\hat{N}}}$$

$$UCL_c = \frac{X + \frac{X}{n}}{n} + \left(UCL - \frac{X + \frac{X}{n}}{n} \right) \times \sqrt{1 - \frac{n}{\hat{N}}}$$

It is possible for the upper confidence bound to exceed 100% – in these cases the confidence bound is set to 100%.

Example

The proportion of statewide Type A Wetland prescriptions that are compliant is an example of a simple proportion. For 2012, there were 12 FPAs containing Type A Wetland prescriptions that were evaluated for application compliance. Of these, 10 were compliant with the application.

$$n = 12$$

$$X = 10$$

$$10/12 = 0.83 \text{ (83\% compliant)}$$

$$v1 = 6$$

$$v2 = 20$$

$$\varpi1 = 22$$

$$\varpi2 = 4$$

$$LCL = \frac{10}{10 + (12 - 10 + 1) * 3.128} = 0.52(52\%)$$

$$UCL = \frac{11 * 8.533}{12 - 10 + (11) * 8.533} = 0.98(98\%)$$

The population estimate for 2012 Type A Wetlands is 54. Correcting for finite populations:

$$LCL_c = \frac{10 - 0.5}{12} - \left(\frac{10 - 0.5}{12} - 0.52 \right) \times \sqrt{1 - \frac{12}{54}} = 0.55 (55\%)$$

$$UCL_c = \frac{10 + 0.83}{12} + \left(0.98 - \frac{10 + 0.83}{12} \right) \times \sqrt{1 - \frac{12}{54}} = 0.97 (97\%)$$

In this case, the FPCF changed the confidence interval from (52,98) to (55,97).

Ratio Proportions

There are some compliance proportions that are estimated using a ratio proportion. This is necessary when both the numerator and the denominator of the proportion are random variables. The only estimation that used a ratio proportion for 2012 was the haul route analysis. The haul route compliance for each FPA is the length of road that is compliant divided by the length of road evaluated. Because the length of road being evaluated differs among FPAs, the denominator of the compliance ratio is a random variable. In this case, the estimated compliance proportion is:

$$\hat{p} = \frac{\sum_{i=1}^n y_i}{\sum_{i=1}^n x_i},$$

which is the total length of compliant haul route segments divided by the total length of haul route segments that were sampled across all FPAs (n is the number of FPAs sampled).

A 95 percent confidence interval for the proportion compliant is formed as follows:

$$\hat{p} \pm t_{.025, (n-1)} \cdot SE(\hat{p}),$$

where $t_{.025, (n-1)}$ is the 97.5th percentile of the student- t distribution with $(n-1)$ degrees of freedom, n is the number of sampled FPAs, and

$$SE(\hat{p}) = \frac{\sqrt{n \cdot \left(1 - \frac{n}{N}\right) \cdot \sum_{i=1}^n (y_i - \hat{p}x_i)^2}}{\sqrt{(n-1)} \cdot \sum_{i=1}^n x_i} \quad (\text{Cochran, 1977, p32}).$$

These confidence intervals are symmetric. Note that the FPCF is already built in to this equation. It is possible for the upper confidence bound to exceed 100% — in these cases the confidence bound is set to 100%.

12. References

Cochran, William G. (1977). *Sampling Techniques*. John Wiley & Sons, New York.

Efron, Bradley (1987). "Better Bootstrap Confidence Intervals." *Journal of the American Statistical Association*, 82 (397): 171-185.

Zar, Jerrold H. (1996). *Biostatistical Analysis*. Third Edition. Prentice Hall. Upper Saddle River, New Jersey.