Idaho's 2000 Forest Practices Water Quality Audit

Final Report

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ACKNOWLEDGEMENTS

The members of the 2000 Forest Practices Water Quality Audit Team appreciate the help of the Idaho Department of Lands and the U.S. Forest Service staff in assembling information on the timber sales and assisting with the sale visits. The FPWQ Audit team also recognizes the assistance provided by Lyn Morelan and the Idaho Forest Practices Act Advisory Committee in planning the FPWQ Audit. The final FPWQ Audit report was completed through the editing and preparation assistance provided by Don Zaroban and Leslie Jercha of the Idaho Department of Environmental Quality.

EXECUTIVE SUMMARY

The fifth statewide Forest Practices Water Quality Audit (FPWQ) was conducted between July and September 2000. The purpose of the FPWQ Audit was to assess the application and function of the forest practices described in the 1998 Forest Practices Act (FPA). The 2000 FPWQ Audit team was comprised of representatives from the Idaho Department of Lands, the Idaho Department of Fish and Game, the Intermountain Forest Association, the Idaho Forest Owners Association, the U. S. Forest Service, and the Idaho Department of Environmental Quality. Timber sales were randomly selected from sales harvested between 1996 and 1999 that:

- Occurred on unstable geologic types, and
- Bordered or encompassed a Class I stream.

The 2000 FPWQ Audit addressed the FPA requirements for timber harvest and road construction and maintenance, focusing on the specifications for shade, leave tree, site-specific riparian management plans, and fish passage. From their findings, the FPWQ Audit team made the following recommendations:

- Changing the shade requirements to account for fish species distribution, elevation and yearly variations in climate, in situations where the desired shade amounts do not naturally occur.

- Revising the FPA table that specifies the number of trees to be left in the stream protection zone to account for natural variation in tree stand density and climate between north and south Idaho.

- Developing a point system for large organic debris recruitment in order to express standing tree requirements as a minimum number of points per 1,000-feet of stream, distributed across all size classes present.

- Identifying the need for a site-specific riparian management plan when the Notification of Forest Practices form is completed. Currently, site-specific riparian management plans appear to be overlooked.

- Ensuring that adequate fish passage is provided at stream crossings by having culverts shorter than 50-feet be installed at less than a 1.0% grade and culverts longer than 50-feet be installed at less than 0.5% grade unless special installation measures are taken.

INTRODUCTION

The *Idaho Nonpoint Source Management Plan* (Dailey et al. 1999) lists long-term goals and short-term objectives for silvicultural activities in Idaho, which include auditing, refinement and implementation of forest practices to enhance water quality. The Idaho Department of Lands Forest Practices Act (FPA) implements the goals and objectives of the *Idaho Nonpoint Source Management Plan* that pertain to forest practices. The approved management practices for Idaho forests are regulated by:

- the 2000 Idaho Department of Lands (IDL), Title 38, Chapter 13, Idaho Code, *Rules Pertaining to the Idaho Forest Practices Act* (FPA *Rules*), as adopted by the Board of Land Commissioners, and
- the 2000 Idaho Department of Environmental Quality (DEQ), *Water Quality Standards and Wastewater Treatment Requirements* (*Water Quality Standards*) for water quality protection.

As outlined in the *Idaho Nonpoint Source Management Plan,* Appendix A-2, DEQ is responsible to coordinate and chair the statewide Forest Practices Water Quality Audit (the FPWQ Audit) every fourth year. Audits have been conducted previously in 1984, 1988, 1992, and 1996. By conducting the FPWQ Audit and recommending revisions to the FPA *Rules*, the FPWQ Audit team also implements the management practice evaluation and modification provisions of the *Water Quality Standards.* The FPWQ Audit is one step in the process to determine if forest practices are being implemented and maintained on the ground and if water pollutants are being effectively controlled.

Findings and recommendations from the FPWQ Audit are reported to the Idaho Governor, the Forest Practices Steering Committee, the Forest Practices Act Advisory Committee, and the Idaho Board of Land Commissioners. The report also goes to the Idaho Board of Environmental Quality and the Idaho Department of Lands for their consideration.

Purpose and Objectives

The purpose of the FPWQ Audit is to conduct on-site reviews and to assess the application and function of the forest practices described in the FPA *Rules.* To accomplish this, the FPWQ Audit team undertook several objectives:

- assess the extent to which the FPA *Rules* were implemented and whether they functioned as intended when properly applied and maintained;
- determine if the FPA *Rules* are effective in protecting stream habitat: by maintaining large organic debris (LOD) recruitment, by meeting shade needs, by ensuring fish passage at stream crossings, and by preventing sediment delivery from roads; and
- recommend rule and administrative procedure revisions to the FPA *Rules,* as indicated by FPWQ Audit findings, and to ensure compliance with the *Water Quality Standards* and the Federal Water Pollution Control Act, as amended (Clean Water Act).

Scope and Interpretation

The methods used in the FPWQ Audit determine the extent of appropriate interpretation that can be made from the findings and needed 1) to yield data comparable to previous FPWQ Audits as well as 2) to fit within reasonable time and logistical constraints.

For water quality purposes, answering three primary questions monitors management practice effectiveness. These questions are: 1) have the practices been properly applied and maintained; 2) are the practices functioning as intended; and 3) are the practices causing the desired in-stream results? The FPWQ Audit was designed to answer these questions.

The focus of the FPWQ Audit was to assess applications of the FPA *Rules* in areas most susceptible to erosion. To do so, the FPWQ Audit team looked at timber sales randomly selected from a pool of sales determined to be in such areas. In looking at applications of the FPA *Rules,* more than one may apply to a given forest practices activity. In instances where the implementation or function of a management practice was insufficient, the most applicable of the FPA *Rules* was rated. The FPWQ Audit team based its conclusions and recommendations on evaluation of the FPA *Rules,* as well as on the judgment of the FPWQ Audit participants. The strength of the FPWQ Audit is in the fact that the assessments were made on a statewide basis. To a lesser extent, inferences can be drawn regarding the four administrative units of land ownership: federal, state, industrial private and non-industrial private.

The FPWQ Audit was not intended to be statistically robust or to evaluate the cumulative effects of forest practices within a specific drainage. Little effort was made to assess within-sale or between-sale variability. Storms and runoff events were not characterized for each sale. Timber sales were not weighted to account for differences in the amount of harvest, roadwork or spatial distribution. Not every cutting unit, road, landing or skid trail was observed in larger sales. The FPWQ Audit team selected the areas of the sale to be observed.

Audit Team Selection

Letters of solicitation to participate on the FPWQ Audit team were sent to natural resource agencies and other interested parties on February 14, 2000. Association and agency heads were initially contacted to announce the FPWQ Audit and to request participation. The association or agency heads then designated FPWQ Audit team members. As a result, the FPWQ Audit team was comprised of representatives from the Idaho Department of Lands, the Idaho Department of Fish and Game (IDFG), the Intermountain Forest Association, the Idaho Forest Owners Association, the U.S. Forest Service (USFS), and the Idaho Department of Environmental Quality. In addition, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the U.S. Environmental Protection Agency, were involved in the planning process for the FPWQ Audit, but did not participate in the actual data collection. Thus, the FPWQ Audit team was a combined effort of all the groups concerned with natural resources and was made up of members with technical backgrounds in forestry, fisheries biology, geology, hydrology, and water quality.

Timber Sale Selection

Timber sales and logging jobs for the FPWQ Audit were selected by the IDL. The IDL keeps forest practice notification and compliance records on all forest practices that occur in Idaho. From the IDL notification and compliance database, a pool of sales was generated that met the following criteria:

- The timber sale area must occur in an unstable geologic type. The definition the FPWQ Audit team used for unstable geologic types is listed in the IDL 2000, *Forest Practices Cumulative Watershed Effects Process for Idaho 2000* (CWE).
- The timber sale boundary must border or include a Class I stream.
- The timber harvest must have occurred between 1996 and 1999.
- Ten sales must be selected from each of the following administrative units of land ownership: state, federal, industrial private, and non-industrial private.

To aid in the selection process, maps were produced that showed where Class I streams occurred on unstable geologic types. For a sale to be selected from the pool, its sale boundary must have bordered or included one of these streams. As sales were selected, forest practice advisors were contacted to insure that all sales met the criteria listed. In addition, if a sale had major disturbances, such as grazing, agriculture, or urban development, that sale was dropped from the list of candidates for audit. This was done to insure that the FPWQ Audit evaluated impacts that occurred mostly from forestry practices. Once a pool of sales that met all criteria was determined, twenty sales were randomly selected from the four types of land ownership as the FPWQ Audit semi-finalists. These 80 sales were then plotted on a map. The 40 sales closest together geographically were selected as the primary sales to be audited, thereby allowing the most convenient travel logistics, with the remaining 40 sales serving as alternates.

MANAGEMENT PRACTICES COMPLIANCE

Although the 2000 version of the FPA *Rules* was available at the time of audit, the FPWQ Audit team used the July 1, 1998 version of the FPA *Rules* to assess compliance. The 1998 version was chosen because it was the version in place on the ground at the time of timber harvest for the sales audited. Primarily, the FPWQ Audit team addressed Rule 030 (timber harvest) and Rule 040 (road construction and maintenance) of the FPA *Rules.* The purpose of Rule 030 is "to establish minimum standards for forest practices that will maintain the productivity of the forest land and minimize soil and debris entering streams and protect wildlife and fish habitat." The purpose of Rule 040 is "to provide standards and guidelines for road construction and maintenance that will maintain forest productivity, water quality, and wildlife habitat."

Assessment of Compliance (Rules 030 and 040)

To determine compliance with the FPA *Rules*, the FPWQ Audit team split into two groups. One group walked and/or drove road segments and skid trails to evaluate Rule 040, road construction and maintenance, and the other group walked a section of Class I stream to evaluate Rule 030, timber harvest. After each group finished their assessments, they reconvened to discuss the compliance of each sale with the applicable portions of the FPA *Rules*. For a sale to be considered to be in non-compliance required either unanimous consent of the FPWQ Audit team or a vote in which the majority ruled. Certain portions of the FPA *Rules* were best evaluated through quantitative measurements. Compliance was not determined until the data was processed for Rule 030.07.ii (shade evaluation), Rule 030.07.iv (leave trees within the SPZ), Rule 030.07.e.vii (site-specific riparian prescriptions), and Rule 040.02.g (fish passage). Details on the methods used to evaluate these rules are discussed below.

The FPWQ Audit team compiled data on the applicable FPA *Rules* by sale from the 40 audited timber sales. Assessment of the findings and data was done on a statewide basis and by land ownership. No conclusions or recommendations were drawn from an assessment of the findings on an individual sale. The conclusions and recommendations contained in this report represent the consensus opinion of the FPWQ Audit team.

The extent to which the FPA *Rules* were implemented for each land ownership category was assessed by the following procedure. First, both the number of implemented rules and the number of applicable rules were counted for each timber sale. The number of implemented rules, divided by the number of applicable rules, determined the implementation rate for that sale. Next, each sale was sorted into the appropriate land ownership. Finally, the implementation rates were averaged for that land ownership.

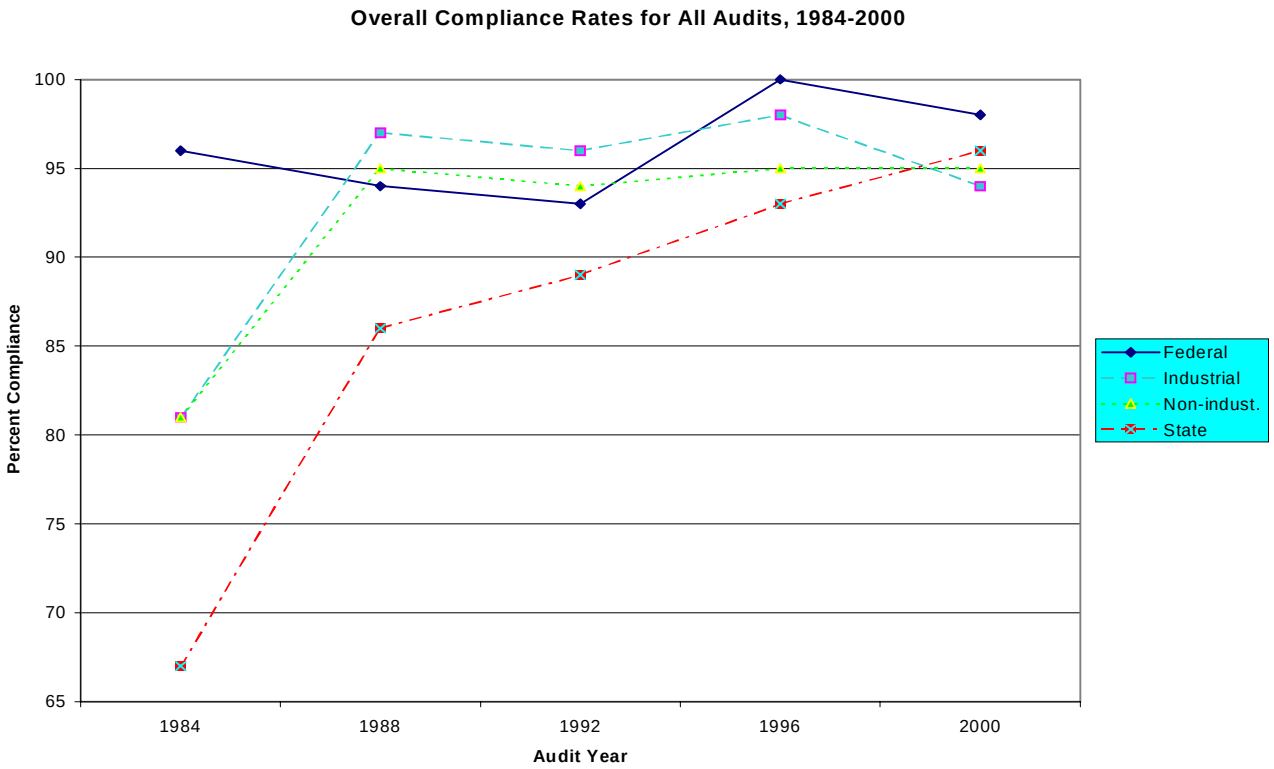
The FPWQ Audit team assessed Rule 030, (timber harvest) and Rule 040, (road construction and maintenance) on 40 timber sales. The FPA *Rules* were applicable in 1,680 instances in these sales. The FPA *Rules* were complied with in 1,610 instances, resulting in a 96% compliance rate

for the FPWQ Audit overall. The compliance rates for the land ownership were federal, 98%, industrial private, 94%, non-industrial private, 95%, and state 96%.

Of the 70 instances of non-compliance, 34 were Rule 030, timber harvest violations (including one variance issue concerning a landing in the stream protection zone) and 36 were Rule 040, road construction and maintenance violations. Under Rule 030, the stream protection subsection (Rule 030.07) was the portion most often violated (15 out of 34 instances or 44% of Rule 030, the timber harvest non-compliance). Under Rule 040, the road maintenance subsection (Rule 040.04) was the portion most often violated (28 out of 36 instances or 78% of Rule 040, the road construction and maintenance non-compliance).

Compliance Rates Compared to Previous Audits

Figure 1 shows the overall compliance results from the 2000 FPWQ Audit as compared with previous audits conducted in: 1984 (Bauer et al. 1985), 1988 (Harvey et al. 1989), 1992 (Hoelscher et al. 1993), and 1996 (Zaroban et al. 1997). An overall upward trend is indicated for compliance in all land ownership's since 1984.



• **Figure 1. Overall Compliance Rates for All Audits**

Audit Year	Federal	Industrial	Non-Industrial	State
1984	96	81	81	67
1988	94	97	95	86
1992	93	96	94	89
1996	100	98	95	93
2000	98	94	95	96

Evaluation of Selected Portions (Rules 030 and 040)

As mentioned above, certain portions of the FPA *Rules* could not be evaluated by observation alone, so the FPWQ Audit team took quantitative measurements in regards to:

- Rule 030.07.e.ii, shade evaluation,
- Rule 030.07.e.iv, leave trees in the stream protection zone,
- Rule 030.07.e.vii, site-specific riparian prescriptions, and
- Rule 040.02.g, fish passage at stream crossings.

Compliance for these portions of the FPA *Rules* was not determined until the data was entered into a computer and processed. Details on the methods used to obtain quantitative measurement to evaluate the selected portions of the FPA *Rules* follow.

Methods - Shade Evaluation (Rule 030.07.e.ii)

The best technique to evaluate whether 75% of the shade is maintained over a stream after harvest (Rule 030.07.e.ii) is to measure shade or canopy occurring over the stream before and after logging occurs. Estimates of pre-logging shade were not available for the FPWQ Audit.

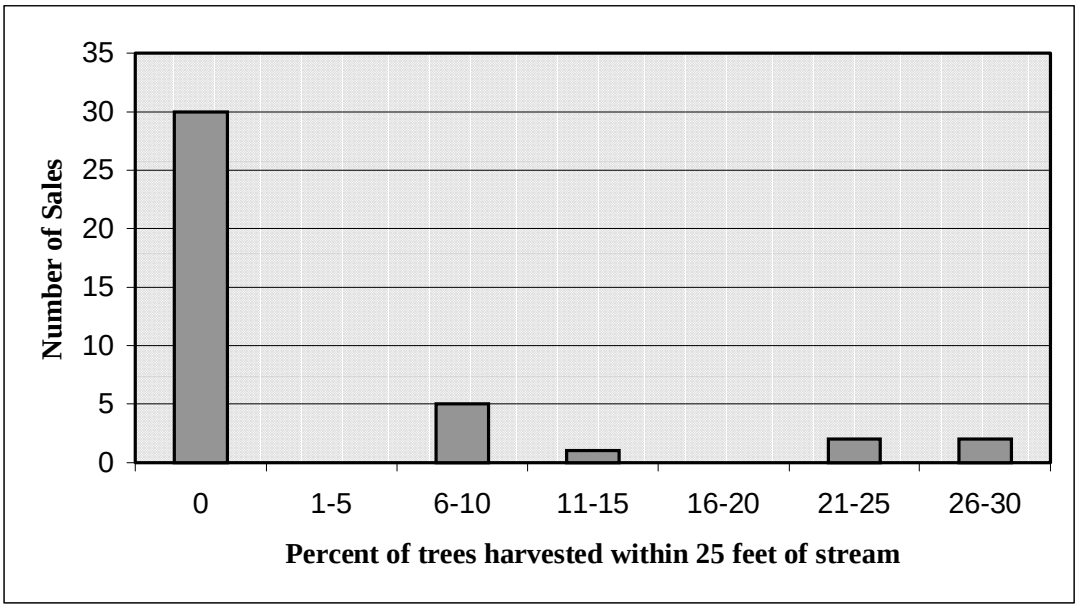
Faced with this limitation, the FPWQ Audit team used information provided in the Heat Source Model (Boyd 1996 and Oregon Department of Environmental Quality 1999). Based on the Heat Source Model, the majority of riparian shade provided during hours of peak water temperature (12:00 p.m.-5:00 p.m.) occurs within 25 feet of the ordinary high water mark. This is especially true when dense brush or conifers occur immediately adjacent to the stream. Trees that are removed beyond this first layer of vegetation often provide little or no shade to the stream during this period.

Based on this reasoning, the FPWQ Audit team assessed Rule 030.07.e.ii (stream shading) by first determining what percent of trees were harvested from within 25 feet of the streams ordinary high water mark, which is called the stream protection zone (SPZ). When over 25% of the trees were removed from within 25-feet of a stream; additional information would need to be considered. In those sales, the FPWQ Audit team evaluated 1) the size and location of the cut trees, 2) the canopy cover occurring over the stream, and 3) the occurrence of deciduous trees, before making a determination on whether the sale was in compliance with Rule 030.07.e.ii.

Results - Shade Evaluation (Rule 030.07.e.ii)

In two out of the 40 timber sales the FPWQ Audit team evaluated, slightly over 25% of the trees (27% and 29%) were harvested within 25 feet of the streams ordinary high water mark (as shown in Figure 2, below, in the column labeled “26-30%”). In both sales, the larger trees were harvested (greater than 12 inches dbh), which tend to provide the most shade. The FPWQ Audit team measured the amount of canopy cover occurring over the streams using a concave spherical densiometer as described in Platts et al. (1987). After harvest, measurements revealed that 54% and 68% canopy cover occurred over these streams. Most of the stream canopy was conifer over-story, although deciduous species did contribute shade. In both of these cases, the FPWQ

Audit team was unable to determine if the harvest reduced the shade more than 25% as the amount of canopy prior to harvest was not known. However, because harvest did not significantly exceed 25% of the trees, and because brush did provide a portion of the shade, it is unlikely these two sales removed over 25% of current shade from the stream.

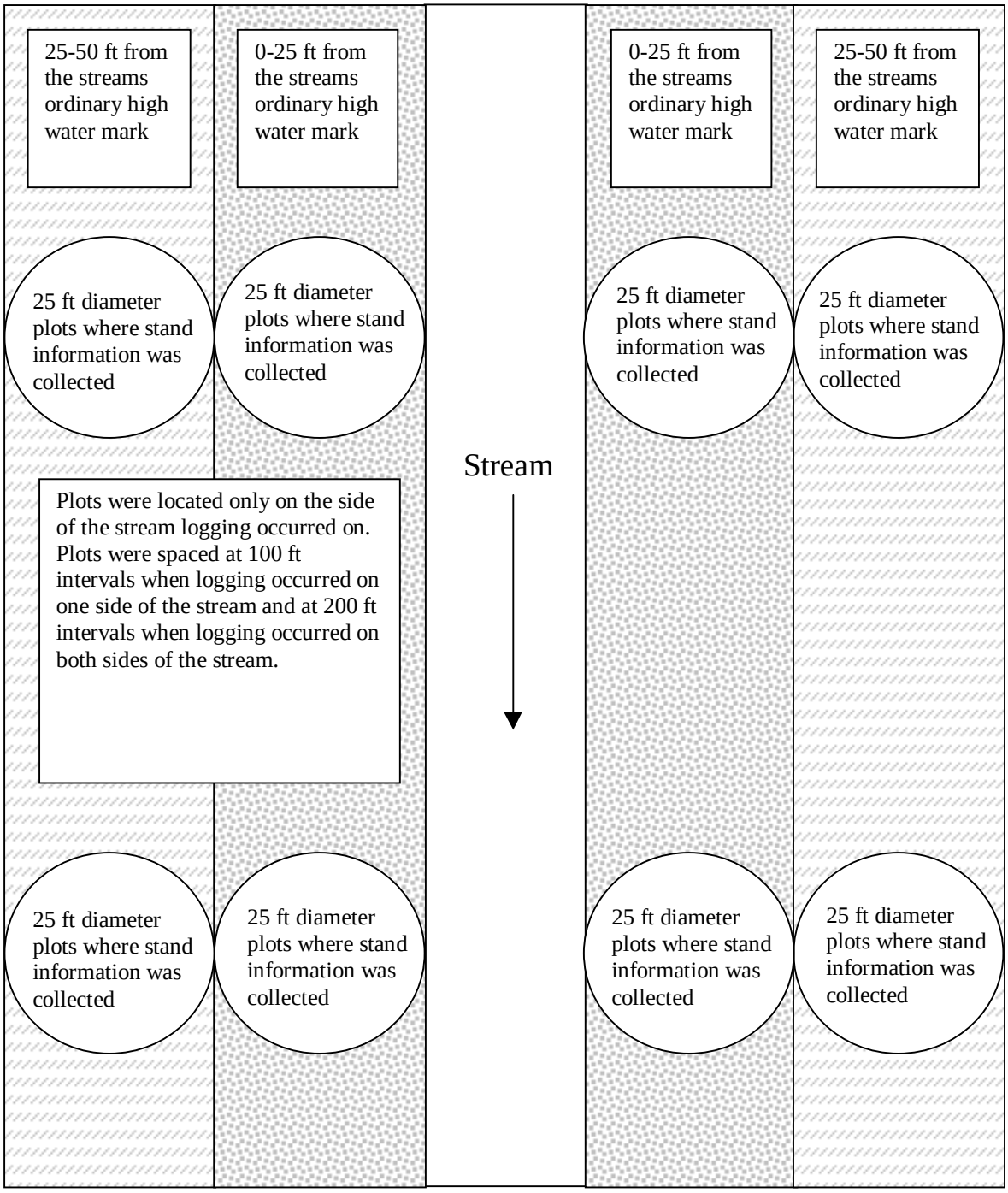


- **Figure 2. Percentage of trees removed within 25 feet of the ordinary high water mark of streams in timber sales audited during the FPWQ Audit.**

It is important to point out that in 30 of the 40 sales (75%) examined by the FPWQ Audit team (see Figure 2, the column labeled "0"%), the harvest did not remove any of the trees that occurred within 25 feet of the ordinary high water mark of the stream. This suggests that operators and landowners routinely exceed the minimum shade standards of the FPA *Rules.*

Methods - Leave Tree Evaluation (Rule 030.07.e.iv)

To evaluate Rule 030.07.e.iv, the numbers of trees retained and cut within the SPZ were quantified. This was accomplished by setting up transects along 1,000 feet of the Class I stream either at 100 feet intervals (if logging occurred on one side of the stream) or at 200 feet intervals (if logging occurred on both sides). At each transect, two 25 feet in diameter circular plots were selected. The diameter of one circular plot went from the stream's normal high water mark to 25 feet from the stream. The farther plot touches the first plot at 25 feet from the stream and extends to 50 feet from the stream, as shown in Figure 3. Within each plot, on one or both sides of the stream as needed, the FPWQ Audit team recorded the number of trees, their species and their diameter at breast height (dbh). When a road paralleled in the SPZ, trees were only counted in plots along the side of the stream opposite from the road. For each stream, attempts were made to quantify trees from 20 plots, which normally included ten plots along the normal high water mark of the streams and ten plots 25 feet away from the normal high water mark. However, if logging occurred along less than 1,000 feet of the stream, then fewer plots were evaluated.



- **Figure 3. Illustration of the strategy used to collect data on the shade provided by the trees within a stream protection zone during the FPWQ Audit.**

To evaluate how many trees were retained and harvested from the SPZ for a distance of 1,000-feet the following steps were taken:

- the area that occurs within a 1,000-feet of SPZ (1,000-feet X 50-feet or 1.15 acres) was divided by the area surveyed within the plots (0.225 acres when 20 plots were evaluated.
- this value (5.1 when 20 plots were evaluated) was then multiplied by the total number of trees and stumps that were counted within the plots to evaluate how many trees were retained and harvested from within 1,000-feet of SPZ.

To evaluate whether logging operators complied with Rule 030.07.e.iv (leave trees), the number of trees retained and harvested within the 1,000-feet of the SPZ were compared to the table in Rule 030.07.e.iv. The dbh recorded for each tree is compared to the table to see which of the four columns apply. These columns (labeled "3-7.9", "8-11.9", "12-19.9", and ">20") define a range of dbh for trees, which is called the size class. For ease of use, the values from the table in Rule 030.07.e.iv, including size class, are incorporated into Table 1 (below) as the gray line labeled "FPA minimum." If the number of retained trees (by size class) falls below what is required in the table in Rule 030.07.e.iv, and trees were harvested from these size classes, the sale was considered to be in non-compliance with Rule 030.07.e.iv.

Results - Leave Tree Evaluation (Rule 030.07.e.iv)

Five of the sales (12.5%) examined by the FPWQ Audit team violated Rule 030.07.e.iv that specifies the minimum number of standing trees that should be maintained on each side of a thousand foot reach of stream. These five sales are indicated by the red cells labeled "Violated minimum standards" in Table 1. For each of the five sales, the minimum leave tree standards of Rule 030.07.e.iv were not met prior to harvest, as shown by the yellow cells in Table 1, labeled "Number of leave trees below FPA minimums". Despite these deficiencies, additional trees were cut; further reducing the number of trees below what is specified in Rule 030.07.e.iv for each size category. The FPWQ Audit team believes two of these sales actually complied with the intent of Rule 030.07.e.iv (met the LOD needs of the stream). The reason for this is, more large trees were maintained than were required, as shown by the blue cells in Table 1, labeled "Met the LOD needs".

The FPWQ Audit team believes four sales violated the intent of Rule 030.07.e.iv, although, technically, the rule was not violated. The green cells labeled "Violated the intent of FPA" in Table 1 indicate these four sales. All four sales occurred in southwestern Idaho along smaller streams (less than 20 feet wide) where there is no requirement in Rule 030.07.e.iv to maintain large trees in the SPZ. As shown in Table 1, Rule 030.07.e.iv specifies 0 trees in the 12-19.9 and >20 size classes for streams under 10 feet wide; 21 trees in the 12-19.9 and 0 in the >20 size class for streams under 20 feet wide.). When harvest occurred, only the large trees were removed. The problem with this was that the resulting overall basal area is too small because very few small trees were present prior to harvest, as shown in Table 1 by the violet cells labeled "Basal Area below FPA minimums". The FPWQ Audit team believes that following harvest of the larger trees, the basal area of the remaining trees does not meet the required standing tree levels and is not suitable to provide adequate long-term benefits of LOD to the stream.

- **Table 1. The number of trees retained and removed from 25-foot plots by dbh from the SPZ from timber sales audit during the FPWQ Audit.**

Land Ownership	Stream Width	Number of Trees/1000 ft Retained				Basal Area	Number of Trees/1000 ft Removed				Road in SPZ
		3-7.9	8-11.9	12-19.9	>20	Retained	3-7.9	8-11.9	12-19.9	>20	
FPA minimum	<10 ft	200	42	0	0	49					
Federal	3.8	0	10	31	25	118	0	0	0	0	no
State	4.0	244	112	10	0	101	0	0	0	0	yes
Industry	4.3	20	5	15	0	24	0	0	10	5	yes
State	4.4	61	41	5	15	80	0	0	15	10	yes
Federal	4.7	138	25	46	41	209	0	0	0	0	no
Federal	5.2	163	76	46	10	146	0	0	0	0	no
State	5.8	263	42	25	42	215	0	0	17	17	no
State	5.8	56	20	25	46	185	0	0	0	10	no
Industry	7.2	25	0	15	5	37	0	0	5	0	yes
Federal	8.2	66	46	46	31	178	0	0	0	0	no
Federal	8.6	81	36	56	51	248	0	0	0	0	no
Industry	9.0	10	66	10	31	136	0	0	0	0	no
State	9.6	56	36	61	51	251	0	0	0	0	no
FPA minimum	10-20 ft	200	42	21	0	74					
Industry	10.1	51	31	51	20	144	5	5	25	0	no
State	10.1	0	0	0	20	61	0	0	31	31	yes
Non Industrial	10.1	138	97	36	10	139	0	0	0	5	no
Federal	11.4	36	25	76	76	337	0	0	0	0	no
State	11.9	112	41	56	41	225	0	0	0	0	no
Industry	12.0	132	66	92	20	223	0	0	0	0	no
Industry	12.1	158	51	46	46	239	5	0	5	5	no
Non Industrial	12.1	10	10	20	10	61	0	0	0	5	yes
Non Industrial	12.4	344	286	70	6	290	0	0	13	13	no
Non Industrial	12.6	382	112	36	0	152	0	0	0	0	yes
Federal	13.2	102	20	25	41	176	0	0	0	0	no
Non Industrial	13.4	76	51	127	38	304	0	0	0	25	no
Industry	13.5	25	20	5	10	50	0	0	0	0	yes
Non Industrial	13.9	192	57	23	17	132	0	0	0	0	no
Non Industrial	14.2	92	31	76	25	196	0	0	10	5	no
Non Industrial	14.2	56	5	15	0	29	0	0	5	0	no
Industry	14.7	56	20	20	10	73	0	5	5	15	no
State	17.4	51	10	25	10	73	0	0	0	0	yes
Industry	18.3	168	66	51	5	133	0	0	0	0	no
FPA minimum	> 20 ft	200	42	21	4	86					
Non Industrial	20.3	102	64	51	38	220	0	0	0	0	no
State	21.3	0	31	31	41	173	0	0	0	5	no
Non Industrial	22.9	41	46	46	5	99	0	0	0	5	no
Industry	23.0	112	41	36	36	185	0	0	0	0	no
Federal	25.0	0	0	10	41	133	0	0	0	0	no
Federal	31.1	51	25	15	20	99	0	0	0	0	no
Federal	37.6	148	5	0	10	54	0	0	0	0	no
State	beaver ~20+	407	117	112	5	266	0	0	20	5	no

	Number of leave trees below FPA minimums		Violated minimum standards
number	Met the LOD needs		Violated the intent of FPA
	Basal Area below FPA minimums		Site-specific riparian plan not implemented
number	Sales without harvest in the SPZ		

Each of the four sales also has a road that parallels the stream in the SPZ on the opposite side of the stream from the harvesting, as shown in Table 1 by a "yes" in the column labeled "Road in SPZ". The combination of these two factors significantly reduces the amount of LOD that will reach these streams.

Part of the problem is that many SPZs do not have the number of smaller trees specified by Rule 030.07.e.iv. This is shown in Table 1 by the large number of cells colored yellow, indicating how many sales did not have smaller trees. In fact, these numbers of smaller trees may not be possible in some forest types, such as Ponderosa pine forests. Of the 40 sales examined by the FPWQ Audit team, only five had a sufficient number of trees (prior to harvest) to meet or exceed what is required for each size class. The cells without yellow indicate these five in Table 1. On the other hand, the basal area retained in the SPZ (following harvest) for 31of the sales the FPWQ Audit team audited exceeded the amount Rule 030.07.e.iv required (as shown in Table 1 by the cells without violet in the column labeled "Basal Area Retained"). The reason for this is that more large trees are retained in the SPZ than is required by Rule 030.07.e.iv. The requirement is no trees for 0 to 20 feet wide streams or four trees for streams greater than 20 feet, as shown in Table 1 by the white cells in the column labeled "Number of Trees/1000 ft Retained" for the "12-19.9" and ">20" size classes).

The landowners, operators and forest practices advisor all believed these sales were meeting or exceeding the minimum standards of Rule 030.07.e.iv. The FPWQ Audit team did not believe any of the sales violated Rule 030.07.e.iv until the actual measurements and calculations were summarized. As a result, the FPWQ Audit team concluded that visual estimates were not adequate to evaluate Rule 030.07.e.iv. Despite these concerns, in 22 of the sales (55%) audited, as shown in Table 1 by all zeros (colored pink) in the size classes for the columns labeled "Number of Trees/1000 ft Removed", no trees were harvested within 50 feet of the ordinary high water mark.

Methods - Site-Specific Riparian Prescriptions (Rule 030.07.e.vii)

To determine whether site-specific riparian prescriptions were appropriately applied (Rule 030.07.e.vii.), the FPWQ Audit team evaluated logging jobs where a road occurred within the SPZ, since that means it is unlikely that minimum standing tree requirements will be met. For this reason, site-specific plans should be applied to the opposite side of the stream before harvesting occurs. The harvest was considered to be in non-compliance with Rule 030.07.e.vii:

- when one side of the SPZ did not meet the minimum standing trees requirement of Rule 030.07.e.iv, such as when a road is present, and
- trees were harvested on the opposite side of the stream without prior application of a site-specific management plan.

Results - Site-Specific Riparian Prescriptions (Rule 030.07.e.vii)

Nine sales (23%) were audited that had SPZ roads paralleling the stream (Table 1). In five of the nine sales, timber was harvested from the side of the stream opposite the road. A plan is only required when timber is harvested, not for a road; the other four sales did not have harvest in the SPZ. In each of the five sales with harvest, a site-specific riparian prescription was not developed

to insure that the timber left after harvest would meet the LOD needs of the stream. As a result, low basal areas were preserved (less than 80 square feet/acre) following harvest. Accordingly, all five sales (13%) are considered to be in violation of Rule 030.07.e.vii. Neither IDL nor the owners or operators recognized the need to consider a site-specific riparian prescription.

Methods - Fish Passage Evaluation (Rule 040.02.g)

The FPWQ Audit team evaluated each sale as to whether any culverts installed on the Class I streams within the boundary of the sale provided fish passage (in compliance with Rule 040.02.g) by recording the length, diameter, outlet drop and corrugation on each culvert. The recorded information was used to calculate water velocities, using Manning's equation (1994) that would occur through a culvert during various time periods. These velocities, as well as the drop from the culvert's outlet, were compared to the requirements in the Stream Channel Alteration Rules (SCA Rules) of the Idaho Administrative Procedures Act, Title 03, Chapter 07.062.05.a, and Appendix 1, Figure 17, to determine if Rule 040.02.g (fish passage) were violated.

Results - Fish Passage Evaluation (Rule 040.02.g)

Thirty Class I stream crossings were evaluated during the FPWQ Audit. Details on these crossings are described in Table 2.

• Table 2. Summary of the FPWQ Audit: Class I Stream Crossing Results.

Type of Crossing	Number of Crossings		Does Not Meet Minimum Requirements of the SCA Rules	
	New[1]	Existing[2]	New[1]	Existing[2]
Culvert	4	14	2	11
Bridge	1	3	0	0
Ford	3	1	0	0
Temporary	4	0	0	0
Total	12	18	2	11

[1] "**New**" refers to crossings that were constructed during the most recent timber sale.
[2] "**Existing**" refers to crossings that were installed before the audited timber sale occurred.

Eighteen of the 30 crossings examined by the FPWQ Audit team were culverts. Thirteen (shown in yellow in Table 2) of the 18 culverts (72%) were not in compliance with the minimum requirements of the SCA Rules: either the water velocity was too fast or the drop was too high. Only five of the culverts were in compliance with the minimum requirements. None of the other types of crossings were non-compliant. Only two of the four newly installed culverts were considered a violation of Rule 040.02.g. Both of the recently installed culverts were installed on non-industrial private lands. The other 11 of the 13 problem culverts were legacy issues from previous timber sales. Landowners or operators are not responsible for upgrading fish passage through culverts that were installed previously (prior to the FPA *Rules*). However, if a landowner or operator is reconstructing or upgrading a road, they must meet or exceed all applicable FPA *Rules*, which include Rule 040.02.g, fish passage. The FPWQ Audit team did not evaluate whether stream crossings were upgraded when roads were reconstructed or upgraded, therefore, it is not known if these other culverts were in violation of Rule 040.02.g, fish passage, or not.

The majority of the newly installed stream crossings the FPWQ Audit team observed (10 out of 12) provided adequate fish passage. However, of the twelve new crossings on Class I streams assessed during the FPWQ Audit, crossings other than culverts, which are bridges, fords, and temporary crossings, represented eight of them. Thus, when culverts are installed in streams, there is likelihood that they will be installed in a manner that impedes fish passage. Unfortunately, many landowners or operators have historically installed culverts that do not meet the minimum requirements (11 out of 18) and are still unaware of how to install culverts so that they do not impede fish passage. This may be because the FPA *Rules* do not have water velocity or drop requirements and do not specify how to install culverts to insure that fish passage is not impeded.

Recommendations

The FPWQ Audit team has recommendations for improving compliance regarding two portions of Rule 030, timber harvest, and one portion of Rule 040, road construction and maintenance. The FPWQ team also examined the effectiveness of the FPA *Rules*, as discussed in the next section: "Management Practice Effectiveness".

Shade Evaluation (Rule 030.07.e.ii)

Based on the results described above, the FPWQ Audit team found most owners and operators are exceeding the minimum requirements of Rule 030.07.e.ii. No audited sales were considered to be in non-compliance. Refer to "Management Practice Effectiveness" for further discussion of Rule 030.07.e.ii.

Leave Tree within the SPZ (Rule 030.07.e.iv)

The FPWQ Audit team believes there are several concerns with Rule 030.07.e.iv that need to be addressed, which include:

- The minimum standards were exceeded five times;
- The intent of Rule 030.07.e.iv is being violated; and
- Compliance with Rule 030.07.e.iv is difficult to evaluate without quantitative measurements and calculations.

The FPWQ Audit team believes these problems stem from the fact that some SPZs naturally do not have the number of smaller trees that Rule 030.07.e.iv specifies. This prevents the harvest of smaller trees, which is often desired to maintain healthy tree stands. The FPWQ Audit team believes this concern could be addressed by allowing a larger diameter tree to be substituted for several smaller diameter trees. To insure that an equal trade occurs, a point system could be developed based on basal area. A new table could be developed for Rule 030.07.e.iv that provides a point system instead of actual numbers of trees. In fact, since drier sales in southern Idaho have lower natural standing tree rates than northern Idaho, it would be appropriate to develop at least two new tables for Rule 030.07.e.iv that represent the different climatic zones or broad habitat types. These two new tables would provide the number of points that should be maintained within the SPZ. The required number of points could be achieved through a combination of basal area and numbers of trees. This method would have several advantages:

- It would help insure the intent of Rule 030.07.e.iv was met (a minimum basal area would be required);
- The revised Rule 030.07.e.iv would be easier to assess as total points could be converted to basal area, which can be quickly evaluated in the field; and
- Easier assessment of Rule 030.07.e.iv would make it easier to enforce and easier for landowners and operators to understand and more objective to enforce.

Site-Specific Riparian Prescriptions (Rule 030.07.e.vii)

Site-specific riparian management plans appear to be overlooked, despite being required by Rule 030.07.e.vii. Additional training that focuses on the importance of developing such plans prior to tree harvest and how such plans should be applied is necessary to insure that landowners, operators and Forest Practices Advisors understand and comply with Rule 030.07.e.vii.

To make landowners, operators and Forest Practice Advisors aware of Rule 030.07.e.vii, the need for a site-specific riparian management plan could be an element that is identified when a Notification of Forest Practices form is filled out. For example, a notification of intent to reuse a road within the SPZ (Rule 040.02.g) would require checking a box that indicates a site-specific riparian plan might be required, along with a comment to "Refer to Rule 030.07.e.vii for more information".

Fish Passage Evaluation (Rule 040.02.g)

It appears that the reason fish passage is often not provided at stream crossings is because there is a lack of understanding on what it takes to provide fish passage. Additional guidance on what it takes to provide for fish passage should be included in the FPA *Rules*. The FPWQ Audit team suggests the following FPA *Rules* changes:

> "Plan stream crossings to be minimum in number and in compliance with the minimum standards for stream channel alterations under the provisions of Title 42, Chapter 38, Idaho Code, Stream Channel Alterations Act. Plan all culvert installations on a Class I stream to provide for fish passage. *Culverts less than 50 feet in length must be installed at less than a 1.0% grade to provide adequate fish passage unless special measures are taken. Culverts greater than 50 feet in length must be installed at less than a 0.5% grade unless special measures are taken. For more details on what special measures may be necessary to provide for fish passage at stream crossings contact the department."*

Serious fish passage problems mainly occur at stream crossings that were installed in the past, prior to the FPA *Rules.* For many of these stream crossings, little effort is being put into upgrading them. To address this lack of effort, the FPWQ Audit team has two recommendations:

- According to the FPA *Rules*, when a landowner or operator is reconstructing or upgrading a road, they must follow all applicable FPA *Rules*, which includes Rule 040.02.g, providing fish passage at stream crossings. This principle should also apply before anyone receives a variance to reuse a road located within the SPZ. These situations should be utilized more often to help improve fish passage at problem crossings.
- For landowners or operators with limited funding, perhaps income tax credits could be made available to provide incentives, as they have been in the past, in order to improve fish passage at problem stream crossings.

MANAGEMENT PRACTICE EFFECTIVENESS

As mentioned in the discussion above on "Audit Team Selection", the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the U.S. Environmental Protection Agency joined the FPWQ Audit team in the planning process. During the planning process, the group agreed that better techniques should be used to evaluate the effectiveness of the FPA *Rules*. Based on findings from past audits and concerns from USFS, NMFS, and IDFG, plans were made to focus on assessments of shade, LOD recruitment, and sediment delivery from roads. The FPWQ Audit team took quantitative measurements and made counts to assess the effectiveness of FPA *Rules* dealing with:

- shade evaluation for Rule 030.07.e.ii,
- leave tree evaluation (looking specifically at LOD recruitment) for Rule 030.07.e.iv, e.v and e.vi
- road evaluation, (looking specifically at sediment problems) for Rule 040.02.g.

Taking quantitative measurements and counts to assess management practice effectiveness represents a significant change from previous audits. Throughout the history of audits in Idaho, quantitatively determining the effectiveness of Rule 030, timber harvest, and Rule 040, road construction and maintenance, has always been a challenge. This is due primarily to the single point-in-time nature of the audits and the lack of long-term monitoring data, particularly for shade, LOD, and sediment. Past audits have attempted to answer the effectiveness question by relying on qualitative assessments that describe the information needed, such as the relative amounts and duration of delivery of pollutants in the case of sediment from roads. Despite the limitations of a qualitative approach, significant changes have been made in Rule 030, timber harvest, and Rule 040, road construction and maintenance, because of past audits. This has been possible because the previous audit teams have combined qualitative information with their knowledge and experience to derive conclusions concerning cause and effect relationships. For the FPWQ Audit, the team decided to use methods that are more objective.

Methods: Shade Evaluation (Rule 030.07.e.ii.)

To evaluate the effectiveness of Rule 030.07.e.ii, the FPWQ Audit team measured the amount of canopy cover occurring over the stream using a concave spherical densiometer as described in Platts et al. (1987). Canopy cover measurements were collected from five locations spaced at intervals 200 feet apart on a Class I stream that occurred in the audited sale. The average percent of canopy cover occurring over each stream was compared to percentages contained in the IDL 2000, *Forest Practices Cumulative Watershed Effects Process for Idaho 2000* (CWE), Tables C-1 and C-2. The CWE Tables provide the percentages of canopy cover (at different elevations) that are needed to maintain the stream temperatures preferred by chinook salmon, bull trout, other salmonids, and non-salmonids. The model used to develop the CWE Tables uses elevation, stream canopy cover and a summer drought index to predict stream temperature. These were the variables found to have a significant relationship with stream temperature. When

combined, these variables explained 58% (northern Idaho) and 71% (southern Idaho) of the variation in stream temperature. Other variables, such as aspect, ground water inflow, and topographic shading, can influence stream temperature. These variables were not collected during the FPWQ audit although they could influence the actual stream temperature.

The FPWQ Audit team suggests that the harvest activities that occurred were not in compliance with Rule 030.07.e.ii and may negatively impact stream temperatures in those sales:

- where the percentage of canopy cover occurring over the stream falls below what is specified in the CWE Tables and,
- timber harvesting occurred in the SPZ.

Results: Shade Evaluation (Rule 030.07.e.ii)

The FPWQ Audit team evaluation found that the canopy cover occurring over 22 of the streams was less than what is required by the CWE Tables, indicated by red cells in the "CWE Target Canopy" column in Table 3. Of these 22 streams, timber harvest occurred in the SPZ for 11 of them, indicated by red cells in the "SPZ Harvest Yes/No" column. Two of the 11 sales were then excluded from the shade evaluation because the harvest in the SPZ took only burned trees, which provided little if any shade, indicated in Table 3 by a green cell in the "Comments" column labeled "Burn". Thus, the result is nine sales where the FPWQ Audit team believes that the forest practices were not effective in protecting the stream temperatures preferred by the fish found there. In Table 3, these nine sales are where the two red cells line up horizontally, indicating that both the canopy was less than required by CWE (in 22 sales) and that there was harvesting in the SPZ (in 11 sales), minus the two excluded sales. The harvesting that occurred along the streams in these nine sales (23%) potentially increased stream temperatures above what is preferred by the fish that occur there.

Given the conditions in Idaho, the FPWQ Audit team suspects that, in many cases, the percentage of canopy cover specified in the CWE Tables cannot be met, even if the stream was in an undisturbed condition. Wide streams and streams in dry climates do not naturally have high amounts of canopy cover. Other factors that have reduced canopy cover over streams include historic (pre-FPA *Rules*) logging, road construction, grazing, and mining. It is possible that the harvest that occurred along some of these streams removed very little canopy and had little effect on stream temperature. It’s difficult to say what effect the current tree harvest had on stream temperature without knowing how much canopy cover was removed from the SPZ.

• **Table 3. Summary of canopy cover assessment conducted for the FPWQ Audit.**

Stream Name	Land Ownership	Chinook Salmon	Bull Trout	Other Salmonids	FPA Region	Elevation	Percent Canopy	CWE Target Canopy	SPZ Harvest Yes/No	Comments	Potential Impacts
Sears Creek	NIPF	N	N	Y	N	1,640	88	100	yes		No
Fleming Creek	NIPF	N	N	Y	N	2,070	87	100	no		Yes
Unnamed Creek	NIPF	N	N	Y	N	2,400	95	92	yes		Yes
W. Branch Priest R.	Federal	N	N	Y	N	2,500	32	92	no		Yes
Lost Creek	State	N	N	Y	N	2,500	93	92	no		Yes
Three Bear Creek	Industry	N	N	Y	N	2,700	64	86	no		Yes
Crocker Creek	NIPF	N	N	Y	N	2,720	32	86	no		Yes
Roush Creek	NIPF	N	N	Y	N	2740	95	86	no		Yes
Trib to Curtus Creek	Industry	N	N	Y	N	2,750	92	86	no		Yes
Cone Creek	State	N	N	Y	N	2,760	49	86	yes	beaver activity	No
Long Meadow Creek	State	N	N	Y	N	2,800	42	80	no	channelization	Yes
Casey Creek	Industry	N	N	Y	N	2,880	86	80	no		Yes
Nat Brown Creek	Federal	N	N	Y	N	3,000	76	73	no		Yes
Flewsie Creek	NIPF	N	N	Y	N	3,000	48	73	yes	Grazing	No
Waters Creek	State	N	Y	Y	N	3,100	85	97	no		Yes
Cedar Creek	Federal	Y	N	Y	N	3,200	79	100	no		Yes
Trib to Big Creek	Federal	N	N	Y	N	3,200	94	67	no		Yes
Falls Creek	Industry	N	N	Y	N	3,240	85	67	no		Yes
Johnson Creek	Industry	N	N	Y	N	3,280	99	67	yes		Yes
Parallel Creek	State	N	N	Y	N	3,280	99	67	no		Yes
Trib to Berry Creek	Industry	N	Y	Y	N	3,300	90	91	no		Yes
Bat Creek	State	N	N	Y	N	3,360	100	67	yes		Yes
Yakala Creek	Federal	N	N	Y	N	3,520	98	61	no		Yes
Trib to Deadman Creek	Federal	Y	Y	Y	N	4,400	100	30	no		Yes
Minneha Creek	State	N	N	Y	S	3,680	6	100	yes	Burn	Yes
Round Valley Creek	NIPF	N	N	Y	S	4,120	78	98	yes	Grazing	No
Scriver Creek	Federal	N	N	Y	S	4,400	61	88	no		Yes
Tenmile Creek	Federal	N	N	Y	S	4,400	38	88	no		Yes
Dry Buck Creek	NIPF	N	N	Y	S	4,520	70	88	yes	Grazing and Road	No
N.F. Thorn Creek	State	N	N	Y	S	4,680	88	83	yes		Yes
Miller Gulch Creek	Industry	N	N	Y	S	4,700	91	83	yes		Yes
Mica Creek	Industry	N	N	Y	S	4760	72	83	yes		No
W.F. Clear Creek	Industry	N	N	Y	S	4,800	80	77	yes		Yes
Hartshell Creek	NIPF	N	N	Y	S	4,970	68	77	yes		No
Grimes Creek	NIPF	N	N	Y	S	5,080	24	72	yes	Historic mining	No
Squaw Creek	Federal	N	Y	Y	S	5,240	57	89	no		Yes
Murray Creek	Industry	N	N	Y	S	5,280	66	67	yes		No
Carey Creek	Federal	N	Y	Y	S	5,300	90	89	no		Yes
Brush Creek	State	N	N	Y	S	5,847	15	51	yes	Burn	No
Trib to Big Creek	State	N	N	Y	S	6,000	91	46	yes		Yes

Methods: LOD Recruitment (Rule 030.07.e.iv)

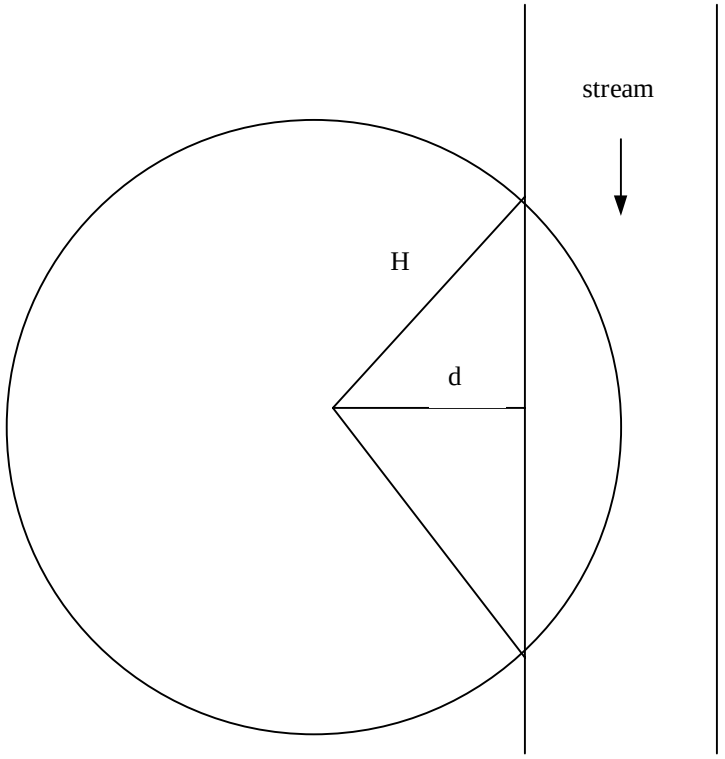
Random Tree Fall Model

A random tree fall model assumes that any given tree that falls will fall in a random direction, i.e., there is no preferred direction of fall in relation to the location of the stream. Such a random tree fall model is characterized by a purely geometrical construction, as shown in Figure 4. For this random tree fall model, the probability that a given tree will fall such that it reaches the stream is expressed by:

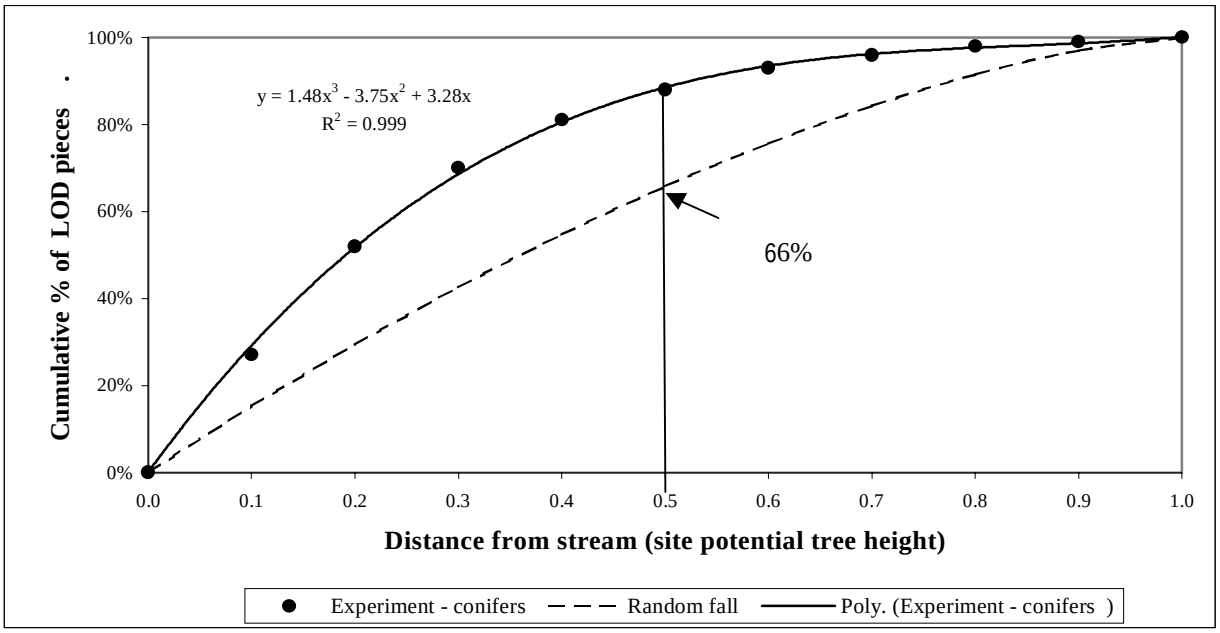
$$P_d = \cos^{-1}(d/H)/\pi$$

where d = distance from the base of the tree to the stream bank
H = tree height

Integrating and normalizing this expression provides the cumulative probability distribution that predicts the proportion of LOD in the stream that originates within a given distance of the stream.



• **Figure 4. Geometry associated with random tree fall model.**



• **Figure 5. LOD recruitment probability distributions, comparing both models.**

The dashed line in Figure 5 represents this distribution. For example (the arrow in Figure 5), approximately 66% of the LOD in the stream originates from within one-half of a tree height (where $d = 0.5H$).

The McDade Model

In contrast to the random tree fall model, McDade et al. (1990) found that more LOD in the stream originates from distances closer to the stream (observation data represented by dashs in Figure 5) than that predicted by the random fall model. The solid line in Figure 5 represents a polynomial function fit to the observed data, as per McDade et al. (1990). For example, McDade et al. (1990) found that approximately 88% of (conifer) LOD in the stream, not 66% as predicted by the random fall model, originates from within one-half of a tree height ($d = 0.5H$).[1] By working the mathematics backwards, i.e., differentiating this fitted curve and normalizing again, the experimental probability for the McDade model that a given tree will fall such that it reaches the stream is expressed by:

$$P_x = 1.35x^2 - 2.29x + 1$$

where d = distance from the base of the tree to the stream bank
H = tree height
$x = d/H$ is the effective tree height

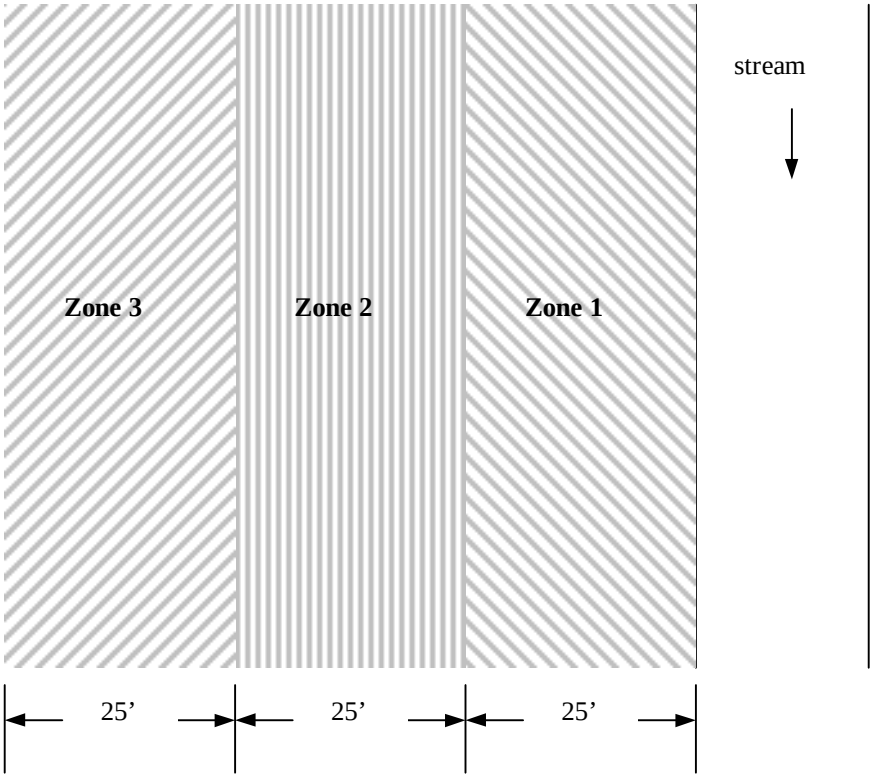
[1] This prediction assumes a representative tree height of 164 feet for the dominant trees in mature and old growth conifer stands of the Cascades and Coast Range, as stated by McDade et al. (1990).

• **Table 4. Percentage of trees, within 25-foot zones, predicted by the McDade model to fall into a stream.**

	Effective Tree Height (feet)									
Zone	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
1	12%	25%	36%	46%	54%	60%	65%	69%	72%	74%
2			1%	3%	8%	12%	18%	24%	29%	34%
3					0%	2%	4%	5%	8%	11%

Zone 1 = 0 – 25 feet from stream bank
Zone 2 = 25 – 50 feet from stream bank
Zone 3 = 50 – 75 feet from stream bank

The effective tree height is the height to which a tree bole has at least a four-inch diameter, the minimum diameter considered to be effective for LOD recruitment. Using the equation derived from the McDade experimental result to evaluate the probability of LOD recruitment over a range of distances from the stream and effective tree heights, the FPWQ Audit team calculated new percentages. Table 4 is the result, and shows the proportion of trees growing in three zones (25 feet wide) that would be expected to contribute LOD to the stream. Figure 6 illustrates the three zones defined for Table 4.[2]



• **Figure 6. Riparian zones defined for LOD recruitment calculations.**

[2] The percentages for the McDade model calculated in Table 4 are based on effective tree height, i.e., the height to which a tree bole is at least a four-inch diameter, the minimum diameter considered to be effective LOD. Table 4 also assumes that the tree falls over from its base, rather than having broken off at some distance above the ground.

For example, suppose the area within 0 to 25 feet of the stream bank (Zone 1) has a uniform population of trees that are 40 feet tall (effective tree height). Then, according to the McDade model, as calculated in Table 4, 46% of the trees within Zone 1 (25 feet wide) would be expected to contribute LOD to the stream. Similarly, according to the McDade model only 3% of a uniform population of trees that are 40 feet tall (effective tree height) in Zone 2 would contribute LOD to the stream. Obviously, no 40 feet tall trees located 50-75 feet from the stream (Zone 3) will reach the stream.

Field data collection

A Class I stream, which had been harvested within the last five years,[3] was surveyed over a 1,000-feet length. If the recent harvest had taken place on both sides of the stream, then transects were located on both sides of the stream at intervals 200 feet apart. If the recent harvest had taken place on only one side of the stream, then transects were located on the harvested side of the stream at intervals100 feet apart. This resulted in a total of ten transects for most of the streams surveyed.

At each transect, a point 12.5 feet from the stream bank, measured perpendicular to the stream bank, was located and used as the center of a 12.5-feet radius survey circle. The species and dbh measurement was recorded for every tree of at least 3" dbh within that 12.5-feet radius. Snags were also tabulated, including a visual estimate of the snag height. Diameters, and if possible species, of stumps were also recorded. The same measurements were repeated at the same transect for a second 12.5-feet radius circle with its center located at a point 37.5-feet from the stream bank, measured perpendicular to the stream bank. This process was repeated at each transect until ten transects were completed for the stream being surveyed (or until the edge of the designated harvest area was reached).

Analysis

For each tree recorded during the field surveys, an effective tree height was estimated using relationships from Moore et al. (1996), adjusted by the length of the tree bole that is less than four inches in diameter. Using the effective tree height, the probability of the tree hitting the stream from its respective riparian zone was calculated from the equation derived from the McDade model. The results of the calculations are given in Table 5. (For snags, their height estimated in the field was considered the effective tree height in the probability calculations.) The probabilities found for each tree or snag were then summed across all transects for a particular stream to arrive at an estimate of the number of trees expected to contribute LOD to that stream. This estimate, in Table 5, was then extrapolated to the entire stream in two ways:

1. by converting the area within the surveyed transects into the number of acres (0.225 acres in most cases) and multiplying by 1.15 acres (the area of the transect:50 feet wide by1,000 feet long) to get the predicted number of LOD pieces contributed per 1,000 feet of stream (shown in the columns labeled “LOD/1,000 ft.”).
2. by conversion to a predicted number of pieces of LOD per channel width (in Table 5, the columns labeled “LOD/chan. width”).

[3] In a few cases, surveyed stream length was shorter than 1,000 feet because the harvest area was too small to contain 1,000 feet of stream.

• **Table 5. Predicted LOD recruitment results by timber sale.**

			Pre-harvest		Post-harvest	
Timber sale	**# of transects**	**Channel width**	**LOD/ 1,000 ft.**	**LOD/ chan. width**	**LOD/ 1,000 ft.**	**LOD/ chan. width**
002562	10	13.2	78.7	1.04	78.7	1.04
007280	10	31.1	41.9	1.30	41.9	1.30
026108	10	4.7	105.2	0.49	105.2	0.49
026686	10	5.2	48.9	0.25	48.9	0.25
026850	10	8.6	137.7	1.18	137.7	1.18
027023	10	3.8	49.2	0.19	49.2	0.19
027098	10	25.0	55.0	1.38	55.0	1.38
10073F	10	23.0	83.8	1.93	83.8	1.93
11076F	10	12.6	166.3	2.10	166.3	2.10
12971F	10	11.4	169.7	1.93	169.7	1.93
12978F	10	8.2	69.1	0.57	69.1	0.57
13304F	6	5.8	139.9	0.81	95.0	0.55
16202F	10	13.5	13.2	0.18	13.2	0.18
16956F	4	13.4	192.4	2.58	175.8	2.36
16973F	10	14.7	52.9	0.78	34.0	0.50
17352F	10	12.1	32.5	0.39	24.6	0.30
17981F	10	10.1	62.5	0.63	60.1	0.61
18021F	10	4.3	20.6	0.09	15.4	0.07
18867F	8	12.4	256.0	3.17	229.1	2.84
21070F	10	12.0	104.6	1.25	104.6	1.25
22100E	10	9.0	87.8	0.79	87.8	0.79
22400F	10	14.2	132.5	1.88	118.0	1.67
24404F	10	18.3	88.0	1.61	88.0	1.61
25151F	10	22.9	50.9	1.17	47.8	1.10
25163F	10	7.2	15.3	0.11	15.3	0.11
34084F	10	14.2	5.6	0.08	4.6	0.07
557590	10	37.6	12.7	0.48	12.7	0.48
88094E	10	21.3	74.9	1.59	67.9	1.45
91810E	9	13.9	79.3	1.10	79.3	1.10
94129E	4	20.3	136.2	2.76	136.2	2.76
98129F	10	12.1	158.0	1.91	146.8	1.78
98675F	10	10.1	121.8	1.23	99.3	1.00
TS12872	10	9.6	145.3	1.40	145.3	1.40
TS22887	10	No data	200.1	No data	183.2	No data
TS23137	10	11.8	129.9	1.53	129.9	1.53
TS42730	10	5.8	97.5	0.57	85.7	0.50
TS42857	10	17.4	30.8	0.54	30.8	0.54
TS43002	5	2.1	71.9	0.15	71.9	0.15
TS62957	5	10.1	111.9	1.13	34.6	0.35
TS63084	10	4.4	46.4	0.20	29.7	0.13

	Changed post-harvest
	LOD of 2.0 or greater

To assess the impacts of harvest within the riparian zone of Class I streams on LOD recruitment, heights of harvested trees were estimated from stump diameters.[4] For each stump, the probability of the tree hitting the stream from its respective riparian zone (had it not been harvested) was found, using the calculated values shown in Table 4. These probabilities were then summed for each stream. When the stump probabilities were added to the probabilities for live trees and snags, the FPWQ Audit team arrived at an estimate of the number of trees predicted to contribute LOD to the stream had there been no harvest in the SPZ.

Results: LOD Recruitment (Rule 030.07.e.iv)

The results of applying the calculations from the McDade model to data collected per transect for the audited sales are shown in Table 5 by timber sale. Figure 7 is a histogram that shows the number of audited sales where predicted LOD recruitment exceeds the value indicated on the X-axis of the histogram for both the pre-harvest and post-harvest conditions. For example, prior to harvest, 22 of the 40 sales exceeded a predicted LOD recruitment of 0.8 pieces per channel width. After harvest, 20 of the 40 sales still exceeded 0.8 pieces per channel width predicted LOD recruitment.

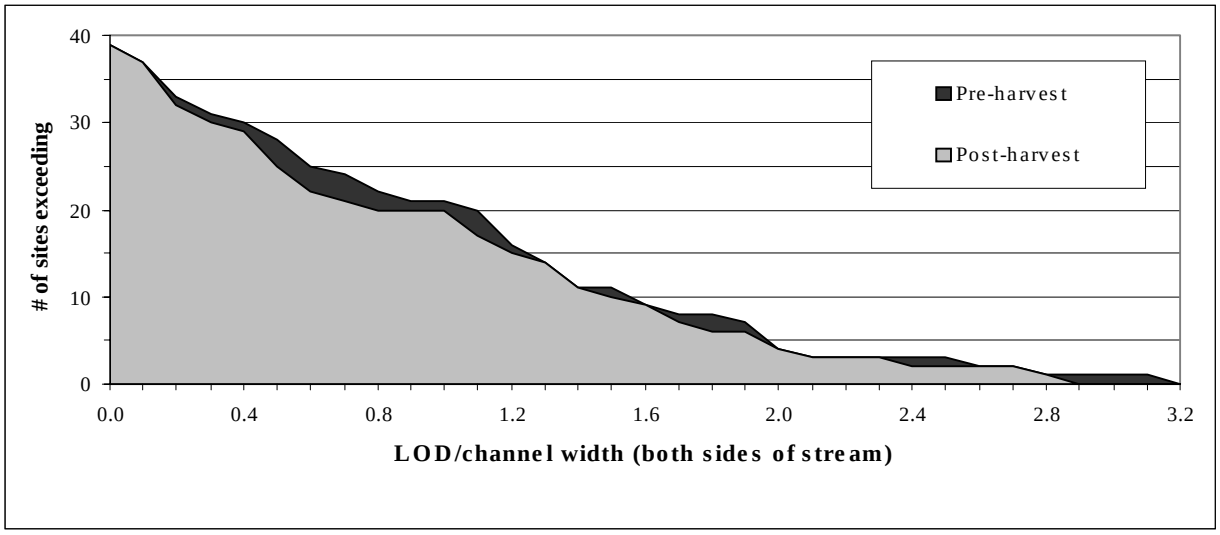
Rule 030.07.e.iv, (leave trees in the SPZ) requires that a certain number of trees must be left in the SPZ of Class I streams, as shown in Table 6. Harvest of trees within the SPZ occurred at only 18 of the 40 audited sales. For those 18 sales, the FPWQ Audit team determined the change in predicted LOD recruitment in pieces per channel width. At this point, one of the sales (as shown in Table 5 by the cells marked "No data") had to be eliminated from this analysis because the sale was located in a large beaver pond complex. Channel width could not be estimated, due to the beaver pond, which meant that the LOD per channel width could not be calculated for that sale. Yellow cells in Table 5 indicate the 17 sales with harvest within the SPZ, which are examined in more detail below.

- **Table 6. Idaho minimum number of standing trees per 1,000 feet of Class I stream within 50 feet of ordinary high water mark on each side of stream.**

Tree size class (dbh)	Number of trees required
3 - 8”	200
8 - 12”	42
12 - 20”	21 *
20”+	4 †

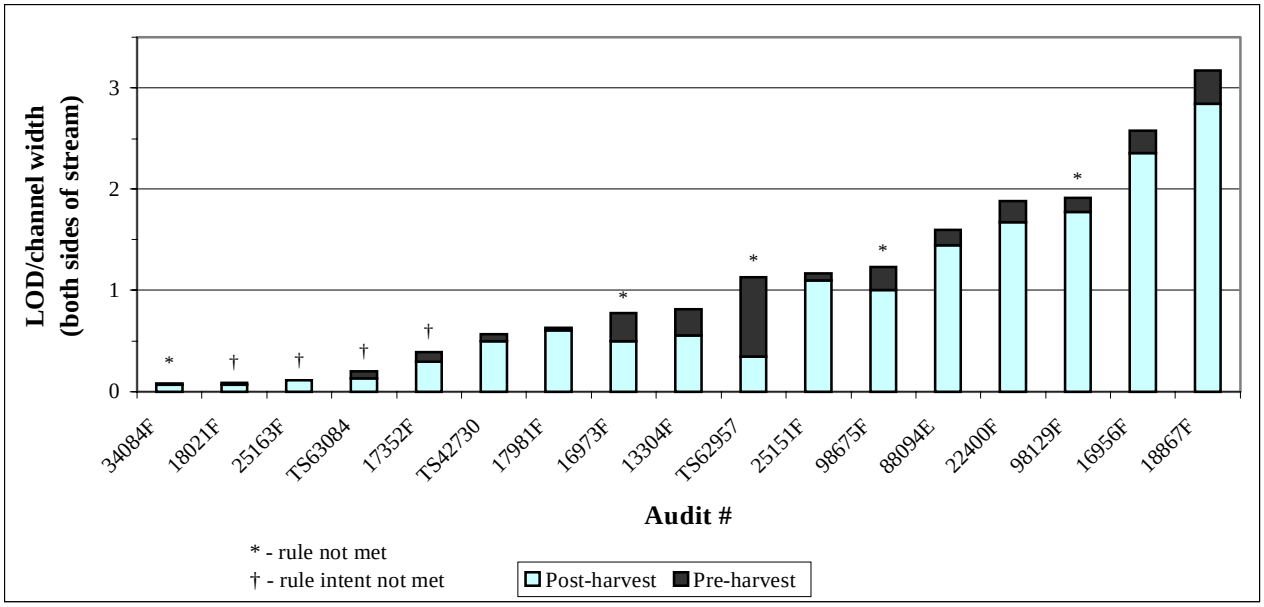
* not required for streams under 10-feet wide
† not required for streams under 20-feet wide

[4] For lack of any better relationships, the same height-diameter relations used for live tree dbh’s were used with stump diameters to estimate heights of harvested trees. Although this is recognized as an error in the methodology, it is a conservative error, as it will tend to increase the probability that a harvested tree would have provided LOD had it not been harvested.



• **Figure 7. Frequency distribution of audited sales by LOD recruitment category.**

The overall effect of timber harvest in the SPZ on LOD recruitment potential across the audited sales is summarized in Figure 7. Trees were harvested within 50 feet of Class I streams in18 of the 40 sales audited. The proportion of black area compared to the total gray area is a relative measure of the change in predicted LOD recruitment due to timber harvest for all the audited sales. Figure 7 shows a discernible leftward shift between pre-harvest and post-harvest conditions (i.e., some sales moved toward lower values of LOD recruitment), particularly in the range of 0.2 to 1.2 pieces of LOD per channel width. LOD potential recruitment to Class I streams can be substantially reduced at some sales. To understand why this occurred, the FPWQ Audit team examined in more detail the 17 audited sales with harvest in the SPZ. The results are shown in Table 5, earlier, and Figure 8, below.

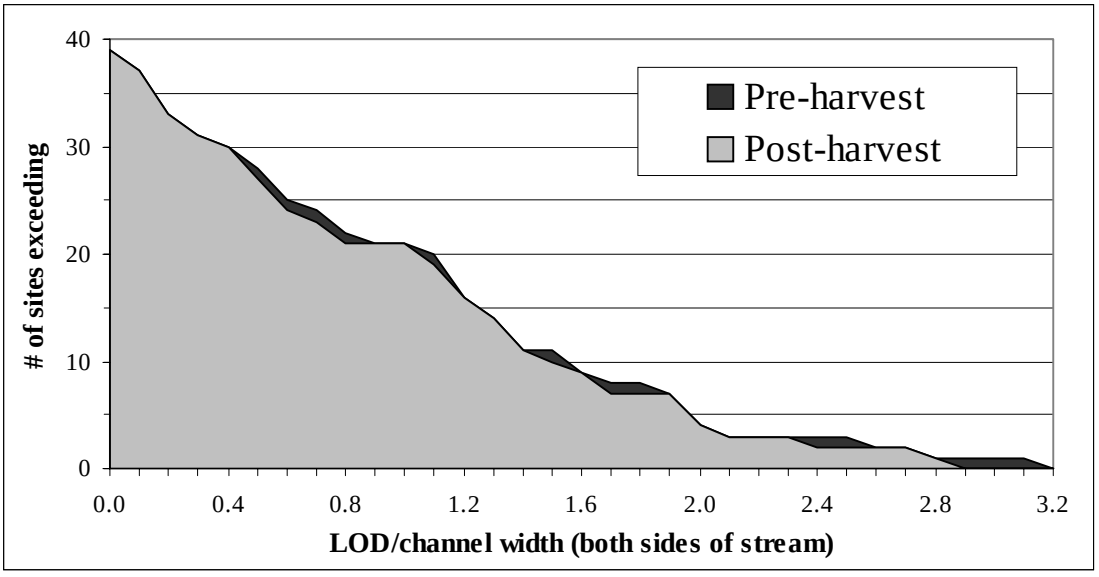


• **Figure 8. Changes in predicted LOD recruitment due to harvest.**

The analysis revealed that the majority of the leftward shift in Figure 7 is due to nine sales that had not complied with Rule 030.07.e.iv, in either the letter, for five sales (indicated by * in Figure 8), or with the intent, for four sales, (indicated by † in Figure 8). For more information on the violations, refer to the earlier discussion, "Results of the Leave Tree Evaluation, Rule 030.07.e.iv", and study Table 1.

The four sales that met the letter of Rule 030.07.e.iv, leave trees in the SPZ, but not the intent, are all harvests that occurred along smaller streams, where there is no requirement to leave larger trees in the SPZ (see Table 6). In these four sales, there were very few smaller trees present, which did not meet the required standing tree levels for the smaller size classes. The FPWQ Audit team believes that harvesting the larger trees from the SPZ, combined with the presence of a road in the SPZ on the opposite side, gives the result that the remaining smaller trees are not sufficient to provide adequate long-term LOD recruitment to the stream. This conclusion is substantiated by the results (indicated by † in Figure 8), which show predicted LOD recruitment of only 0.1 to 0.3 pieces per channel width (after harvest) at these four sales. However, the FPWQ Audit team also notes that all four of these sales occurred in the dryer climate of southwestern Idaho where standing tree densities are naturally lower.

For comparison purposes, Figure 9 shows the equivalent distributions if there had been no harvest at the nine sales where either the letter or the intent of Rule 030.07.e.iv, the leave tree, were not met, i.e., if the full intent of the FPA *Rules* were met at all sales. Figure 9 shows very little leftward shift between pre-harvest and post-harvest conditions (i.e., very little black area), particularly below values of 1.5 pieces per channel width, where low LOD recruitment is of greatest concern. In other words, if the full intent of the existing rules had been met, then the audited sales collectively would have had minor impacts on predicted LOD recruitment.



• **Figure 9. Frequency distribution of audited sales by LOD recruitment category if no trees had been harvested at the nine sales where either the letter or the intent of Rule 030.07.e.iv was not met.**

Figure 9 demonstrates that at virtually any LOD loading target that might be chosen, harvest practices that comply with the intent of the existing FPA *Rules* have minimal effect on the level of future LOD recruitment. It is important to note that this analysis does not consider how additional entries into the SPZ will influence LOD recruitment. Additional entries and natural events (wind, ice storms, stream migration, etc.) will continue to influence the amount of LOD recruitment that occurs into these streams.

Consideration of the level of LOD recruitment raises a related concern. Only four of the 40 audited sales, indicated by the cells outlined in green in Table 5, contained timber stands capable of providing 2.0 or more pieces of LOD per unit channel width to the adjacent streams, based on an assumption of one piece of LOD per tree. A target of two pieces of LOD per unit channel width has been suggested as appropriate for western Washington, but application to areas of the inland northwest is questionable. It's difficult to determine why many of these streams the FPWQ Audit team assessed have a low potential for future LOD recruitment. Possible explanations are:

- Almost all streams experience historic harvest and other associated impacts. Many SPZs had been entered several times previously;
- Some of the streams had wet riparian areas that did not support conifer growth;
- Dry Ponderosa pine or Douglas fir habitat types, as occurred along several of the streams, do not have naturally high standing tree rates.

However, this difficult question may be moot as it relates to the findings of the FPWQ Audit, as sales that complied with the FPA *Rules* had minimal impact on the LOD recruitment levels.

Methods: Road Construction and Maintenance (Rule 040)

With the format of the audits unchanged for 2000, reliability with respect to assessing effectiveness of Rule 040, road construction and maintenance remained problematic. Compared to past audits, more objective assessment methodologies were sought that could be applied given the audit process and time constraints. The methods selected by the FPWQ Audit team to determine road management effectiveness was the sediment assessment delivery module contained in the CWE manual, as well as quantification of fine sediment using the pebble count method described in Wolman (1954).

Sediment Delivery Assessment

The sediment delivery assessment module in the CWE manual provided the FPWQ Audit team with a systematic and consistent approach to determine the relative degree, for each audited sale, of sediment delivery from roads, skid trails, and mass wasting. Field procedures, as described in the CWE manual, Appendix E, were followed as written, with the exception that the field procedures were applied only to the operating area, not to the entire watershed. For each audited sale, scores were determined for roads, skid trails, and mass wasting by the FPWQ Audit team walking or driving the majority, if not all, of roads or trails. These scores were added to determine the total sediment delivery score. Separate scores were calculated for each road segment that had different degrees of sediment delivery or where road attributes changed. Using

this technique, the FPWQ Audit team could better portray how severe the sediment delivery was. In addition, this allowed the FPWQ Audit team to evaluate the effectiveness of a particular practice in preventing sediment delivery to streams.

Fine Sediment Assessment

To assess whether sediment delivery from problem road segments was influencing stream habitat, fine sediment was quantified in Class I stream within the sale boundary. The FPWQ Audit team used the pebble count method described in Wolman (1954). Because of the FPWQ Audit time constraints and the scope of the Wolman study, modifications were made to the pebble count methodology. To save time only 50 particles were counted and sized from each sample site (Wolman counted 100). Research (Bilby et al. 1989 and Duncan et al. 1987) has found that the particle sizes delivered from road segments are usually less than 0.25 inches. Consequently, the FPWQ Audit team determined whether a particle was less than or greater than 0.25 inches while conducting the pebble counts. Wolman pebble counts began at a random transect on the closest riffle and were then conducted on transects every 200 feet along a 1000 feet of stream. The FPWQ Audit team conducted Woman pebble counts from five sales. In the event that less than 1000 feet of stream occurred within the sale boundary, fewer transacts were evaluated.

Combining Sediment Delivery and Fine Sediment Findings

To evaluate if problem road segments were influencing stream habitat, simple statistical tests (t-test) were conducted. These tests compared the amounts of fine sediment occurring in stream reaches with problem road segments to stream reaches where no or minimal sediment delivery was coming from road segments (lowest possible CWE score). If significantly more fine sediment is found to occur in streams with problem road segments, it could suggest that these problem roads (higher CWE scores) are resulting in degraded habitat conditions.

- **Table 7. Summary of roads assessed during the FPWQ Audit using CWE.**

	Surface Erosion from Roads			Mass Wasting from Roads			All Aspects for Sediment Delivery		
	CWE Score	Miles of Road Evaluated	Percent of Road Miles	CWE Score	Miles of Road Evaluated	Percent of Road Miles	CWE Score	Miles of Road Evaluated	Percent of Road Miles
Low	10.0	94.2	65.4%	9.0	120.7	83.8%	21.0	88.1	61.2%
CWE	11-15	19.0	13.2%	10-15	4.0	2.8%	22-30	21.1	14.7%
Scores	16-20	7.0	4.9%	16-20	16.8	11.6%	31-40	22.5	15.6%
	21-25	8.5	5.9%	21-25	0.0	0.0%	41-50	3.5	2.4%
	26-30	6.3	4.3%	26-30	0.5	0.3%	51-60	7.8	5.4%
							61-70	0.0	0.0%
Moderate	31-35	0.3	0.2%	31-35	0.0	0.0%	71-80	0.5	0.3%
CWE	36-40	8.3	5.7%	36-40	1.5	1.0%	81-90	0.5	0.3%
Scores	41-45	0.0	0.0%	41-45	0.0	0.0%	91-100	0.0	0.0%
	46-50	0.5	0.3%				101-110	0.0	0.0%
High	51-55	0.0	0.0%	46-50	0.0	0.0%	111-120	0.0	0.0%
CWE	56-60	0.0	0.0%	51-55	0.5	0.3%	121-130	0.0	0.0%
Scores	61-65	0.0	0.0%	56-60	0.0	0.0%	131-140	0.0	0.0%
	66-70	0.0	0.0%	61-65	0.0	0.0%	141-150	0.0	0.0%
	71-75	0.0	0.0%	66-70	0.0	0.0%	151-160	0.0	0.0%
	76-80	0.0	0.0%	71-75	0.0	0.0%	161-170	0.0	0.0%
	81-85	0.0	0.0%	76-80	0.0	0.0%	171-180	0.0	0.0%
	86-90	0.0	0.0%	81.0	0.0	0.0%	181-189	0.0	0.0%
	Total	144.0	100.0%	Total	144.0	100.0%	Total	143.0	100.0%

Results: Road Construction and Maintenance (Rule 040)

Approximately 54 road segments (representing 144 miles of road) were evaluated using the process defined in the CWE manual to assess sediment delivery and erosion. From this survey the FPWQ Audit team found that very few road segments or miles of road actually resulted in significant sediment delivery problems (Table 7 and Figure 10). Regardless of whether the FPWQ Audit team evaluated road surface erosion or mass wasting or a combination of the two over 94% of the road miles evaluated were considered to deliver little or no amounts of sediment to the stream. In the CWE manual, the lowest category is "little or no" sediment. In fact, the FPWQ Audit team found only one road segment (0.5 miles) that was considered a serious (high CWE score) sediment delivery problem.

Those road segments that had moderate CWE scores (occasional signs of sediment reaching a stream channel) did have common attributes associated with them. These road segments tended to have native surfaces, exceeded 8 percent slope, were located near a stream and/or delivered sediment directly from inside ditches to Class II stream channels.

Most Effective Practices

The FPWQ Audit team found that in the majority of circumstances, current management practices were adequately controlling erosion and sediment delivery from roads in unstable geologic types. Some of the practices that the FPWQ Audit team found most effective in preventing erosion and sediment delivery to streams in these unstable geologic types included:

- Applying gravel to the road surface, especially when the road grade exceeded 8%;
- When road surfaces weren't graveled, closing or gating the road to prevent continued use by public traffic (sight seers, berry pickers, anglers, hunters, etc.);
- Frequent use of rolling dips combined with out-sloping where public traffic is expected;
- Constructing the road at flat grades (less than 3%) located away from stream courses.

Evaluation of Skid Trails

During this audit, the FPWQ Audit team also evaluated the condition of skid trails to determine whether they were responsible for sediment delivery to streams. There were very few erosion problems found on skid trails during the FPWQ Audit. In fact, only three skid trails were identified that were delivering sediment to the stream network. The reason two of these skid trails delivered sediment is because cattle used them as trails, which resulted in compacted surfaces and destroyed cross ditches. Most skid trails appeared to have been re-vegetating following timber harvest activities, which reduces the probability of accelerated erosion and sediment delivery. In addition, surface drainage structures (cross ditches) were usually constructed frequently and properly allowing for effective erosion control. Typically, the public does not use skid trails, unlike forest roads, which do tend to be used by the public; accordingly, skid trails generally do not become rutted or have their drainage structures compromised.

Evaluation of Fine Sediment

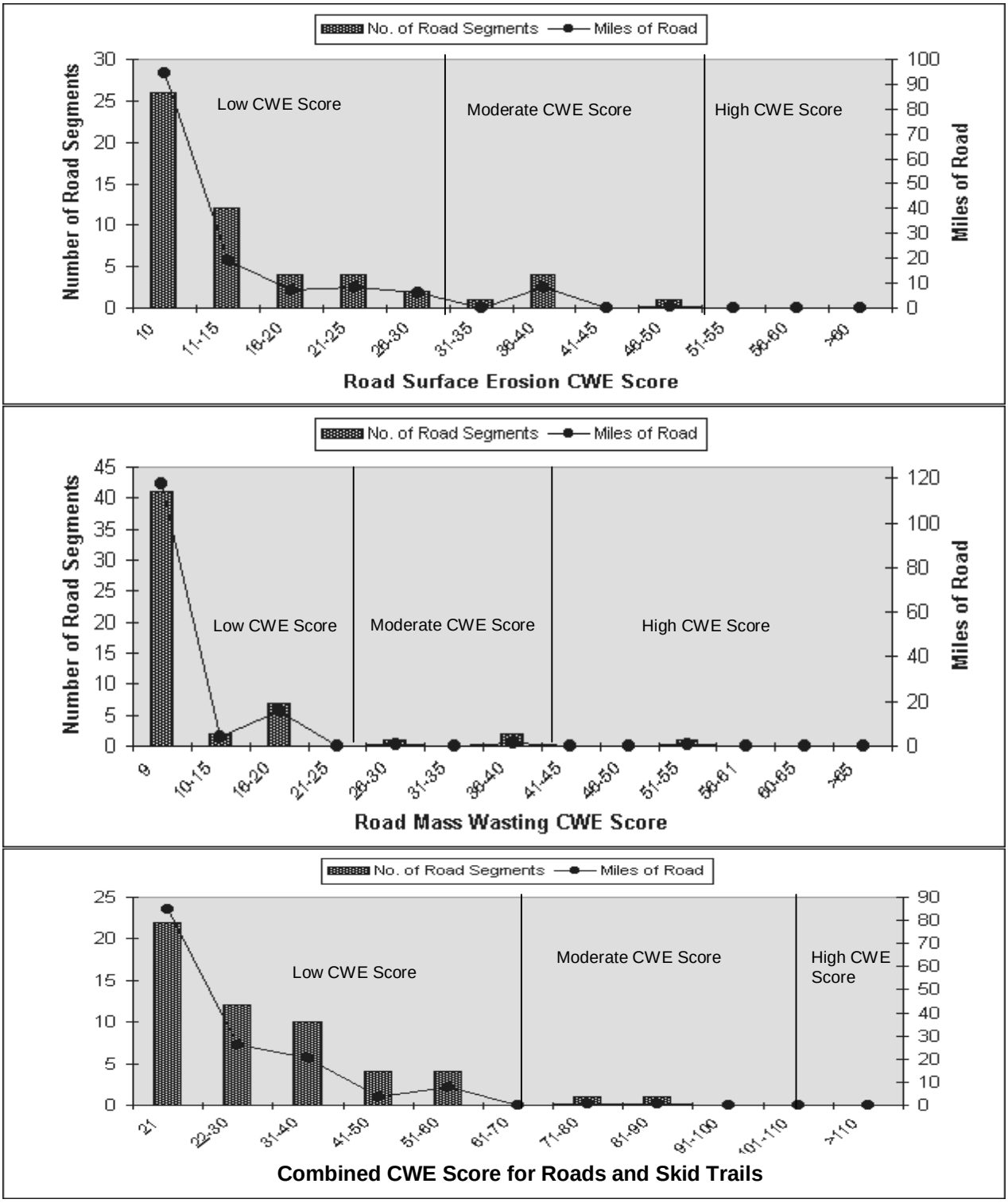
The FPWQ Audit team found the amount of fine sediment occurring in stream reaches with problem road segments were not significantly higher than stream reaches where no or minimal sediment was being delivered from road segments (Table 8). In fact, the amount of fine sediment occurring in stream segments where problem roads existed had on average less fine sediment than streams where no or minimal sediment delivery was occurring from roads.

• Table 8. Comparison of high and low scores of sediment delivery using CWE and (Wolman pebble count)

Summary Topic	Aspects of CWE (Sediment Delivery and Erosion Source) Evaluated		
	Surface Erosion	Mass Wasting	All Aspects
% Fines Mean Value (High CWE Score)	39.2	40.5	40.5
% Fines Mean Value (Low CWE Score)	45.1	43.2	45.8
No. of Observation (High CWE Score)	6	3	6
No. of Observations (Low CWE Score)	16	28	15
T-Test P-Value (one tailed test)	0.241	0.381	0.266

The amount of fine sediment occurring in streams is dependent on many stream attributes including but not limited to, stream grade, stream size, and LOD and floodplain characteristics. For this audit, the FPWQ Audit team did not stratify stream reaches by these attributes when evaluating the amount of fine sediment occurring in them. In addition, the FPWQ Audit team did not consider other activities or disturbances that occurred outside the sale boundary that influenced sediment delivery. Consequently, this type of analysis would probably only be able to detect if gross sediment delivery problems occurred. Other techniques or methods would be necessary to detect more subtle sediment delivery problems, as occurred in the timber sales the FPWQ Audit team audited.

A better approach to evaluate whether fine sediment delivery from timber sales was influencing stream habitat (fine sediment) would be to quantify the amount of fine sediment that occurred upstream and within the timber sale area. This would insure that stream reaches with similar characteristics were compared to one another, and it would help eliminate the complication of how to factor contributions or disturbances that occurred outside the timber sale area.



• Figure 10. A Summary of the FPWQ Audit Road Assessment using CWE Scores for Sediment Delivery: Low (Little or No), Moderate (Occasional), and High (Frequent).

Recommendations

Shade Evaluation (Rule 030.07.e.ii)

Predominately deciduous vegetation, such as grass, shrubs and brush, provided almost the entire canopy occurring over the stream for several of the sales the FPWQ Audit team examined. Technically, in these situations, most of the conifers could be removed from these sales without reducing the amount of shade by more than 25%: the stream would still retain 75% of the existing shade. The FPWQ Audit team is concerned that there would be limited thermal cover provided to streams when the coverage provided by deciduous vegetation is gone during the winter. Winter is often when the highest fish mortality occurs due to ice formation. Decreasing stream temperature during the winter could increase this mortality. The concern is that reducing the conifers would reduce important thermal cover and possibly increase fish mortality. In actuality, this should not happen, as minimum numbers of trees must be maintained along the stream for LOD recruitment, Rule 030.07.e.iv.

Findings from the FPWQ Audit suggest that Rule 030.07.e.ii, shade evaluation, and could be made more effective in maintaining stream temperatures in the ranges preferred by fishes. The existing Rule 030.07.e.ii allows 25% of the current shade to be removed from the SPZ. Where the current shade levels are below what is believed necessary to maintain preferred temperatures, removal of up to 25% of the shade could have adverse impacts on the fishery. Our findings suggest the harvest that occurred along nine streams did not result in shade levels that maintain stream temperatures in the ranges preferred by the fish that occurred there and may have negatively impacted stream temperatures.

The FPWQ Audit team recommends that changes in Rule 030.07.e.ii, shade evaluation, be made so that it will better protect or maintain stream temperatures preferred by the fishes that occur there. This could be accomplished by the following suggestions:

- Develop target shade or canopy cover amounts that are necessary to maintain or protect stream temperatures preferred by fishes that occur there;
- These target shade or canopy cover amounts should take in consideration at least elevation and yearly variations in climate; and
- Variations in stream width and habitat types often make it impossible for desired shade quantities to be met; consequently, reasonable solutions need to be developed for when these conditions are encountered.

LOD Recruitment (Rule 030.07.e.iv)

Our findings indicate that at virtually any LOD loading target, harvest practices that comply with the intent of the existing rules have minimal effect on the level of future potential LOD recruitment. The FPWQ Audit team recommends changes to Rule 030.07.e.iv focus on better implementation to achieve the intent of the FPA *Rules*. For example, the four cases where the intent of Rule 030.07.e.iv was not met were locations where larger trees were harvested although

smaller trees did not meet standing tree density requirements. Instituting a "point" system, whereby larger leave trees would count for greater point values than smaller leave trees, might prevent such a result. The standing tree level requirements could then be expressed as a minimum number of points per 1,000 feet, distributed across all size classes, rather than a certain number of trees in each size class. Lastly, numerous areas in the dryer climate of southwestern Idaho were noted as possibly having naturally lower standing tree densities. Rule changes to be considered then may also include different standing tree densities for southern Idaho.

Road Construction and Maintenance (Rule 040)

Findings from the FPWQ Audit do not warrant changes to Rule 040, road construction and maintenance, as adequate management practices to effectively prevent sediment delivery to streams were applied the vast majority of the time. In addition, where sediment delivery to streams did occur, no increases in fine sediment could be detected in the stream's substrate. However, the FPWQ Audit team found that sediment delivery tended to occur from roads with 1) native surfaces, 2) a slope greater than 8% 3) that were located near a stream, and 4) that delivered sediment directly from inside ditches to Class II stream channels. To insure sediment delivery from roads is minimized in unstable geologic types, it would be reasonable to include this type of information in future training sessions. Another mechanism to reduce sediment delivery in unstable geologic types would be to insert some language into the FPA *Rules* that states the situations that often result in sediment delivery and the various management practices that can be applied to prevent sediment delivery from occurring.

Based on the erosion information collected for skid trails during the FPWQ Audit, it appears that the current FPA *Rules* pertaining to erosion control on skid trails is well understood, regularly implemented and effective in preventing sediment delivery to streams. The FPWQ Audit team suggests no changes or modifications to Rule 040.

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