2004 Interagency Forest Practices Water Quality Audit

February 13, 2007

Department of Environmental Quality
1410 North Hilton Street
Boise, Idaho 83706

2004 Interagency Forest Practices Water Quality Audit

Final Report

Prepared by
The 2004 Forest Practices Water Quality Audit Team

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EXECUTIVE SUMMARY

The first portion of the sixth statewide Forest Practices Water Quality (FPWQ) Audit (FPWQA) was conducted between June and October 2004. The purpose of this FPWQ Audit was to conduct an on-site review of timber harvest and forest practice activities and assess the application and effectiveness of forestry best management practices (BMPs) as described in the 2000 Idaho Forest Practices Act (FPA). The 2004 FPWQA Team was comprised of representatives from the Idaho Department of Lands (IDL) and the Idaho Department of Environmental Quality (DEQ). Timber sales to be audited were randomly selected, with sales for the compliance component of the FPWQ Audit having occurred between 2002 and 2003, and sales for the effectiveness component are to be completed in between the fall of 2004 and the fall of 2005. Sales were selected based on these criteria:

- They occurred on unstable geologic types,
- They bordered or encompassed at least 500 feet of a Class I stream, and
- They were inspected previously by agency foresters with a final report.

The 2004 FPWQ Audit addressed the FPA requirements for timber harvest and road construction and maintenance, and focused on specifications for retaining shade, leaving trees, and providing fish passage. From their findings, the FPWQA Team recommends the following:

- Adopting the 2002 Rule package, developed by the Forest Practices Act Advisory Committee.

- Modifying Rule 030.03 by defining the “immediately adjacent” provision and prohibiting ground based skidding on slopes greater than 45% upslope of the SPZ until the slope breaks to less than 45%.

- Adding a provision to Rule 030.07 that is specific to prescribed fire, to prohibit slash piling using equipment in the stream protection zone, stating hand piles need to be at least 10 feet from the stream, and stating broadcast burns should be conducted under prescriptions designed to achieve cool burns in the stream protection zone.

- Clarifying all road planning, construction, and maintenance rules with guidance language to the effect that "FPA road planning, construction, and maintenance rules apply to roads that primarily exist to manage forest lands. For all other existing roads that are not primarily in place to manage forest lands, where incidental forest practices occur, only the related active road maintenance rules apply.”

INTRODUCTION

Long-term goals and short-term objectives for silvicultural activities in Idaho include auditing, refinement, and implementation of forest practices to enhance water quality, as listed in the *Idaho Nonpoint Source Management Plan* (Dailey et al. 1999). The Forest Practices Act —Idaho Department of Lands, Title 38, Chapter 13, Idaho Code—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 2000a), Rules Pertaining to the Idaho Forest Practices Act (FPA Rules; IDAPA 20.02.01), and
- the 2000 Idaho Department of Environmental Quality (DEQ 2000), Water Quality Standards and Wastewater Treatment Requirements (Water Quality Standards; IDAPA 58.01.02) 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 (FPWQ) Audit (FPWQA) every fourth year. Audits have been conducted previously in 1984, 1988, 1992, 1996 and 2000. By conducting the FPWQ Audit and recommending revisions to the FPA Rules, the FPWQA 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, 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 Forestry Practices Act Advisory (FPAA) 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 (IDL) for their consideration.

Purpose and Objectives

The purpose of the FPWQ Audit is to conduct on-site reviews of timber harvest and forest practice activities and to assess the application and effectiveness of forestry best management practices (BMPs) as described in the FPA Rules. To accomplish this, the FPWQ Audit has several objectives:

1. Assess the extent to which the FPA Rules were implemented;
2. Assess the extent to which forest practices inspectors capture FPA rule compliance during routine inspections;
3. Determine if the FPA Rules are effective in protecting stream habitat: by meeting shade needs in order to preserve stream temperature, by maintaining large organic debris (LOD) recruitment, and by ensuring fish passage at stream crossings;
4. Recommend rule and administrative procedure revisions to the FPA Rules, as indicated by FPWQ Audit findings; and
5. Ensure compliance with the Water Quality Standards and the Federal Water Pollution Control Act, as amended (Clean Water Act; U.S.C.).

This audit has two components: a compliance component (Part I) designed to meet the first two objectives and an effectiveness component (Part II) designed to meet the third objective. Results of these two components will combine to make recommendations as described in the fourth objective.

Scope, Schedule, and Interpretation

For the compliance component (Part I), 23 sales were audited in 2004 and for the effectiveness component (Part II), four sales were assessed for pre-harvest conditions in 2004. In 2005, the four sales selected for effectiveness will be assessed for post-harvest conditions and will also be audited for compliance. When the audit is complete in 2005 there will be a total of 27 sales audited for compliance, with four of those sales also evaluated for BMP effectiveness. This schedule of activities is summarized in Table 1.

Table 1. Scheduled activities for each component of the 2004 FPWQ Audit

Audit Component	2004 Activities	2005 Activities
Compliance These sales are listed in Table 2, page 6, and shown on a map in Figure 1, page 7	Audited 23 sales	Complete a compliance audit in addition to the effectiveness audit for 4 sales that were pre-assessed for effectiveness in 2004
Effectiveness These sales are listed in Table 7, page 24, and shown on a map in Figure 1, page 7	Assessed pre-harvest condition at 4 sales	Complete the effectiveness audit of these 4 sales that were pre-assessed in 2004

For water quality purposes, management practices compliance and effectiveness are determined by answering three primary questions: 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.

Methods used in the FPWQ Audit to meet the above objectives were limited by personnel, funding, time, sample size, and logistical constraints. Due to the limited sample size, the FPWQ Audit was not intended to be statistically robust nor to evaluate the cumulative effects of forest practices within a specific drainage. Regardless of budget and sample size constraints, the FPAA Committee recognized the importance, for compliance monitoring trend purposes, to yield data comparable to previous FPWQ Audits.

By stratifying regions of similar characteristics, the audit provides a cursory evaluation of BMPs and their effectiveness related to region baselines. The audit is not necessarily a robust sample of sites within each region, however, the strength of the FPWQ Audit is in the fact that the assessments will be made on a statewide basis and will be representative of general effectiveness across Idaho. To a lesser extent, inferences can be drawn regarding the four administrative units of land ownership: federal, state, industrial private, and non-industrial private.

If, or when, these audit results indicate a significant change in effects following forest practice activities, a more statistically valid study should be employed for that particular region by a volunteering lead agency.

Little effort was made to assess within-sale or between-sale variability. Storm and runoff events were not characterized for each sale. Timber sales were not weighted to account for differences in the amount of harvest, road work, or spatial distribution. Not every cutting unit, road, landing, or skid trail was observed in larger sales. The FPWQA Team selected the areas of the sale to be observed.

PART I

MANAGEMENT PRACTICES COMPLIANCE

Introduction to the Compliance Component

The compliance component of the FPWQ Audit focused on assessing applications of the FPA Rules in areas most susceptible to erosion and on assessing reliability of inspection reports generated by inspecting foresters. To do this, the FPWQA Team examined and assessed completed timber sales from the years 2002 and 2003. These timber sales were randomly selected from a pool of sales previously inspected by agency foresters, for which final reports exist. In addition, all sales selected for the effectiveness audit will also be audited for compliance after harvest activities are completed.

In looking at applications of the FPA Rules, more than one rule may have applied 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. When the most applicable of Rules was rated, the FPWQA Team based its conclusion and recommendations on evaluation of the FPA Rules as well as on the judgment of the FPWQ Audit participants.

Originally, 43 sales were expected to be audited for compliance; 23 in 2004 for compliance between June and October, with an additional 20 audited for compliance as well as effectiveness in 2005. During the 2004 field season 23 sales were audited for compliance as planned. However, of the 20 sales planned for the effectiveness component in 2005, only four were available for pre-harvest assessment in 2004, therefore, only four will be assessed for compliance during the 2005 field season.

Audit Team Participation

The FPWQ Compliance Audit team was comprised of a qualified representative from the IDL and from the DEQ. A crew of four personnel from the IDL assisted the representatives by collecting measurements and data in the stream and stream protection zone (SPZ) within or adjacent to audited sales. For each audit, the original compliance inspector accompanied the team to provide background information, but was not involved with the rating operation. Of the affected landowners, operators, other natural resource agencies, and interested parties invited to attend, persons from the National Oceanic and Atmospheric Association (NOAA) Fisheries and from the Idaho Forest Owners Association joined the FPWQA Team on several occasions.

Compliance Timber Sale Selection

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

1. The timber sale area must occur in an unstable geologic type. The definition the FPWQA Team used for unstable geologic types is listed in the *Forest Practices Cumulative Watershed Effects* (CWE) *Process for Idaho 2000* (IDL 2000b).
2. The timber sale boundary must border or include 500 feet of a Class I stream.
3. The timber harvest must have been completed by 2003.
4. At least one FPA inspection report must have been completed.

For 2004, 23 sales were selected that represent the following four types of land ownership administrative units: five from state lands, five from federal lands , six from industrial private lands, and seven from non-industrial private lands. Of the five from state lands, one sale will be selected from each of the following IDL Supervisory Areas: Priest Lake, Cataldo, St. Joe, Clearwater, and Payette Lake. Of the five from federal lands, one was selected from each of the following national forests; Idaho Panhandle, Clearwater, Nez Perce, Payette, and Boise. Of the 13 from private lands (six industrial and seven non-industrial), one sale will be selected for each of the 13 IDL Forest Practice Advisors, based in 11 IDL Supervisory Areas. Due to limited activity, no audits are planned for the south, central or eastern parts of Idaho.

In 2005, each sale audited for effectiveness will also be audited for compliance, assuming the sale is complete or near completion.

A pool of sales in the State was created, stratified by ownership, and weighed against the selection criteria above. From those that met the above criteria, sites were then randomly selected to ensure the objectivity of the sample. Objectivity is especially important since the effectiveness component has been added to the FPWQ Audit and since new methods for evaluating compliance and effectiveness have been adopted (see Part II, starting on page 21, for purpose, objectives, and methods).

Another important aspect related to both compliance and effectiveness is the stratification of selected sites in key areas. These sites were delineated by geologic region within the State. Stratifying the sites into similar regions provided for better comparison within a particular region and the flexibility to extrapolate findings of effectiveness to other parts of the state with similar characteristics.

Forty-six sales were initially selected from the pool for participation in the compliance audit. After 46 sales were selected, forest practice advisors or sale administrators were contacted to determine whether they met the criteria listed above. If a sale had other significant land use disturbances, such as grazing, agriculture, mining, or urban development, the FPWQA Team attempted to avoid it as a candidate for the audit—although it was not always possible—to ensure that the FPWQ Audit evaluated impacts that occurred mostly from forestry practices. The 46 sales were then plotted on a map. The 23 sales closest together geographically were selected as the primary sales to be audited (see Figure 1, page 7, for audit site locations), allowing the

most convenient travel logistics. The remaining 23 sales were listed as alternates. A list of the 23 timber sales audited for compliance and their general descriptions is shown in Table 2.

Table 2. Management Practice Compliance sales general descriptions.

Stream	Sale	Notification No.	Ownership	County	Volume	Av.Channel Width
Alder	Alder	48232-F	NIPF	Bonner	250 mbf	2.2'
Bane	Bane	51399-F	PI	Boundary	2 mmbf	2.5'
Big Cedar	Big Cedar	43315-F	PI	Idaho	2 mmbf	8.2'
Bond	Fire Draw	40300-F	PI	Shoshone	7.7mmbf	16.3'
Cocolalla	Little Blacktail	558531	Federal	Bonner	5 mmbf	6'
Cold Spring Ck.	Cold Spring	45818-F	NIPF[a]	Lewis	890 mbf	2.7'
Corral	Honker 2	24224	Federal	Idaho	2.8 mmbf	No data
E. Fk. Fishhook	Camp 44	43558-F	PI[b]	Shoshone	800 mbf	12.6'
Goose	Second Chance	005530	Federal	Adams	7038 ccf	6'
Granite	Granite	43842-F	NIPF	Boise	50 mbf	17'
Hazendorf Gulch	Linfor Hill	22070-F	State	Shoshone	3.1 mmbf	7'
Hornet	Disappointed Grouse	19151-F	State	Valley	3.8 mmbf	5.5'
Humboldt Gulch	Burke Canyon	40441-F	PNI	Shoshone	2.8 mmbf	8.5'
Hunt	West Hunt	19047-F	State	Bonner	2 mmbf	25'
Knoll	Knoll Bugs Unit 6	27510	Federal	Idaho	1.3 mmbf	8'
Little Mud	Between Muds	52844-F	PI	Adams	2.1mmbf	5'
Little Sand	Sand Creek	55283-F	NIPF	Bonner	50 mbf	19'
N. Fk. Tyson	Tyson	51076-F	State	Benewah	3.9 mmbf	2.5'
Ophir	49er		Federal	Boise	400 mbf	3'
Orofino	Oro-Copter	27099-F	State	Clearwater	3.5 mmbf	85'
Randall Flat	Randall Flat	19445-F	NIPF	Latah	479 mbf	4'
Roush	Roush	51533-F	NIPF	Kootenai	1.2 mmbf	6.8'
Whiskey	Miller Bridge	41285-F	PI	Clearwater	621 mbf	26'

a. NIPF indicates Non-Industrial Private Forestry, and PI indicates Private Industrial.
b. Federal sale notification numbers are represented by USFS Contract number.

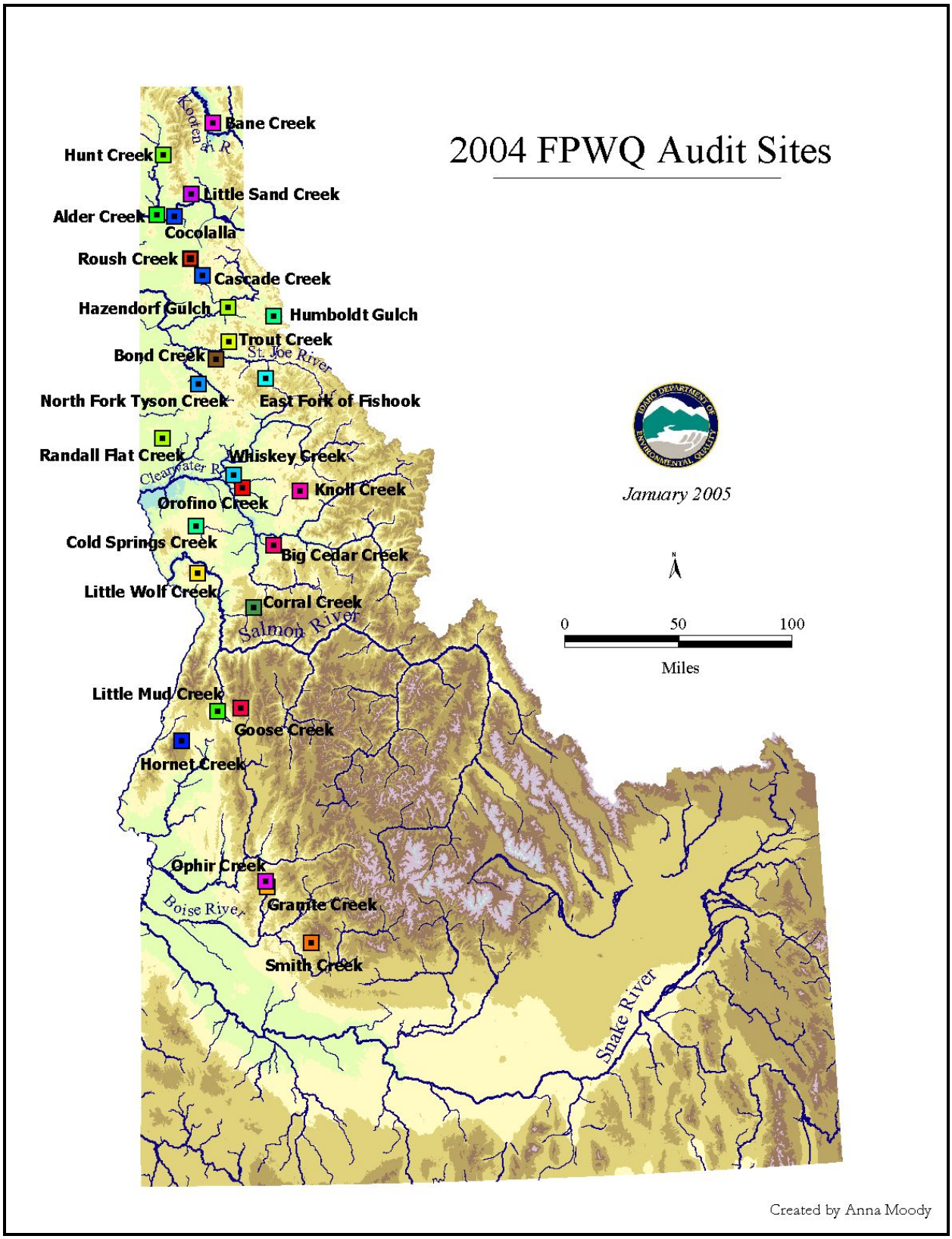

Figure 1. Map of Idaho with location of compliance and effectiveness audit sales.

Assessment of Compliance (Rules 020, 030, 040, and 060)

The FPWQA Team used the April 1, 2000 version of the FPA Rules to assess compliance. The team primarily addressed Rules 20.02.01.030 (timber harvest) and 040 (road construction and maintenance). Portions of Rules 20.02.01.020 (general rules) and 060 (use of chemical and petroleum products) were evaluated as they pertained to water quality. The purpose of these Rules is:

- Rule 020 – General Rules.
- Rule 030 – "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."
- Rule 040 – "to provide standards and guidelines for road construction and maintenance that will maintain forest productivity, water quality, and wildlife habitat."
- Rule 060 – "to regulate handling, storage and application of chemicals in such a way that the public health and aquatic and terrestrial habitats will not be endangered by contamination of streams or other bodies of water."

To determine compliance with the FPA Rules, the FPWQA Team divided into two groups. One group, the DEQ representative and IDL representative, walked and/or drove road segments and skid trails to evaluate compliance with Rule 040 (road construction and maintenance). The other group, the four-person IDL field crew, walked a section of Class I stream for each sale to evaluate compliance with 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.

Many road and harvest rules have descriptive, not prescriptive, compliance standards. For a sale to be considered in non-compliance with descriptive rules, consent of agency representatives of the FPWQA Team was required. To assign ratings of non-compliance with prescriptive rules required further evaluation necessary for non-biased results. Prescriptive rules are best evaluated through quantitative measurements. Therefore, measurement data was collected at each audited timber sale to assist in the evaluation of compliance with the prescriptive rules, such as Rule 030.07.ii (shade evaluation), Rule 030.07.iv (leave trees within the SPZ), rule 040.02.e.i (fish passage), rule 040.02.e.ii (culvert design-fifty year peak flow), and various rules related to SPZ widths. Compliance for prescriptive rules was determined by evaluating the sample data collected at each audit location. Details of methods used to evaluate compliance with these rules are discussed below.

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 classified into the appropriate land ownership category. Finally, an average implementation rate was calculated for each land ownership category.

The extent to which the FPA Rules are complied with during routine inspections was assessed by the following procedure. First, the audit team conducted a compliance audit as described above and further in this report. Next, agency generated inspection reports were reviewed by the Audit team. Finally, assessments were made to calculate the degree of variability between the audit teams' findings and those of the field inspectors.

For the 23 timber sales audited in 2004, the FPWQA Team assessed compliance with portions of Rule 020 (general rules), Rule 030 (timber harvest), Rule 040 (road construction and maintenance) and portions of Rule 060 (use of chemicals and petroleum products). The FPA Rules were applicable in 987 instances for these sales and were complied with in 964 instances, resulting in an overall compliance rate of 97.7% for the 2004 FPWQ Audit. The compliance rates in the land ownership categories were: federal lands, 99.6%; state lands, 98.4%; private industrial lands, 98.9%; non-industrial private lands, 93.4%.

Of the 23 instances of non-compliance, four were violations of Rule 020.a.i-a.iii, variance requirements, ten were violations of Rule 030, timber harvest, nine were violations of Rule 040, road construction and maintenance, and there were no violations of Rule 060.02.a.-c., petroleum products. Under Rule 020, every provision that was evaluated was violated one time. Under Rule 030, the stream protection subsection – Rule 030.07 – was the provision most often violated (5 out of 10 instances or 50% of all non-compliance with Rule 030, timber harvest). Under Rule 040, the road maintenance subsection – Rule 040.02 – was the provision most often violated (5 out of 9 instances or 55.6% of all non-compliance with Rule 040, road construction and maintenance).

Regulatory Compliance and Consistency

Comparison of inspector findings to audit team findings

In an effort to determine whether field personnel were adequately administering the FPA, an assessment was made of the comparison between field observations and inspection reports completed by regulatory or sale administration personnel and FPWQA Team findings. This is the first time since the inception of the interagency audit program that such an assessment has been made. Generally, the FPWQA Team found a high degree of correlation between audit team findings and FPA compliance inspection findings.

This first part of this assessment was made by reviewing inspection reports and interviewing sale inspectors or other administrative personnel who had knowledge of the sale. The team recognized a direct comparison might not be possible because any field inspections are snapshots in time and space and other land use activities, subsequent logging, or natural events can result in different BMP conditions at the time of audit compared to when the sale was inspected at various times. Nonetheless, the audit team recognizes harvest and road construction activities do leave evidence of land management on the landscape and therefore chose to assess comparisons to capture regulatory compliance and consistency. The FPWQA Team has a high degree of confidence in the results presented below.

Of the 23 sales audited for compliance, 18 had corresponding rates of BMP compliance between the FPWQA Team and the inspecting forester. Of these 18 sales, three had previously identified

BMP compliance issues regarding road maintenance that were subsequently resolved by the time of the audit. The FPWQA Team also observed four instances of BMP non-compliance for three of the 18 sales, pertaining to road maintenance and landing in a Class II SPZ, which resulted from subsequent forest practices not related to the audited sale.

Six BMP discrepancies were found on five sales. This amounts to a 99% consistency rate between what the audit team found compared to what inspecting foresters found. Three of the discrepancies involved providing for fish passage through culverts, and in all three locations, inspectors used ocular estimates to determine fish passage compared to the quantified and modeled approach used by the FPWQA Team. One BMP discrepancy involved equipment use in the SPZ; this was not observed by the inspector because the activity occurred during slash piling operations, which occur after harvest operations. Likewise, infractions involving landing in an SPZ and excessive skid trails were not previously observed by the inspector.

Comparison of audit compliance rates with statewide compliance rates

In an effort to gauge whether the audit BMP compliance rates reflect overall statewide compliance rates on all forest practices inspected, the FPWQA Team sought data concerning all inspected forest practices for the years 1996, 2000, and 2004; those were years when interagency audits were most recently conducted. It quickly became apparent that this data is either not readily available or does not exist for all land ownership classes in a useful format for the years 1996 and 2000. This is due primarily to the paper form and filing systems currently in place to store individual sale compliance reports. The team concluded the 2004 inspection data for private lands was the only reliable and readily available data set.

The FPWQA Team found 256 inspection reports, out of a total of 3,032 completed by IDL on private land, that had at least one BMP non-compliance item noted. A total of 537 water quality related BMP infractions were cited. Using an average of 18 applicable BMPs per inspected sale, this results in an overall BMP compliance rating of 99% on inspected private sales.

Section Summary

The FPWQA Team believes an extremely high degree of consistency exists between what an auditor may find and what individual inspectors may find with respect to FPA BMP compliance. The team also believes audit compliance rates, despite being derived from a small sample of operations that occur annually in Idaho, reflect the overall rate of compliance statewide. IDL has well-developed regulatory program guidance documents, less formal yet rigorous training and outreach programs, and an informal FPA mentoring system that collectively has demonstrated its effectiveness and should continue to be implemented.

Compliance Rates Compared to Previous Audits

Table 3 and Figure 2 (page11) show the overall compliance results from the 2004 FPWQ Audit as compared with previous audits conducted in 1984 (Bauer et al. 1985), 1988 (Harvey et al. 1989), 1992 (Hoelscher et al. 1993), 1996 (Zaroban et al. 1997), and 2000 (Hoelscher et al. 2001). An overall upward trend is indicated for compliance in all land ownership categories

from 1984 through 1996. A trend of stabilization of compliance in the 90th percentile for all land ownership categories from 1996 through 2004 is also indicated.

Table 3. Overall compliance rates for all FPWQ audits from 1984-2004.

	Percentage Compliance by Land Ownership Category			
Audit Year	Federal	Industrial	NIPF	State
1984	96	82	82	67
1988	94	95	86	97
1992	93	96	94	89
1996	100	98	95	93
2000	98	94	95	96
2004	99.6	98.9	93.0	98.7

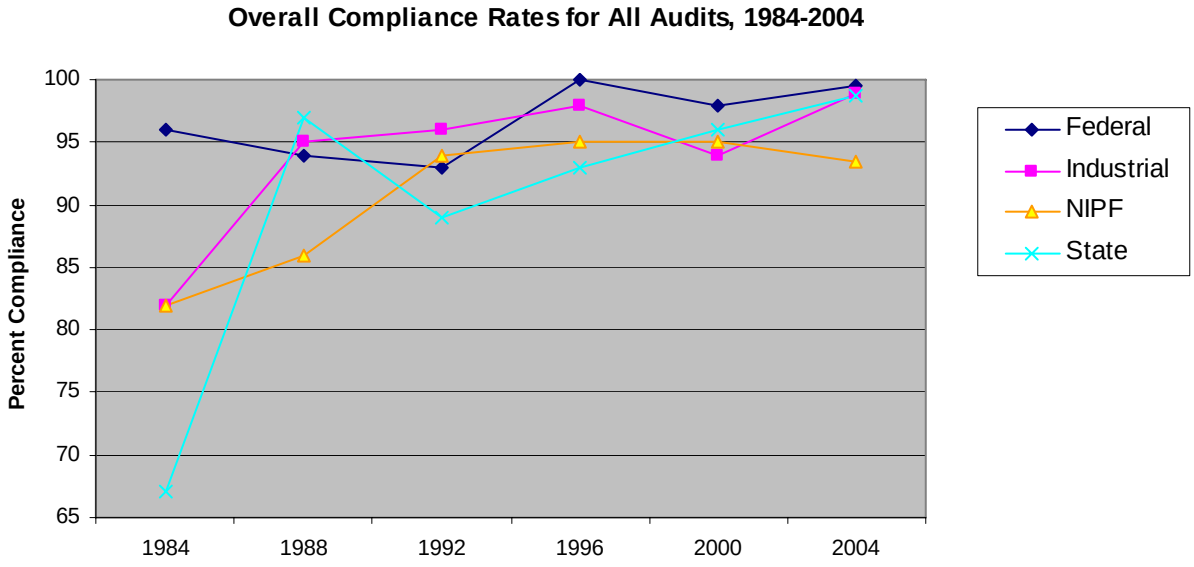

Figure 2. Overall compliance rates for all FPWQ audits from 1984-2004.

Evaluation of Compliance With Selected Portions of Rules 030 and 040

As mentioned previously, compliance with certain prescriptive portions of the FPA Rules could not be evaluated by observation alone. To evaluate the previously described prescriptive rules the FPWQA Team took quantitative measurements related to:

- Rule 030.07.e.iv, leave trees in the stream protection zone, 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 analyzed based upon certain criteria and methods. Details of the methods used to obtain measurements and quantitatively evaluate compliance with these selected portions of the FPA Rules are in respective Methods and Results sections of this report.

Evaluation of compliance with three selected portions of Rule 030 (Rule 030.07.e, provide for LOD (LOD recruitment); Rule 030.07.e.ii, shade evaluation; and Rule 030.07.e.vii., site specific BMPs) was different for the 2004 FPWQ Audit compared to previous FPWQ audits. Discussion of LOD recruitment, shade evaluation and descriptions of methods are provided in Part II, Management Practices Effectiveness beginning on page 21 of this report. Site-specific BMPs were evaluated by verbal inquiry and observation due to the lack of written site-specific prescriptions. Observations of site-specific BMPs are presented in the Recommendations section beginning on page 35 of this report.

To acquire better indications of site characteristics, the audit team collected and analyzed information about the sites surveyed. Current LOD condition data and present shade and canopy cover data, for the compliance portions of the audit, are displayed in Figures a, b and c, and Tables a, b, c, and d, of Appendices A and B beginning on page 46. Methods used for measuring in stream LOD, shade, and canopy cover for the compliance component are the same as those used for the effectiveness component. These measurements are detailed in Part II of this report, Management Practices Effectiveness. Other calculations of data collected in the SPZ such as percent of trees harvested in Zone 1 (within 25 feet from the stream's ordinary high water mark), trees per acre (TPA), basal area (BA) per acre, BA retained, and BA removed, are displayed in Figure d, and Tables d and f, of Appendix C. Measurements recorded in Zone 3 were recorded for potential future uses to characterize the 75 foot SPZ.

Methods and Results for Determining Compliance With Selected Portions of the FPA Rules

The following subsections contain methods and results of determining compliance with three provisions in the FPA Rules: Rule 030.07.e.iv – Leave Tree Evaluation, Rule 040.02.e.i – Fish Passage Evaluation, and Rule 040.02.e.ii – Fifty Year Peak Flow Evaluation.

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

To evaluate compliance with Rule 030.07.e.iv, the numbers of trees retained (left) and cut (harvested) within the SPZ were quantified. This was accomplished by establishing survey plots. Within each plot, trees and stumps were counted and recorded. Plots were established following these steps:

Note: these steps refer to one side of the stream. If harvest occurred on both sides, these calculations were applied separately to each side.

- Five transects perpendicular to the stream were established along the 500-foot reach of the Class I streams assessed for this audit, thereby dividing the reach into four 125-foot transect intervals (except in one instance, where six transects created five 100-foot intervals instead).
- At each transect, a plot 25 feet wide (along the stream) by 75 feet long (back – or up the slope – from the stream), having a total area of 1,875 square feet, was established. (Note that this 1,875 square foot area includes all three zones, while the leave-tree evaluation – for Class I streams – includes only Zones 1 and 2).

- The total plot area was divided into three 625-square foot zones (each 25 feet by 25 feet). Zone 1 extended from the stream (for this purpose, the stream edge is defined as the normal high water mark, as specified in Rule 030.07.e.iv) to 25 feet back (or up the slope) from the stream. Zone 2 started from the upper edge of Zone 1 (25 feet from the stream) and extended back another 25 feet, ending 50 feet from the stream. Zone 3 extended from the upper edge of Zone 2 (50 feet from the stream) to 75 feet from the stream. The plots and zones are shown in Figure 3
- Within each plot and measured zones the FPWQA Team recorded the number of trees and each tree's species, health (live, dying, or dead), dbh, height, and the average percent slope of the ground in the plot. The diameter of each stump, at one foot height, was also recorded in each zone.

Tree and stump data from Zone 1 and Zone 2 were used in calculations to determine compliance. Stumps were assumed to be from trees that tapered three inches from one foot height up to breast height (4.5 ft. or 1.3 m.). For example, if a stump's diameter at one foot height was 15 inches, the dbh was considered to be 12 inches. This "three inches of taper" assumption was derived from a "rule of thumb" that says, depending on species and other characteristics, diameter of trees in Idaho will taper two to four inches from one foot height to breast height. Based on this "rule of thumb" the FPWQA Team decided to use an assumption of three inches for bole taper to calculate which size class a stump would fit into for the leave-tree evaluation.

Rule 030.07.e.iv requires consideration of how many trees are retained (left) and how many are harvested (cut or removed) from each stream's SPZ for a distance of 1,000 feet. To determine the number of trees retained and harvested in a 1,000-foot reach, although the audit encompassed only a 500-foot reach, the following steps were taken:

1. The total area of the SPZ along 1,000 feet of stream was determined; this is the area that must be considered under Rule 030.07.e.iv. Since all streams audited were Class I streams, the SPZ was 50 feet deep as specified in Rule 030.07.e.iv. Therefore, the total area for which compliance with Rule 030.07.e.iv must be considered, was 50,000 square feet (1,000 feet x 50 feet; 1.15 acres).
2. To establish a multiplier for use with the data from the 500-foot reaches audited, this total area to be considered was divided by the total area of the plots surveyed along one 500-foot reach of the SPZ.
3. The total area of the plots surveyed was calculated as 25 feet (width of one plot) x 50 feet (depth of the SPZ) x the number of plots.
4. Note: When the number of plots was five, the total area of the plots surveyed was 6,250 square feet (25 x 50 x 5) and the multiplier was 8: 50,000 / 6,250.
5. The multiplier was then multiplied by the total number of trees and stumps counted within Zone 1 and Zone 2 combined, giving the number of trees assumed retained (left) and harvested (removed) from 1,000 feet of the SPZ.

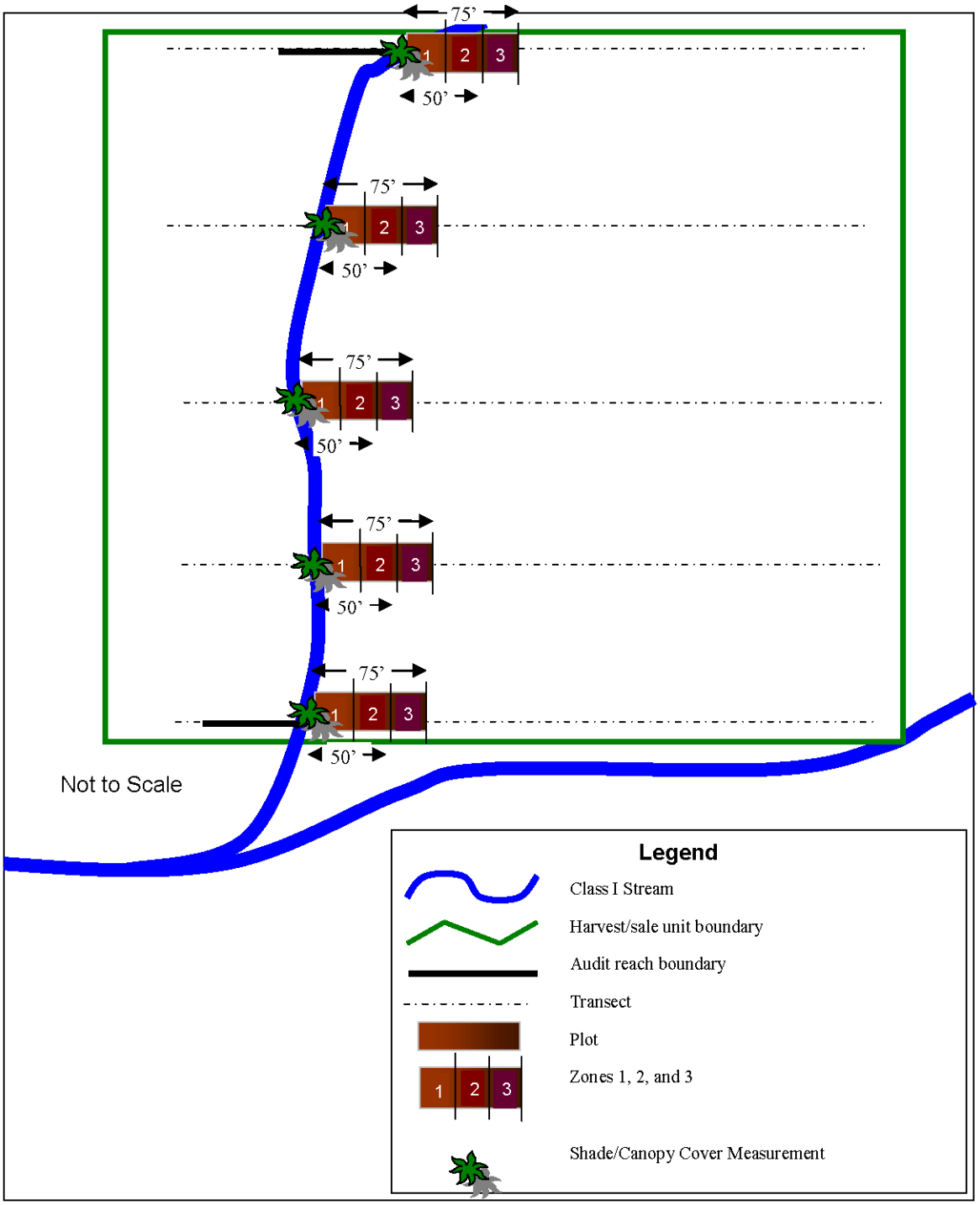

Figure 3. Diagram of stream reach layout, including transects, intervals, plots, and zones.

To evaluate whether logging operators complied with Rule 030.07.e.iv (leave trees), the resulting number of trees retained and harvested within 1,000 feet of the SPZ were compared to the minimum standing tree provision in Rule 030.07.e.iv. The dbh recorded for each tree was compared to criteria for tree size (dbh) and stream width provided in Rule 030.07.e.iv (in the table titled "Minimum Standing Trees Per 1000 Feet Required (each side)") to determine its size

class. These four size classes (3 - 7.9", 8 - 11.9", 12 - 19.9", and 20 +") define ranges of tree dbh. The values from the table in Rule 030.07.e.iv, including size class, are incorporated into Table 4 (at the end of the following Results section of this report) in the gray-shaded row labeled "FPA minimum." If the number of trees assumed retained in any size class was fewer than required by Rule 030.07.e.iv, and trees were harvested in that size class, the sale was considered to be in violation of Rule 030.07.e.iv.

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

In three of the 23 sales (13%) examined by the FPWQA Team, Rule 030.07.e.iv was violated. This rule specifies the minimum number of standing trees that should be retained (left) within the SPZ on each side of a 1,000 foot stream reach. These three sales are represented by the red-shaded cells indicating "Violated minimum standards" in Table 4. For each of the three 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 4, indicating "Number of leave trees below FPA minimums." Despite these deficiencies, additional trees were cut, further reducing the number of trees standing, which was less than specified in Rule 030.07.e.iv.

As shown in Table 4, Rule 030.07.e.iv specifies the following required number of standing trees per 1,000 feet of stream:

- zero trees for both the 12 - 19.9" and 20 +" size classes for streams less than 10' wide;
- 21 trees in the 12 - 19.9" and zero in the 20 +" size class for streams less than 20' wide;
- 21 trees in the 12 - 19.9" and four in the 20 +" size class for streams greater than 20' wide.

Harvested trees were predominantly from the larger size classes, with the exception of the previously mentioned violations. Few small trees were present prior to harvest, and subsequently the majority of sales did not harvest within the SPZ (Zones 1 and 2), as shown in Table 4 in cells with violet font indicating "Sales without harvest in the SPZ."

Of the 23 sales examined by the FPWQA Team, none had a sufficient number of trees prior to harvest to meet or exceed what is required to be left standing in the SPZ for each size class. The incidence of streams monitored for this audit that do not have the minimum number of small diameter (3 - 7.9 in.) trees per 1,000 ft. of stream, shown by the yellow-colored cells in Table 4, can be attributed to site-specific physical and biological characteristics (i.e. climate, soil types, species composition, stream morphology, and various disturbances). These sites may not have the ability to support the required number of smaller trees.

Landowners, operators, and forest practices advisors who attended the FPWQ Audits generally believed, based on visual estimation, that the audited sales met or exceeded the minimum standards of Rule 030.07.e.iv, though judgment was reserved until measurements were calculated. The FPWQA Team also did not believe, based on observation, that any of the sales violated Rule 030.07.e.iv; only the actual survey counts and related calculations revealed this. As a result, the FPWQA Team concluded that visual estimates were not adequate to evaluate compliance with Rule 030.07.e.iv. Despite these concerns, in 15 of the 23 sales (65%) audited, no trees were harvested within the SPZ (within 50 feet of the ordinary high water mark), as shown in Table 4 by all zeros (in violet) in the column labeled "Number of Trees/1000 ft Removed".

Table 4. The number of trees retained and removed within the SPZ in surveyed plots from timber sales in the 2004 FPWQ Audit, by diameter at breast height (dbh) in inches.

Stream bank side* (Left/Right)	Stream Width	Number of Trees/1000 ft Retained Within the SPZ (by dbh in inches)				Number of Trees/1000 ft Removed Within the SPZ (by dbh in inches)				Road in SPZ?
		3-7.9	8-11.9	12-19.9	20 +	3-7.9	8-11.9	12-19.9	20 +	
FPA Minimum	<10 ft.	200	42	0	0					
Alder Lt.	2.2	40	40	32	48	0	0	8	8	no
Alder Rt.	2.2	72	8	32	24	0	0	0	0	no
Bane Lt.	2.5	160	56	56	8	0	0	0	0	no
Big Cedar Rt.	8.2	24	24	32	40	8	24	32	8	no
Cocolalla (ND)	6	(No Data)				N/A				no
Cold Spring Canyon Lt.	2.7	8	16	32	0	0	0	16	32	no
Cold Spring Canyon Rt.	2.7	8	8	16	0	0	0	0	0	no
Corral	ND	(No Data)				N/A				no
Goose	6	(No Data)				N/A				no
Hazendorf Gulch Lt.	7	48	60	36	18	0	0	0	0	no
Hazendorf Gulch Rt.	7	36	6	78	36	0	0	6	12	no
Hornet Lt.	5.5	32	88	56	0	0	0	0	0	no
Hornet Rt.	5.5	40	64	120	48	0	0	8	0	no
Humboldt Gulch Lt.	8.5	40	48	40	0	0	0	0	0	no
Humboldt Gulch Rt.	8.5	48	88	136	48	0	8	0	24	no
Knoll	8	(No Data)				N/A				no
Little Mud Lt.	5	0	0	1	1	0	0	0	0	no
Little Mud Rt.	5	0	0	0	0	0	0	0	0	no
N. Fk. Tyson Lt.	2.5	152	88	48	8	24	32	32	0	no
Ophir Lt.	3	0	16	0	0	0	0	0	0	no
Ophir Rt.	3	16	0	0	0	0	0	0	0	no
Randall Flat Lt.	4	56	0	32	0	16	24	0	8	no
Randall Flat Rt.	4	24	8	16	16	0	0	0	0	no
Roush Lt.	6.8	24	32	8	32	0	0	0	8	yes
Roush Rt.	6.8	56	48	72	80	0	0	0	16	no
FPA Minimum	10-20 ft.	200	42	21	0					
Bond Lt.	16.3	24	32	32	48	0	0	8	8	no
Bond Rt.	16.3	40	16	32	0	0	0	0	0	no
E Fk. Fishhook Rt.	12.6	24	80	56	8	0	0	0	0	no
Granite Lt.	17	8	0	0	0	0	0	0	8	no
Granite Rt.	17	8	0	0	0	0	0	0	0	yes
Little Sand Lt.	19	24	16	120	48	0	0	0	8	no
FPA Minimum	> 20 ft.	200	42	21	4					
Hunt Lt.	25	136	136	96	64	0	0	8	0	no
Orofino Rt.	85	40	32	16	40	0	0	0	0	yes
Whiskey Rt.	26	24	8	48	32	0	0	8	0	no

*Stream bank side when facing up stream; Lt. = left, Rt. = right.

violet number indicates a sale without harvest in the SPZ

Yellow shading indicates fewer than FPA minimums

Red shading indicates minimum standards violated

Methods -- Fish Passage Evaluation (Rule 040.02.e.i)

The FPWQA Team measured and analyzed eight Class I stream crossings within timber sale boundaries, for provision of fish passage.

Two of the crossings did not need to be analyzed for fish passage due to their design. These two crossings simulated the stream channel by encompassing the bankfull width, retaining stream substrate throughout the pipe, and having no inlet or outlet drop, thus they have been considered as fish passable.

All six remaining crossings were analyzed for fish passage based on the criteria listed in the Idaho Stream Channel Alteration Rules (SCA Rules) (IDWR 1993; IDAPA 37.03.07.062.04), which require the following:

1. The minimum required water depth for salmon and steelhead is at least 8 inches, and in all other cases, 3 inches.
2. Maximum flow velocities for streams shall not exceed those shown in the Alaska curve for more than a 48 hour period. The curve used will depend on the type of fish to be passed. For the purposes of this analysis, the maximum flow velocity in the stream is essentially 4 four feet per second (ft/s).
3. Upstream drops at the entrance to a culvert (inlet drops) will not be permitted and a maximum drop of 1 foot will be permitted at the downstream end if an adequate jumping pool is maintained below the drop.

Five of these Class I stream crossings were also assessed for FPA Rule 040.02.e.i, fish passage, having been newly installed for their respective timber sales and therefore subject to the 2000 version of the FPA Rules.

The six crossings measured for analysis for the FPWQ Audit were analyzed using the *FishXing* software (USDA 1999), a widely used and accepted tool for analyzing stream crossings for fish passage.

In order to run the *FishXing* software, certain physical and biological data were required. The Audit team measured culvert length, culvert diameter, outlet drop, inlet drop, water depth at the outlet, corrugation, and the elevation of the inlet and outlet invert. Biological data required for the fish passage assessments were based on a selection of the species, age, and length of fish of concern. The FPAA Committee made a policy decision to assess the crossings for an adult, 6" Cutthroat Trout, therefore, subsequent velocity and depth requirements were based on this selection. The required hydrologic information included an estimate for low and high design flows. The FPWQA Team, in consultation with the IDL Coeur d'Alene Forestry Assistance Bureau, agreed to use the 5% and 95% annual exceedance design flows to assess existing stream crossings on Class I streams for fish passage. The 5% and 95% annual exceedance flows were chosen because these design flows are generally considered to be the bounds at which fish will use the crossing structure.

Annual 5% exceedance is the high passage design flow and represents the mean daily average stream discharge that is exceeded 5% of the time during an average year. The 5% exceedance is

used to compare the velocity requirements allowed for fish passage based on maximum swimming ability of the fish, 4 ft/s for an adult, 6" Cutthroat Trout. Annual 95% exceedance is the low passage design flow and represents the mean daily average stream discharge that is exceeded 95% of the time during an average year. This exceedance flow is used in estimating the water depth allowable for passing fish, 3 inches for an adult, 6" Cutthroat Trout.

In order to determine these design flows, daily stream flow data from 30 Idaho U.S. Geological Survey (USGS) gauging stations, with at least five complete years of historical data and a drainage area of less than 50 square miles, were analyzed. Flow duration curves were then used to determine the 5% and 95% annual exceedance flows at each gauging station. These flows were fit to a line and the slope of the line was used to extrapolate an exceedance flow per drainage area for both the low and the high design flows. For the six analyzed passages these flows per drainage area were then multiplied by the drainage area to determine the 5% and 95% annual exceedance flows for each particular culvert. The values from this analysis were then entered into *FishXing*.

FishXing analyzes for fish passage using two different calculation methods resulting in two outputs, water surface profile results and uniform flow results. Since detailed tailwater cross-sectional data was not collected, *FishXing* was run using the constant tailwater surface method. In order to adequately run *FishXing* using the water surface profile calculations, additional tailwater cross-sectional data would need to be collected. For this reason, only the uniform flow results, which are not affected by the constant tailwater surface assumptions, were used for this fish passage analysis.

Although one of the eight culverts measured and analyzed for fish passage is from Trout Creek, which is a sale chosen for effectiveness audit, the FPWQA Team decided to include that particular culvert with the compliance portion of this report, along with all the other culverts.

Results -- Fish Passage Evaluation (Rule 040.02.e.i)

The five newly installed crossings evaluated for compliance with Rule 040.02.02.e.i. as guided by the SCA Rules are from Big Cedar, Hazendorf, North Fork of Tyson, Roush (# 3), and Trout Creeks (Trout Creek is a sale chosen for effectiveness audit). The three remaining crossings which existed before the timber sale occurred were in Cocolalla, and Roush (# 1, 2) Creeks. The two crossings considered to be fish passable based on their design were in Cocolalla and North Fork of Tyson Creeks.

Results of the fish passage analysis of six culverts indicate none are fish passable. The results of evaluation of compliance with Rule 040.02.e.i for the five newly installed culverts are one in compliance and four in non-compliance (80%). Details on these crossings are displayed in Table 5.

Table 5. FPWQ 2004 Audit culvert fish passage assessment

	Site	Culvert Gradient (%)	Drainage Area (acres)	Outlet Drop (ft)	Inlet Drop (ft)	Length (ft)	Fish Passable due to Velocity	Fish Passable due to Depth	Fish Passable due to Outlet Drop	Fish Passable Overall
Newly Installed	Big Cedar	2.5	3091.2	no	no	61	no	no	yes	no
	Hazendorf	7.7	595.2	2	no	80	no	no	no	no
	N. Fk. Tyson*	1.3	2054.4	no	no	48	n/a	n/a	n/a	n/a
	Roush 3	10.0	534.7	0.21	no	21	no	no	yes	no
	Trout	6.5	249.6	1	no	55	no	no	yes	no
Existing	Cocollala*	1.2	902.4	no	no	50	n/a	n/a	n/a	n/a
	Roush 1	4.0	536.3	0.9	no	23	no	no	yes	no
	Roush 2	4.0	701.8	no	no	30	no	no	yes	no

Red shading indicates non-compliance

*Cocolalla and N. Fk. Tyson considered fish passable based on design

The FPWQA Team acknowledges managers' intentions, through contract agreements, to have culverts and other crossings installed correctly. Despite this recognition the FPWQA Team believes there is a need for better management and control during installation.

Methods -- Fifty Year Peak Flow Evaluation (Rule 040.02.e.ii)

Nine stream crossings, within timber sale boundaries, were measured and analyzed for fifty year peak flow. Six of the nine culverts were newly installed and therefore evaluated for compliance with FPA Rule 040.02.e.ii (fifty year peak flow). In order to determine if the culverts evaluated were adequate for fifty-year peak flow and/or in compliance, the audit team needed certain physical data. The audit team recorded physical measurements such as culvert length, diameter, and elevation for analysis to determine culvert capacity (cubic feet/second) and drainage area (watershed area). Culverts were considered in compliance with Rule 040.02.e.ii when the actual culvert diameter was equal to or greater than the calculated diameter necessary to carry a 50 year peak flow. Measurements are displayed in Table 6.

Peak flow was determined using the Thomas method (Thomas et al. 1973). The Thomas method breaks the state of Idaho into eight regions and gives a separate regression equation for each region in order to calculate the flood flow (peak flow) for a 10-year recurrence interval. In order to calculate peak flow, drainage area was needed for all Thomas Regions and percent forest cover was needed for specific regions, including region 2. The peak flow for a 10-year recurrence interval is then multiplied by a specific ratio to estimate the 50-year flood flow.

Drainage area and percent forest cover were based on 10-meter Digital Elevation Models (DEMs) and National Land Cover Datasets (NLCDs) in ArcView 3.0. Three extensions were used with ArcView, Spatial Analyst, Basins extension, and the Hydrologic Modeling v 1.1 extension.

Results -- Fifty Year Peak Flow Evaluation (Rule 040.02.e.ii)

Results of 50-year peak flow analysis (displayed in Table 6) of nine crossings assessed and analyzed show three (3) are not adequate for culvert carrying capacity of a 50-year peak flow and one (1) that is newly installed and therefore subject to Rule 040.02.e.ii is in non-compliance with the specific measurement requirements of that rule.

Table 6. 50-year peak flow culvert assessment. ***

	Site	Thomas Region	Drainage Area (Acres)	Forested Area (%)	50-Year Peak Flow (cfs)	50-Year Diameter (in)	Culvert Diameter (in)	Undersized for 50-year flow
New	Big Cedar	2	3091.2	74.43	126.92	60	60	no
	Cocolalla	2	902.4	85	45.9	42	48	no
	Unnamed tributary to Fishhook -class 2	1	172.8		24.16	33	36	no
	Hazendorf	1	595.2		70.15	48	60	no
	N. Fk. Tyson	1	2054.4		204.08	78	95X67	no
	Roush 3	1	536.3		64.12	48	36	yes
	Trout	1	249.6		33.17	36	84	no
Existing	Roush 1	1	701.8		80.86	54	45.6	yes
	Roush 2	1	534.7		63.96	48	36	yes

Red shading indicates non-compliance

*** Thomas, Harenberg, & Anderson

The FPWQA Team recognizes all parties attempted to provide for fish passage and comply with FPA Rules, yet also recognizes a need for better management and control during installation of culverts and other crossings.

PART II

MANAGEMENT PRACTICES EFFECTIVENESS

Introduction to the Effectiveness Component

The focus of the Management Practices Effectiveness Audit is on the effectiveness of BMPs. The FPWQA Team's assessment of effectiveness, based on the third objective mentioned earlier in the report (page 1), was measured by the following categories:

1. Stream temperature,
2. Shade and canopy cover
3. Large organic debris (in-stream number of pieces and potential recruitment), and
4. Fish passage.

Under the Rules Pertaining to the Idaho Forest Practices Act (FPA Rules; IDAPA 20.02.01) the categories of water quality listed above are managed through the implementation of multiple BMPs. Following the 2000 audit, the Idaho FPWQA Team and the IFPAA Committee evaluated categories to include in effectiveness audits. The categories chosen by the IFPAA Committee were determined necessary and feasible to include in future effectiveness audits.

Other categories, such as sediment, have purposely not been included in the FPWQA Effectiveness component. Reasons for not including sediment and for focusing efforts on the above four categories are related to the complexity of potential sources of sediment, which make it difficult to determine how effective an individual BMP is in preventing non-point source sediment increases, and implications for monitoring methods.

The original subcommittee proposal to the IFPAA Committee stated that the FPWQ Effectiveness Audit field work would require two visits per sale evaluated. The first evaluative visit was a pre-harvest visit during the 2004 field season between June and October. The second evaluative visit will be in the 2005 field season following the completion of sale activity and will include the audit compliance evaluation. The original proposal also outlined accepted methods with the applicable Quality Assurance and Quality Control (QA/QC) to be used for the evaluation of the water quality categories. Of those methods, water temperature gauges were used, pre-harvest tree stand, in-stream LOD, shade and canopy cover data were collected and one newly installed culvert was measured for fish passage. It is the expectation of the FPWQA Team and the IFPAA Committee that post-harvest data will be measured in 2005 using the same methods as were used in 2004.

Purpose

The purpose of the Management Practices Effectiveness component of the 2004 FPWQ Audit is to evaluate the effectiveness of the Idaho FPA in maintaining riparian, fish, and water quality characteristics and beneficial uses. We hope to begin to answer the question:

Are the Best Management Practices as applied through the Forest Practices Act sufficient to maintain beneficial uses for the State of Idaho?

The IFPAA Committee began to answer this question by developing a monitoring method and deciding that only the categories listed previously (under Introduction to the Effectiveness Component, page 21) would be included in the quadrennial audit. Other categories that are also managed by BMPs will be evaluated separately. For example, BMPs in the State of Idaho provide many rules pertaining to the prevention of sediment from entering the stream system. Sediment is a large category that can be attributed to a broad range of uses, and focusing an evaluation of effectiveness regarding sediment would be outside of the feasible scope of the effectiveness part of this audit. The selected categories are easily referenced by specific rules within the FPA and therefore narrow the scope of evaluation. Sediment can and probably should be addressed with a more specific focus on general effects, which could be accomplished while monitoring TMDL implementation efforts across the State of Idaho.

Evaluation of fish passage (Rule 040.04.e.i) and evaluation for 50-year peak flow (Rule 040.04.e.ii) for Part II, Management Practices Effectiveness, were included in Part I with the compliance audits during 2004. One Class I stream crossing was measured for the effectiveness portion of the 2004 Audit and the FPWQA Team placed the evaluation for the crossing with the compliance portion for better comparison. The evaluation of stream crossing compliance for the Trout Creek effectiveness sale will be included in the compliance portion of the audit in 2005.

Objectives

The primary goal of the effectiveness part of the audit was, and is, to monitor regulated forest practices and accurately identify areas where the FPA Rules may not be effectively meeting the expectation of maintaining beneficial uses, and to do this cost-effectively. This audit is meant to provide enough information to either:

1. Initiate further study of BMPs related to specific categories, or
2. Adjust specific FPA Rules to meet Idaho's beneficial use requirements.

The initiation of either of the above actions falls within the authority of the IFPAA Committee and the audit report should furnish the State of Idaho with the information necessary to make changes to BMPs.

Three questions to focus objectives on have been identified to be of most significance and relevance to the goal of the effectiveness component of the 2004 audit. The first two questions focus on the change between pre- and post-harvest activities and not on the actual numeric measurement of any of the categories. The audit cannot be used to test water quality standards in the stream systems monitored because it is not considered a controlled study. The three questions are:

1. Does application of the FPA Rules managing Class I streams provide enough shade to maintain a stream temperature that does not cause a statistically significant change from current or expected levels, after completion of forest practices activities?
2. Does application of the FPA Rules managing Class I streams provide enough recruitable LOD to maintain LOD amounts that do not cause a statistically significant change from current or expected levels, following forest practice activities?
3. Do the FPA Rules managing Class I streams set adequate criteria to provide sustainable fish passage at road/fish-bearing stream crossings?

Effectiveness Timber Sale Selection

Initial site selection depended on the general selection criteria as stated previously in Part I. To further refine the areas to be audited for effectiveness, a flow chart was used (see Figure e, Appendix D). This decision flow chart served as an indicator to determine when each of the four categories (stream temperature, shade and canopy cover, LOD, and fish passage) would be evaluated for effectiveness during the audit.

To determine appropriate audit areas, DEQ evaluated:

1. Stratification of the sites to represent geologic or other regions across Idaho,
2. Whether the chosen Class I stream includes a representative 500-foot sample reach within or adjacent to the harvest unit,
3. The ability of the site to represent a quality baseline condition that will provide an accurate assessment of BMP effectiveness. Ideally, this condition would be represented by:
    - a site that has no roads within 100 feet of the stream,
    - a site that contains no grazing,
    - a site that does not abut forests managed within the last 50 years, and
    - logging activity occurred from the fall of 2004 to the fall of 2005.

The IFPAA Committee and FPWQA Team initially had a goal to locate 20 sites to include in the effectiveness part of the audit. Due to the limitations placed by the time-frame of the audit (logging activity having to occur between the fall 2004-2005), only four effectiveness timber sale sites were identified by the IDL as candidates for the effectiveness audit for the 2004 field season. After the IDL identified these four sites, they were reviewed by the DEQ for their acceptance as appropriate audit areas. A general description of the Management Practices Effectiveness sales is presented in Table 7.

Table 7. Management Practice Effectiveness sales general descriptions.

Stream	Sale	Ownership	County	Approximate Stream Channel Elevation (ft.)	Avg. Channel Width
Cascade	Cascade	NIPF	Shoshone	3,120	4.8'
Little Trout	Trout Point	NIPF	Shoshone	4,355	9.4'
Little Wolf	Boles Shoreline	State	Idaho	4,950	10'
Smith	Smith Face Unit #2	State	Elmore	3,380	13.4'

Audit Team Participation

The FPWQ Effectiveness Audit team was comprised of the same personnel as mentioned in the compliance audit section; one qualified representative from the IDL and one from the DEQ. A crew of four personnel from the IDL assisted the agency representatives by collecting baseline data in the stream and in the stream protection zone (SPZ). For the compliance portion of the audit conducted in 2005, participation will meet the same criteria as mentioned in the compliance component and interested parties will also be notified.

Evaluation of Stream Temperature and Shade

FPA Rules (IDAPA 20.02.01) References

030.07.e. Provide for Large organic Debris (LOD), shading, soil stabilization, wildlife cover and water filtering effects of vegetation along streams.(7-1-96)

030.07.e.i. Leave hardwood trees, shrubs, grasses, and rocks wherever they afford shade over a stream or maintain the integrity of the soil near a stream.(10-14-75)

030.07.e.ii. Leave seventy-five percent (75%) of the current shade over the Class I streams.(7-1-96)

030.07.e.iii. Carefully remove timber from the Stream protection Zone in such a way that shading and filtering effects are not destroyed.(7-1-96)

030.07.e.iv. Standing trees, including conifers, hardwoods and snags will be left within fifty (50) feet of the ordinary high water mark on each side of all Class I streams, and within thirty (30) feet on each side of those Class II streams that require thirty (30) few stream protection zones, in the following minimum numbers per thousand (1000 feet of stream: (table not included)

030.07.e.v. Snags will be counted as standing trees in each diameter class if snag height exceeds one and one-half (1 ½) times the distance between the snag and the stream's ordinary high water mark. Not more than fifty percent (50%) of any class may consist of snags.

030.07.e.vi. As an alternative to the standing tree and shade requirements, the operator may notify the department that a site-specific riparian management prescription is requested. The department and operator may jointly develop a plan upon consideration of stream characteristics and the need for large organic debris, stream shading, and wildlife cover which will meet the objective of these rules.

Methods -- Stream Temperature Evaluation

Stream temperature monitoring was implemented as part of the effectiveness audit to examine whether there is an effective change in temperature resulting from timber harvest activities surrounding or adjacent to Class I streams when FPA Rules have been applied. For each effectiveness-audited sale, temperature gauges were placed at four different locations in the 500-foot stream reach surveyed: one at the upper boundary of the selected harvest unit (to be upstream of harvest disturbances), one each at transects 1 and 5 (except at Smith Creek, where a gauge was placed at transect 3 and not 5), and one at the lower boundary of the harvest unit. Refer to the diagram in Figure 4 below for location of each temperature gauge in a typical reach.

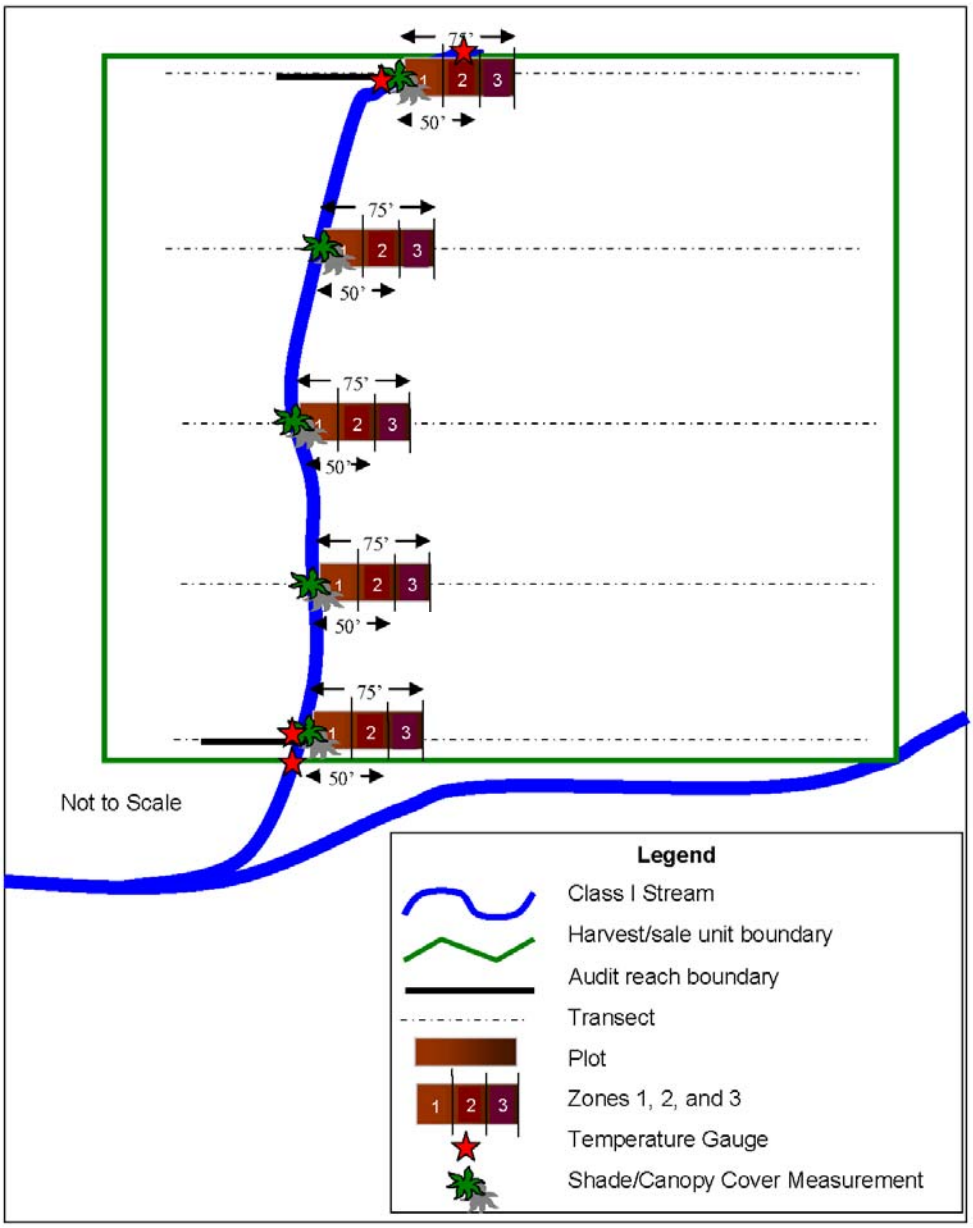

Figure 4. Diagram of monitoring reach showing transects, plots, and zones.

Two types of temperature gauges made by Onset Computer Corporation were used for monitoring stream temperatures. One type of gauge was the Hobo® Temp logger, the second type was the Optic StowAway® Temp logger. Before each of the temperature data loggers were placed in their respective locations, they were calibrated and set to the protocols as defined in *Protocol for Placement and Retrieval of Temperature Data Loggers in Idaho Streams* (IDEQ, 1999). Temperatures were recorded at one hour intervals, one time every hour, for every hour of 24 hours in the days the data loggers were submersed.

Once the data loggers were retrieved, the data was downloaded and sorted for two complete data sets from each stream, one that occurred at the uppermost location and one from the lowest location of the stream reach. When the two complete data sets were organized, the maximum temperature and maximum weekly maximum temperatures (MWMTs) were calculated for each stream.

It is the expectation of the FPWQA Team to compare the temperature baseline information of 2004 with 2005 stream temperatures.

Results -- Stream Temperature Evaluation

Results of the 2004 FPWQ Audit stream temperature data collection for the various dates between June and October varied across the State, as expected. Refer to Table 8 below and Figures f-i (graphs of temperature data sets) in Appendix E starting on page 61.

Table 8. Stream maximum temperature and maximum weekly average temperatures.

Stream Name	Temp. Data Logger Location	*Max. Temp. (°C)	**MWMT (°C)	Approximate Stream Reach Elevation (ft.)
Cascade	Upstream	11.94	11.77	3120
Cascade	Downstream	11.98	11.76	
Little Wolf	Upstream	22.68	21.89	4355
Little Wolf	Downstream	23.63	21.99	
Smith	Transect 1	18.56	17.83	4950
Smith	Downstream	18.76	18.06	
Trout	Upstream	11.38	11.38	3380
Trout	Transect 5	11.77	11.71	

* Max. Temp. refers to the warmest stream temperature that was recorded during the time the temperature data loggers were in the stream.

** MWMT refers to the maximum weekly average temperature. The MWMT is the average of the maximum stream temperature that occurs each day over the warmest consecutive seven day period of the year.

Methods -- Shade Evaluation

To begin to evaluate the effectiveness of Rule 030.07.e.ii, the FPWQA Team measured the amount of canopy cover and shade occurring over the stream prior to harvest activities in order to calculate current percent canopy cover (% cover) and percent shade (% shade). Pre-harvest data will be compared to post-harvest canopy cover and shade when measured in 2005. This comparison will assist the FPWQA Team's assessment of whether 75% of the shade remained over the stream after harvest.

Two instruments were used to measure canopy cover and shade. A concave spherical densiometer, as described in Platts et al. (1987), was used to measure canopy cover, and a solar pathfinder, also described in Platts et al. (1987), was used to measure shade. For each sale, canopy cover and shade measurements were collected from five locations (three locations for Smith) spaced at intervals 125 feet apart on a Class I stream that occurred in or adjacent to the audited sale. Figure 4 on page 25 illustrates the layout of sample sites. The average canopy cover and shade occurring over each stream was calculated into percent cover and percent shade by transect average and reach average, and shade was also calculated for the warmest months (referred to as summer months: May through September) average.

The densiometer and solar pathfinder have been compared to assess their similarities and differences as measurement tools (see Solar Pathfinder Versus Densiometer, APPENDIX F, starting on page 66). While the solar pathfinder attempts to measure actual shade by taking geography, canopy cover, and solar azimuth into account, canopy cover as measured by the densiometer does not necessarily represent actual shade conditions over the stream. Due to these obvious differences in measurement of vegetative conditions over a stream, the FPWQA Team thinks it is also important to make this comparison with stream temperatures to learn which tool may contribute a better correlation with stream temperature.

The FPWQA Team intended to compare cover and shade data collected in 2004 with data that is expected to be collected in 2005, and then compare those data to the 2004 and expected 2005 temperature datasets. By comparing stream temperature with the percent cover and percent shade that occurs over the stream, the team expected to begin to make inferences about forest practices and BMP implementation effects on water quality in the four categories outlined previously. Unfortunately, as discussed below, the harvests did not have enough effect on canopy cover and shade to be measured in post-harvest evaluations.

The FPWQA Team recognizes other variables, such as aspect, ground water inflow, and sedimentation can influence stream temperature. These variables were not measured during the FPWQ Audit due to limitations described in the Scope, Schedule, and Interpretation section (page 2).

Results -- Shade Evaluation

It is important to note that these four effectiveness sale sites have had previous logging activities over the past hundred years and are not in pristine condition.

In 2005, Shade BMP effectiveness monitoring was not completed due to a lack of harvest activity or management in the SPZs. Specifically, of the 4 sites selected for effectiveness monitoring, one was not logged/harvested, one had only a few trees removed, and those were only one side of the stream because there were trees on only one side of the stream before the sale/harvesst. Of the two remaining sites, with valid data, neither had any activity within the 75' Class I riparian SPZ, therefore, there was no effect on canopy cover or shade.

This lack of effect was not known in 2004, so canopy cover and shade measurements were taken and are in Table 9,

Table 10, and Figure 5.

Table 9. Stream transect average cover and shade values.

Transect Average % Cover and % Shade

	Cascade	Little Wolf	Smith	Trout
Densiometer: % Cover	60	14	42	64
Solar Pathfinder: % Summer Shade	84	51	56	79

Table 10. Stream transect average summer shade values.

	Cascade	Little Wolf	Smith	Trout
May	80	46	45	77
June	83	52	37	76
July	80	47	36	74
Aug	83	49	73	77
Sept	94	57	87	90

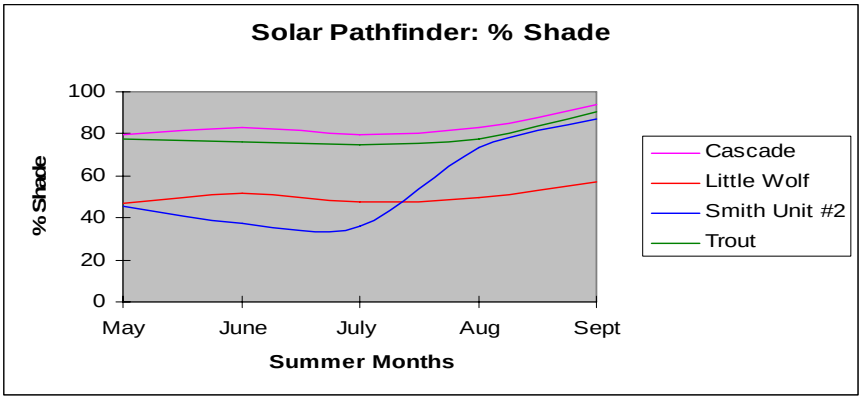

Figure 5. Stream transect average summer shade graph.

Evaluation of Large Organic Debris

FPA Rules (IDAPA 20.02.01) References

030.07.e. Provide for Large organic Debris (LOD), shading, soil stabilization, wildlife cover and water filtering effects of vegetation along streams.(7-1-96)

030.07.e.iv. Standing trees, including conifers, hardwoods and snags will be left within fifty (50) feet of the ordinary high water mark on each side of all Class I streams, and within thirty (30) feet on each side of those Class II streams that require thirty (30) few stream protection zones, in the following minimum numbers per thousand (1000 feet of stream: (table not included)

030.07.e.v. Snags will be counted as standing trees in each diameter class if snag height exceeds one and one-half (1 ½) times the distance between the snag and the stream's ordinary high water mark. Not more than fifty percent (50%) of any class may consist of snags.

030.07.e.vi. As an alternative to the standing tree and shade requirements, the operator may notify the department that a site-specific riparian management prescription is requested. The department and operator may jointly develop a plan upon consideration of stream characteristics and the need for large organic debris, stream shading, and wildlife cover which will meet the objective of these rules.

030.07.e.vii. Where the opposite side of the stream does not currently meet the minimum standing tree requirements of the table, the department and the operator should consider a site specific riparian prescription that meets the large organic debris needs of the stream.

030.07.e.viii. Stream width shall be measured as average between ordinary high water marks.

Methods -- LOD Recruitment

Prior to analyzing pre-harvest potential LOD recruitment for the effectiveness sales, the FPWQA Team's four-person crew collected data in the Class I stream, adjacent to or within the evaluated timber sale, and in the SPZ. A plot with three zones was established at each transect along a representative 500-foot stream reach, on sides where harvest was expected to occur. If harvest was expected on both sides, and there were five transects, ten plots were established (Smith Creek was an exception, having only three plots). The typical layout of data plots, and collection of data, are described in the Leave-Tree Methods section of Part I (Compliance) of this report. In addition to the methods explained in Part I, data was also collected in Zone 3 for LOD recruitment potential analysis.

The FPWQA Team decided to use the McDade Model to determine LOD recruitment potential. A new tree fall model called the Riparian Aquatic Interaction Simulator (Welty et al. 2002) was also available for calculating potential LOD recruitment, though due to limitations on data collection and other limitations mentioned previously in this report, it was not feasible to use this model. McDade et al. (1990) found that more LOD in the stream originates from distances closer to the stream than predicted by previous models. For example, McDade et al. (1990) found that approximately 88% of (conifer) LOD in the stream originates from within one-half of a tree height ($d = 0.5H$).[1] Personnel with Western Watershed (WW) Analysts, as members of the 2000 audit team, developed a probability equation by working the mathematics backwards, i.e., differentiating the fitted curve to the McDade experimental results and normalizing again, and expressing the experimental probability for the McDade model that a given tree will fall such that it reaches the stream by:

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

Where $x = d/H$ is the effective tree height when
d = distance from the base of the tree to the stream bank, and
H = 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).

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 2000 FPWQA Team calculated new percentages, which have been utilized for the purposes of the 2004 FPWQ Audit. Table 11 is the result, and shows the proportion of trees growing in each of three zones, each 25 deep, that would be expected to contribute LOD to the stream. 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). According to the McDade model, as calculated in Table 11, 46% of the trees within Zone 1 (0 to 25 feet from the stream bank) 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 (25 to 50 feet from the stream bank) would contribute LOD to the stream. Obviously, no 40-foot tall trees located 50-75 feet from the stream (i.e., in Zone 3) will reach the stream.

Table 11. 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%	2(5%)	36%	46%	54%	60%	6(5%)	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

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. Distances from the base of measured trees to the stream bank were assumed to be in the center of each zone (12.5', 37.5', and 62.5' from the stream bank). Using the effective tree height, the probability of the tree hitting the stream from its respective riparian zone was calculated from the equation, developed by WW Analysts, derived from the McDade model. The results of the calculations are given in Table 12. 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 12, was then extrapolated to the entire stream in two ways:

1. By converting the area within the surveyed plots into number of acres (.22 with 10 transects) and multiplying by 1.72 acres (the area of the transect, 75 ft. x 1,000 ft.) to get the predicted number of LOD pieces contributed per 1,000 feet of stream (shown in the columns labeled "Pieces LOD/1,000 ft.") and
2. By conversion to a predicted number of pieces of LOD per channel width (in Table 12, the column labeled "LOD/Channel Width").

Table 12. Pre-harvest predicted LOD recruitment results by timber sale.

			Pre-harvest	
Stream Name	**# of Transects**	**Channel Width (ft.)**	**Pieces LOD/ 1,000 ft.**	**LOD/ Channel Width**
Cascade	10	4.8	30	0.14
Little Wolf	10	10.0	25	0.25
Smith	3	13.4	208	2.79
Trout	10	9.4	31	0.29

Results -- LOD Recruitment

The results of applying calculations from the McDade model to data collected per transect for the effectiveness sales are shown in Table 12 by timber sale. The FPWQA Team intends to compare the pre-harvest LOD recruitment potential with post-harvest data collected in 2005. If harvest occurs in the SPZ, LOD recruitment potential data and leave-tree data will be compared for the evaluation of effectiveness of BMPs for potential LOD recruitment.

Methods -- Current Condition of LOD

The FPWQA Team used methods for measurement of current LOD providing stream habitat, which were adapted in the Environmental Protection Agency's Environmental Monitoring Assessment Program (Peck undated), from Robison and Beschta (1990). By counting LOD, both before timber harvest activities and after, quantitative estimates of the number, size, total volume and distribution of LOD within the stream reach allow for characterization of the stream habitat. For the purpose of the FPWQ Audit and in-stream data collection, LOD is defined as woody material with a small end diameter of at least 10 cm. (4 in.) and a length of at least (1) one meter (3.3 ft.).

The procedure for counting and recording LOD pieces included recording all pieces that were at least partially in the baseflow channel, the "active channel" (flood channel up to bankfull stage), or spanning above the active channel. The active, or bankfull channel, is defined as the channel that is filled by moderate sized flood events that typically recur every one to two years. LOD in and above the active channel was tallied over the entire 500-foot stream reach, for any piece of wood that was "all/part" in the active channel or "bridging above" the active channel, length, (with 1 m (3.3 ft.) minimum) and diameter (from where the small end was a minimum of 10cm. (4 in.)) were measured to determine its size class (each class is a particular combination of three length and four diameter ranges). Wood pieces partially in the 500-foot stream reach were tallied based on the portion of that piece which was in the measured stream. The numbers of tallied LOD pieces in each size class are given in Table 13 and Table 14 and displayed in Figure 6 and Figure 7.

Results -- Current Condition of LOD

Table 13. Cumulative pieces of LOD in active channel

Size Class: diameter in. (length ft.)	Cascade	Smith	Trout	Little Wolf
3.3-6.6 (4-8)	12		4	1
3.3-6.6 (8-12)		2	3	1
3.3-6.6 (12-16)		3		2
3.3-6.6 (16-20)		2	1	
3.3-6.6 (>20)		1	1	
6.6-9.9 (4-8)	6	3	1	
6.6-9.9 (8-12)	1		1	1
6.6-9.9 (12-16)		2		
6.6-9.9 (16-20)		2		1
6.6-9.9 (>20)			2	
9.9-13.2 (4-8)	4		3	
9.9-13.2 (8-12)	4	1	5	1
9.9-13.2 (12-16)	2		3	
9.9-13.2 (16-20)		1	3	
9.9-13.2 (>20)			4	
>13.2 (4-8)	12		1	
>13.2 (8-12)	2		4	1
>13.2 (12-16)	3	2	6	
>13.2 (16-20)		1	4	
>13.2 (>20)			12	
Total	46	20	58	8

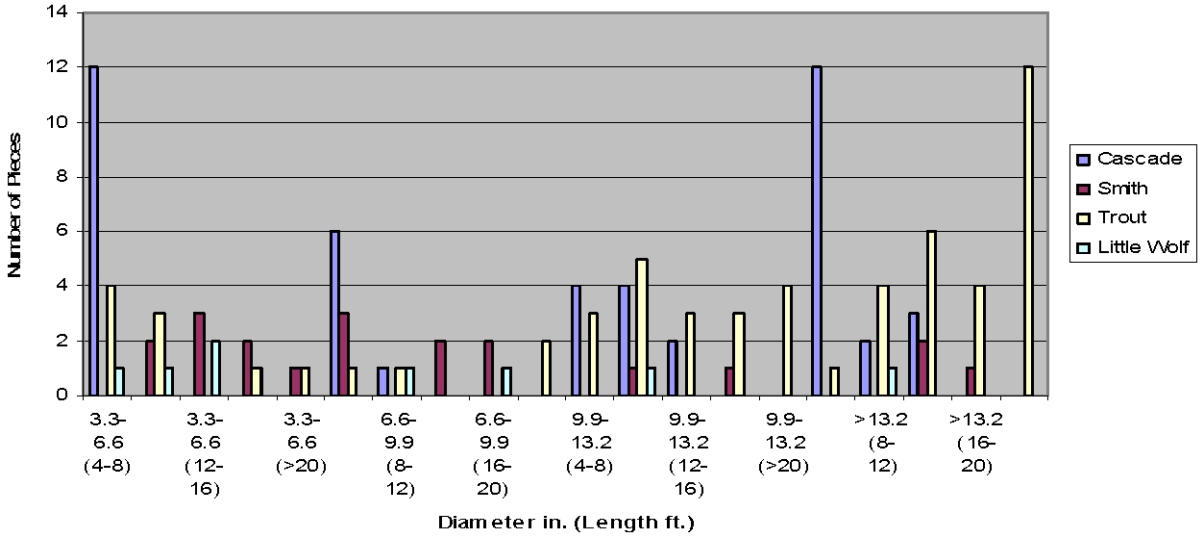

Figure 6. Cumulative pieces of LOD in active channel.

Table 14. Cumulative pieces of LOD bridging above active channel

Size Class: diameter in. (length ft.)	Cascade	Smith	Trout	Little Wolf
3.3-6.6 (4-8)	3			3
3.3-6.6 (8-12)				1
3.3-6.6 (12-16)	1			
3.3-6.6 (16-20)				
3.3-6.6 (>20)				
6.6-9.9 (4-8)	1		1	2
6.6-9.9 (8-12)	1		2	
6.6-9.9 (12-16)	1		1	
6.6-9.9 (16-20)				
6.6-9.9 (>20)				
9.9-13.2 (4-8)	2		1	1
9.9-13.2 (8-12)			1	
9.9-13.2 (12-16)			2	
9.9-13.2 (16-20)				
9.9-13.2 (>20)			1	
>13.2 (4-8)	4			4
>13.2 (8-12)	1		1	1
>13.2 (12-16)	2		3	2
>13.2 (16-20)			2	1
>13.2 (>20)		1	3	
Total	16	1	18	15

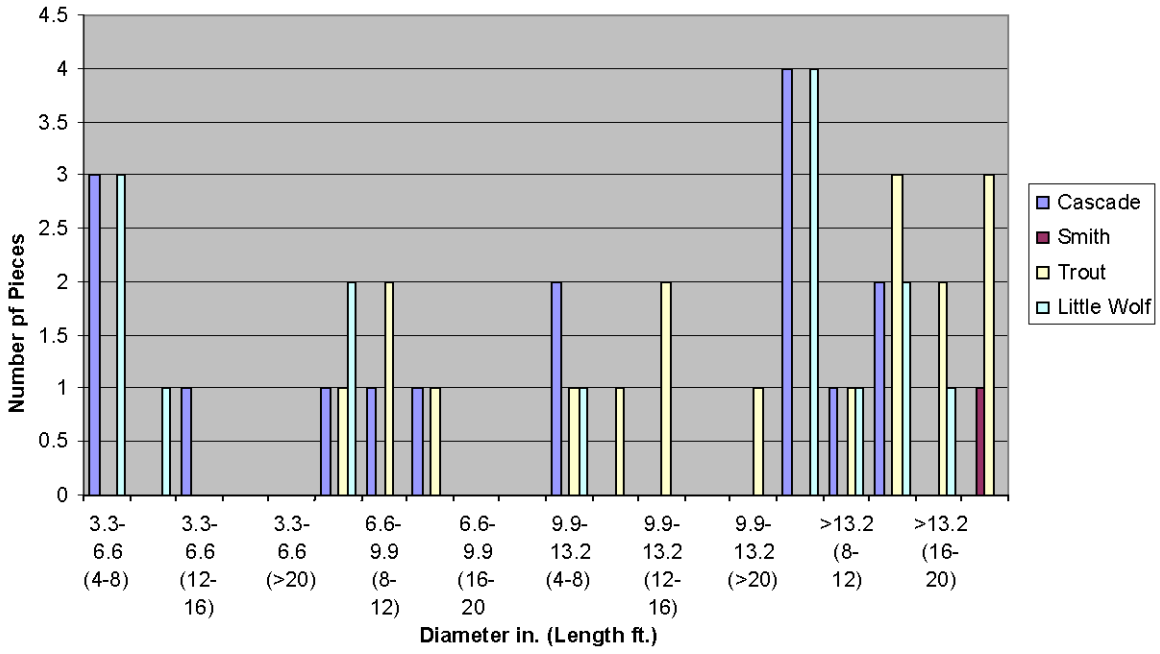

Figure 7. Cumulative pieces of LOD bridging above active channel

Methods -- Leave-Tree Evaluation

The FPWQA Team used the same methods for pre-harvest leave-tree (trees per 1,000 ft. of Class I stream) measurement collection as described in the Part I of this report, however, the evaluation of compliance with rule 030.07.e.iv. will not occur until post-harvest leave-tree measurements are recorded and compared to pre-harvest data.

Results -- Leave-Tree Evaluation

Table 15 gives the number of estimated trees per 1,000 feet in diameter classes and per stream width before harvest (pre-harvest).

Table 15. Number of trees estimated to be within 50-foot SPZ in surveyed plots combined, per 1,000 ft. of Class I stream, classed by diameter at breast height (dbh) in inches.

Stream Bank Side (Left/Right)	Stream Width	Pre-harvest Number of Trees/1,000 ft.				Road in SPZ?
		3-7.9	8-11.9	12-19.9	20+	
FPA Minimum	<10 ft.	200	42	0	0	
Cascade Lt.	4.8	32	16	8	0	No
Cascade Rt.	4.8	72	48	8	16	No
Trout Lt.	9.4	16	24	32	40	No
Trout Rt.	9.4	48	16	32	0	No
FPA Minimum	10-20 ft.	200	42	21	0	
Little Wolf Lt.	10	16	8	16	8	Yes
Little Wolf Rt.	10	48	32	32	16	Yes
Smith Lt.	13.4	0	13	53	173	No

Yellow shading indicates fewer than FPA minimum

RECOMMENDATIONS

2002 Rule Package

The 2000 Forest Practices Water Quality Audit included recommendations to modify rules related to LOD recruitment and shade. The FPAA Committee debated these recommendations, and other suggestions stemming from internal IDL audits, to develop a rule package for the State Board of Land Commissioners (Board) to consider taking through the Administrative Procedures Act rulemaking process. With Board approval, this rule package went through the rulemaking process in 2002. Following the public comment period, the FPAA Committee made additional changes and prepared a set of final recommendations for the Board to formally adopt. However, these proposed rules were vacated and were never formally adopted.

Findings from the 2004 FPWQ Audit illustrate that shade, LOD, riparian access, and various management issues still raise understanding and application questions and that uncertainty in application could be reduced by rule modification. It is therefore suggested the following rule changes be considered in order to improve understanding of FPA requirements and reduce the likelihood of creating adverse impacts on beneficial uses. These suggestions include water quality related rule modifications, with consideration of public comments, developed by the FPAA Committee prior to the rule package being vacated in 2002.

030.07.e.

iii. During harvesting, carefully remove timber from the Stream Protection Zone in such a way that large organic debris, shading and filtering effects are ~~not destroyed~~ maintained and protected. When portions of felled trees fall into or over a Class I stream, leave a portion consistent with the LOD definition of Subsection 010.34.

iv. For planned salvage operations of trees that have fallen naturally into or over a Class I stream, leave a portion consistent with the LOD definition of Subsection 010.34. Leaving the section with the root ball attached is preferred.

v. During harvesting operations, portions of trees not meeting the LOD definition shall be removed, consistent with the slash removal requirements of Subsection 030.06.

~~(7-1-96)~~( )

~~vi~~viii. As an alternative to the standing tree and shade requirements, the operator may ~~notify the department that~~ develop a site specific riparian management prescription ~~is requested~~ and submit it to the department for approval. The ~~department and operator may jointly develop a plan upon consideration of~~ prescription should consider stream characteristics and the need for large organic debris, stream shading and wildlife cover which will meet the objective of these rules. ~~(3-13-90)~~( )

040.02.f. On existing roads that are not reconstructed or damaged by catastrophic events, landowners or operators are encouraged, but not required, to replace or provide mitigation for culverts that do not provide for fish passage in accordance with Subparagraph 040.02.e.i. or can not carry the fifty (50) year peak flow of Subparagraph 040.02.e.ii. ( )

~~f~~g. Stream crossings, including fords, shall be minimum in number and planned and installed in compliance with the Stream Channel Protection Act, Title 42, Chapter 38, Idaho Code, and with culvert sizing requirements of ~~Subsection~~ Paragraph 040.02.e. Fords are an acceptable stream crossing structure on small, shallow streams, less than twenty (20) feet in width, with flat, less than four (4) percent gradients. Fords should cross the stream at right angles; approaches shall be adequately cross-drained and rocked for at least seventy five (75) feet. During times of salmonid spawning and egg incubation or to protect active domestic water diversions, use shall be limited to low water, dry, or frozen conditions and hauling or equipment crossing trips limited to minimize sediment delivery to streams. ~~(4-5-00)~~( )

~~g~~h. Avoid reconstruction ~~or reuse~~ of existing roads located in stream protection zones, except for approaches to stream crossings, unless it will result in the least long-term impact on site productivity, water quality, and fish and wildlife habitat. Reconstruction ~~or reuse~~ of existing roads in stream protection zones will require a variance. Reusing existing roads in stream protection zones for skidding or landing logs shall require a variance. Reusing existing roads in stream protection zones for hauling fully suspended logs only, where no reconstruction will occur, does not require a variance. ~~(4-5-00)~~( )

Shade and Large Organic Debris

The FPWQA Team believes prescriptive standards for LOD and shade may not adequately reflect the level of vegetative retention needed to protect beneficial uses. In the case of LOD, for the two small size classes, the baseline standard for trees to be retained appears to be unachievable from a silvicultural perspective, except in rare cases. Except in a regenerated forest, a condition not normally found along Class I Streams, it may be unrealistic to expect the size distribution contained in the LOD table to be naturally present. These results are similar to those found in the 2000 audit.

The team also believes the shade rule needs to be better quantified to insure that stream temperatures are not adversely impacted as a result of harvest. The current rule allows for a standard shade reduction regardless of the status of stream temperature as a pollutant. There also appears to be confusion regarding the rule which refers to maintaining stream shade (from vegetation, topography, or orientation) or canopy cover (nearby vegetation only). Results indicate different values arise depending on which measure is chosen. The Audit team members suggest shade, from any source, is the most appropriate measure.

While the FPWQA Team believes changes should be made, due to the limited sample size and the effectiveness portion of the audit not being completed until fall of 2005, the following recommendations should be considered a starting point for discussion. The audit team does suggest that the effectiveness work continue and additional sales be found and similarly

monitored to better quantify results. It is also suggested additional applied research and monitoring efforts be reviewed as to applicability in Idaho settings.

The FPWQA Team believes using residual stocking requirements as a starting point, displayed in the table below (Table 16) with numbers of leave trees per one thousand (1000) feet of stream, might be a better indicator of conditions needed to protect a broad range of beneficial uses, rather than the number of leave trees specified for the current rule.

030.07.e.
iv. Leave standing trees, including conifers, hardwoods, and snags within fifty (50) feet of the ordinary high water mark on each side of all Class I streams, to provide ***trees as displayed in the following table*** per one thousand (1000) feet of stream for current and future LOD. Leaving more of the trees closer (within 25 feet) to the stream is preferable.

Table 16. Trees Per One Thousand (1000) Feet Required To Be Left / Retained (each side)

	Class II Streams	**Class I Streams - recommended distribution**		
Tree diameter (DBH)	**All widths**	**Stream Width**		
		Under 10' wide	**10'-20' wide**	**Over 20' wide***
3 - 7.9" Zone 1 25%	60 trees (20 ft tall)	100 trees (20 ft tall)	100 Trees** (20 ft tall)	See Note*
8 - 11.9" Zone 1 54% Zone 2 8%	20 trees (50 ft tall)	35 trees (50 ft tall)	35 trees (50 ft tall)	See Note*
12 - 19.9" Zone 1 69% Zone 2 24%		20 trees (80 ft tall)	15 trees (80 ft tall)	See Note*
20" + Zone 1 74% Zone 2 34%			5 trees (100+ ft tall)	See Note*
Minimum trees Required	35 trees > 5” required	55 trees > 8” required	55 trees > 8” required	None

* These streams more than 20 feet wide are riverine systems where material needed for organic debris is not a critical component. Shade requirements should suffice for the minor amounts of material needed in these larger systems.

** Primarily to provide for larger trees in the future (likely would not contribute LOD as stream flushing would move this size material out of the system).

Note that this would likely result in 20.5 trees predicted to fall into streams greater than 10 but less than 20 feet wide, 20.1 trees in streams less than 10 feet wide, and 22 trees in Class II streams. (Assume half of the trees amounts listed would be in the first 25-foot zone, and the other half in the second 25-foot zone). Site specific stream protection zone plans would need to have 20+ trees per 1,000 feet predicted to fall into streams.

With limited data, the FPWQA Team suggests the following language regarding shade be used as starting point for discussion:

ii. ~~Leave seventy-five percent (75%) of the current shade over the Class I streams. (7-1-96)~~ Leave shade (canopy closure as measured by a densiometer measured at high-water mark) at the 70% level (averaged for both banks for streams <10 feet wide, treatment-side bank for streams >10 feet wide). Consider increasing the amount of shade through management (shrub or tree plantings) if current shade is lower than 70%.

Fish Passage

The relatively high degree of non-compliance, according to methods used in this audit, associated with providing for fish passage, indicate additional rule, guidance, training, or administrative tools are needed. While fish passage must clearly be provided, and prescriptive standards are in place, practically applying those standards in the field can be problematic for administrators, landowners, or operators. The basis for the current prescriptive standards contained in the SCA rules is commonly referred to as the "Alaska curve". Alaska, Oregon and Washington also have their respective prescriptive standards based on this same curve. However, the National Council for Air and Stream Improvement, Inc (NCASI; 2003) suggests reconsideration of current passage criteria is warranted.

The FPWAQ Team suggests the FPAA Committee and the Idaho regulatory agencies review current research on this subject for the purpose of either validating or modifying current prescriptive fish passage standards. In the interim, IDL should continue to review and update, as needed, the current State Forester Forum on fish passage to assist administrators, landowners and operators with meeting the intent of fish passage rules.

Other Streamside Management Considerations

Audit findings indicate that uncertainty exists regarding requirements for using prescribed fire in SPZs. Current rules indirectly address use of fire by requiring that SPZs "be protected to leave them in the most natural condition as possible," which implies some degree of protection from broadcast burns to at least minimize fire effects on riparian vegetation. In addition, since equipment use is precluded in SPZs, in theory it is not possible to use equipment to pile slash in SPZs.

Use of fire is becoming an increasingly important tool for forest management and forest health restoration. From a water quality standpoint, the use of fire in SPZs is not a problem provided mineral soil is not exposed during broadcast or pile burning to avoid a nutrient flush, and brush and trees are not killed during broadcast burns. In order to allow forest managers the option to continue to use prescribed fire as a management tool and help ensure water quality is protected, the FPWQA Team recommends changes to Rule 030.07 as described below, that include specific references to use of prescribed fire.

030.07.f Direct ignition of prescribed burns will be limited to hand piles within stream protection zones (SPZ), all other direct ignitions shall occur outside of SPZs, so a backing (cooler) fire will more likely occur within the SPZ.
i. Hand piles shall be at least 10 feet from the high-water mark of streams.
ii. No mechanical piling of slash or natural forest fuels is allowed in SPZ (an exception is filter windrows for erosion control which shall not be ignited).

Another issue that arose is the use of ground based equipment on steeper slopes near streams. Current rules prohibit ground skidding on slopes greater than 45% which are "immediately adjacent" to streams. The FPWQA Team recognizes several variables go into determining what constitutes "immediately adjacent," including proximity to streams, slope, soil type, topographic breaks, operating conditions, area of impact, and accessibility to name a few. In 1996, the FPA Rules were modified to prohibit use of ground based equipment in SPZs. By inference, "immediately adjacent" is therefore some undefined area outside and upslope from the SPZ.

The FPWQA Team recognizes attempts have been made to better define what constitutes "immediately adjacent", but that such a definition has not yet materialized. From a water quality perspective, the less ground disturbance, the better, and yarding methods other than ground based systems will reduce the risk of potential water quality impacts from sediment delivery. Compiled research (Seyedbagheri, 1996) on this subject is inconclusive. In an attempt to provide additional regulatory consistency in this rule, yet retain the flexibility to base decisions on actual site conditions and potential water quality impacts, it is suggested IDL develop guidance to determine the "immediately adjacent" impact area by measuring upslope at the edge of the SPZ. Ground based skidding on slopes over 45% upslope of the SPZ should be prohibited until the slope breaks to less than 45%.

Road Construction and Maintenance

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. However, the applicability and jurisdiction of FPA road rules in certain situations has become increasingly problematic. These situations primarily involve non-industrial lands that are managed for multiple uses, with forestry often being a minor or incidental use. Some of the audited sites included lands that were mining claims, grazed lands, or lands in a rural residential setting or planned for subdivision conversion. In all these cases, existing roads were used to remove the timber. Generally, these roads are the deeded access, are located in SPZs, and receive little in the way of long term maintenance, other than minor erosion control work upon completion of the logging operation.

The FPWQA Team witnessed active attention to road maintenance BMPs in conjunction with the current harvest operations, but recognizes longer term maintenance needs, or any plan to upgrade or relocate a road in the SPZ, is highly unlikely when the primary land use is something other than forestry. Once a forest practice is complete, FPA jurisdiction on such lands would appear to cease, however, rules are unclear with respect to this issue, and may create a conflict with other local or state regulations, such as they exist. It is suggested that guidance language be

added that clarifies the full suite of FPA road planning, construction, and maintenance rules apply to roads that primarily exist to manage forest lands. For all other existing roads that are not primarily in place to manage forest lands, only the related active road maintenance rules apply.

040.04.d (new rule). Incidental Haul Road. An incidental haul road is a multi-use road (residential traffic, primary use is other than forestry) that has log haul during active harvest activities. Active Road maintenance requirements apply. Once active maintenance is completed, no other maintenance is required.

04.04.~~d~~e Inactive Roads. An inactive road is a forest road (primary use is for forestry) no longer used ……

Administrative Considerations

One of the questions asked during the field audit was if the practice suggested any administrative changes. The FPWQ Audit findings suggest structural changes made by IDL in how the program is administered would increase administrative efficiency, provide more reliable results, and improve long term compliance tracking. While these items do not directly impact water quality, any increases in efficiency or reductions in uncertainty with respect to how and where forest practices occur would most certainly reduce potential long term risk.

IDL essentially administers the FPWQ Audit program as it has since its inception, and has not taken full advantage of digital technology to improve administrative efficiency. For example, a GIS based mapping system to capture and retain components (e.g., stream class, soils, slopes, operating area, roads) contained in the Notification of Forest Practice does not exist. Lack of such a system makes it impossible to track activities and effects over time and space across the landscape. Likewise, several FPA inspection report forms are currently in use in an analog format that make it inefficient to track compliance rates, identify compliance trends, and share information with interested parties. The FPWQA Team recognizes IDL has fiscal, personnel, and time constraints; but would encourage the agency to move forward in pursuit of a digital system to base the FPA program upon.

Another area to be considered is administration of the CWE process for Idaho. A number of audited sites were located in 303(d) watersheds where CWE field work had been completed, but in no case was there a complete final report recommending that additional management practices be generated. IDL should ensure the CWE process is followed through to completion or re-evaluated as to its utility given the current state of scientific knowledge in this field.

Lastly, it appears there is no practical means to sunset or modify site-specific BMPs developed under the Antidegredation Program for Idaho. This program existed from 1989-1995, until its implementation components contained in the FPA were repealed. However, the 1995 repeal of the Stream Segment of Concern program and designated site-specific BMPs left in force practices developed under the program. CWE Rules do provide one way to sunset or modify these site-specific BMPs, but since the CWE process has never been completed, none of these BMPs have been modified.

Regulatory compliance and consistency

After reviewing FPA inspection reports and comparing those reports to FPWQ Audit findings, the team believes IDL should be commended for the high degree of consistency observed. No field administrative changes in the program are warranted and IDL should strive to maintain current internal approaches to achieving regulatory consistency across Idaho. The only recommendation the FPWQA Team has for the IDL is for future FPA administrative training to focus on designing and evaluating stream crossings to provide for fish passage. The team also believes development and implementation of an integrated digital system to track program data will improve administrative efficiency and provide real time mechanisms to monitor changes in BMP compliance and overall program effectiveness.

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APPENDIX A

Current Condition of Large Organic Debris in Compliance-audited Sales

Pieces in Active Channel and Pieces Bridging Above Active Channel

Figure a. Compliance-audited sale current LOD in 500 foot stream reach in active channel by stream name.

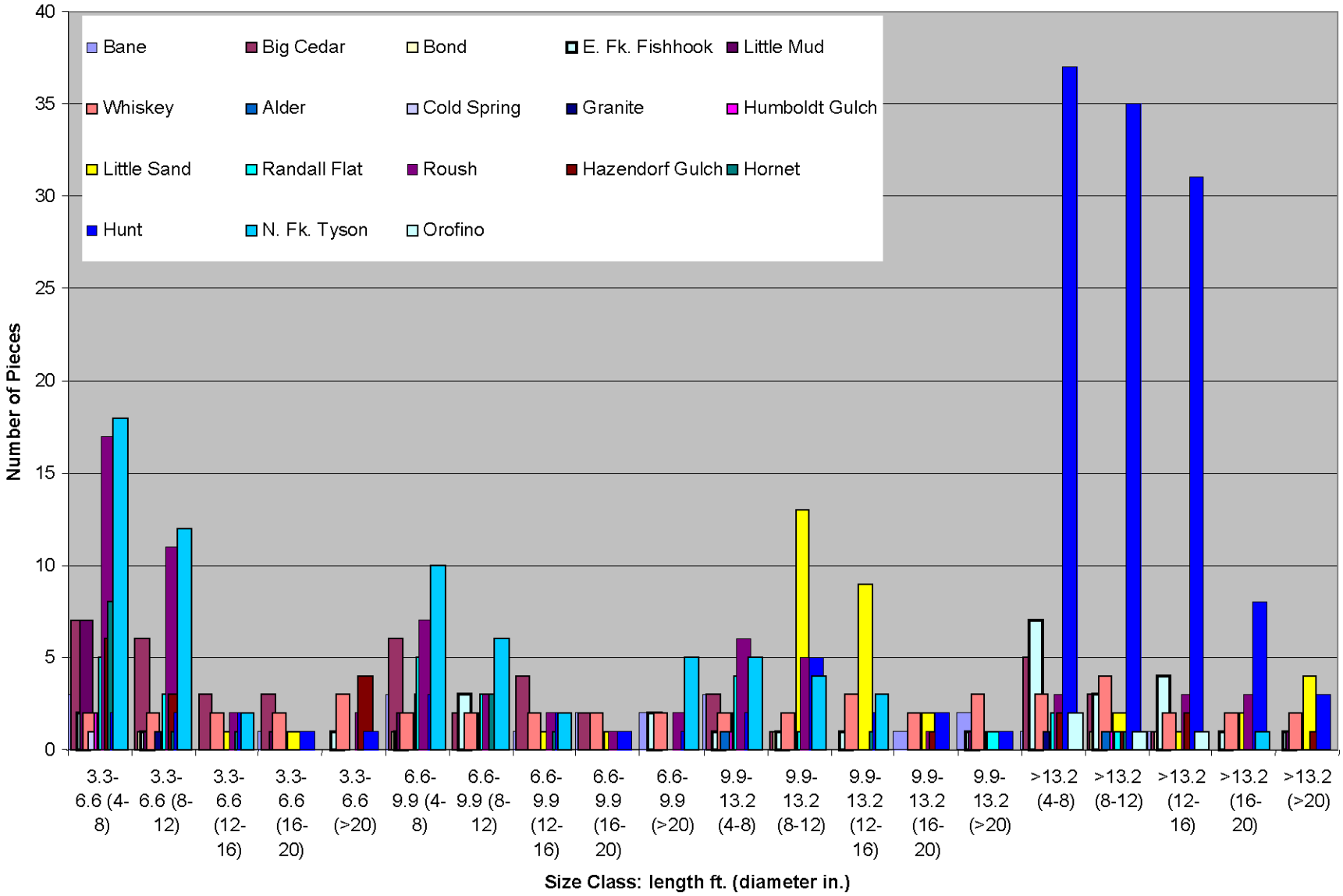


Table a. Compliance-audited sale current condition cumulative LOD pieces in 500 foot stream reach in active channel.

Size Class	Bane	Big Cedar	Bond	E.Fk. Fishhook	Little Mud	Whiskey	Alder	Cold Spring	Granite	Humboldt Gulch	Little Sand	Randall Flat	Roush	Hazendorf Gulch	Hornet	Hunt	N.Fk. Tyson	Orofino
3.3-6.6 (4-8)	3	7		2	7	2		1		2	2	5	17	6	8	2	18	
3.3-6.6 (8-12)		6	1	1	1	2			1		1	3	11	3	1	2	12	
3.3-6.6 (12-16)		3				2					1		2		1	2	2	
3.3-6.6 (16-20)	1	3			1	2					1					1		
3.3-6.6 (>20)				1		3							2	4		1		
6.6-9.9 (4-8)	3	6	1	1	2	2					3	5	7			3	10	
6.6-9.9 (8-12)		2		3		2					2	3	3		3		6	
6.6-9.9 (12-16)	1	4				2					1		2		1	2	2	
6.6-9.9 (16-20)	2	2				2					1		1			1		
6.6-9.9 (>20)	2			2		2							2			1	5	
9.9-13.2 (4-8)	3	3		1		2	1			1	2	4	6			2	5	
9.9-13.2 (8-12)		1	1	1		2					13	1	5			5	4	
9.9-13.2 (12-16)				1		3					9				1	2	3	
9.9-13.2 (16-20)	1					2					2		1	1		2		
9.9-13.2 (>20)	2			1	1	3					1	1				1		
>13.2 (4-8)	1	5		7		3			1		1	2	3	2		37		2
>13.2 (8-12)		3	1	3		4	1			1	2	1		1	1	35		1
>13.2 (12-16)	1	1	1	4		2					1		3	2		31		1
>13.2 (16-20)				1		2					2		3			8	1	
>13.2 (>20)				1	1	2					4			1		3		
Total	20	46	5	30	13	46	2	1	2	4	49	25	68	20	16	141	68	4

Figure b. Compliance-audited sale LOD of 500 foot stream reach above active channel by stream.

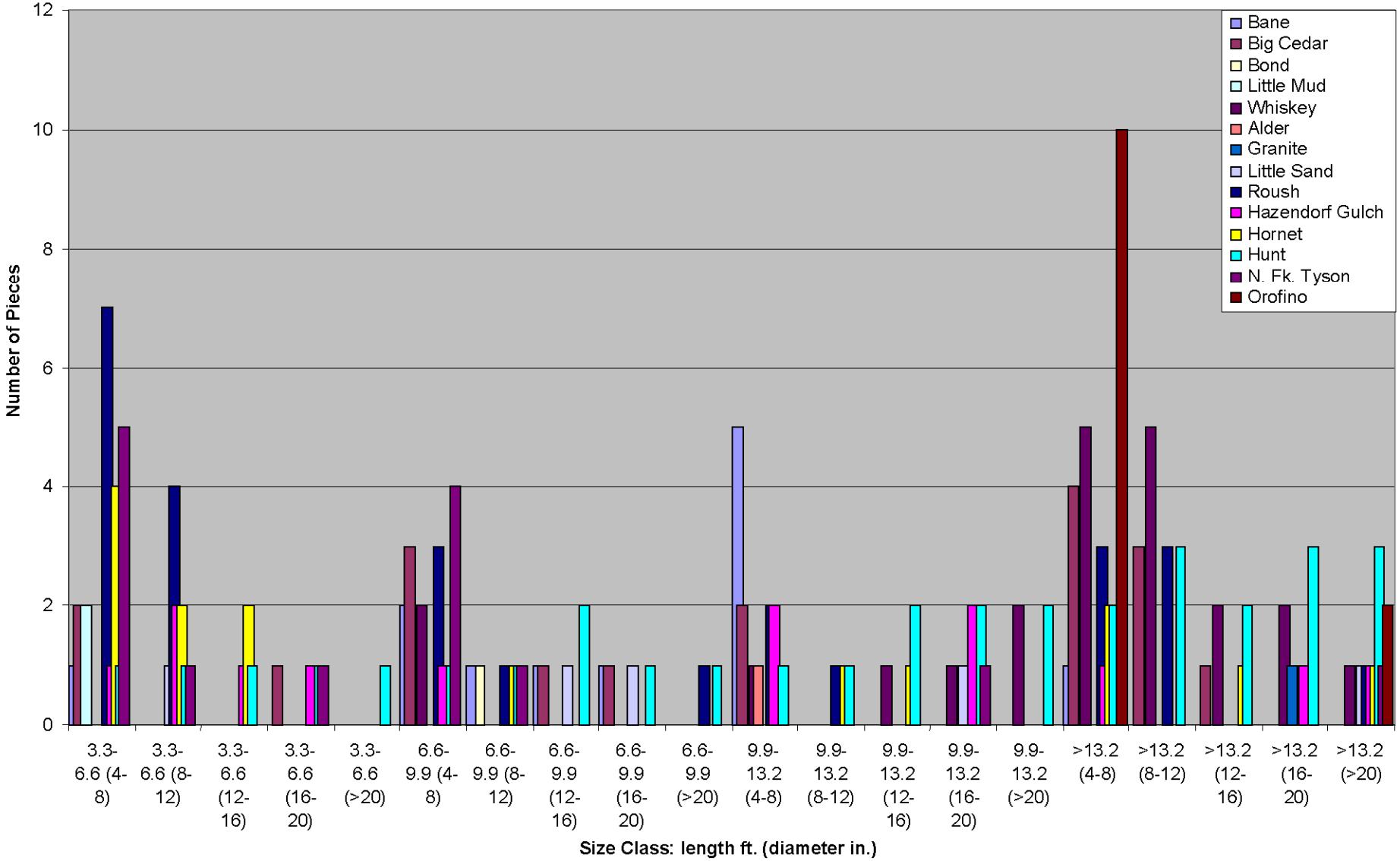


Table b. Compliance-audited sale current condition cumulative LOD pieces in 500 foot stream reach above active channel.

Size Class	Bane	Big Cedar	Bond	Little Mud	Whiskey	Alder	Granite	Little Sand	Roush	Hazendorf Gulch	Hornet	Hunt	N.Fk. Tyson	Orofino
3.3-6.6 (4-8)	1	2		2					7	1	4	1	5	
3.3-6.6 (8-12)								1	4	2	2	1	1	
3.3-6.6 (12-16)										1	2	1		
3.3-6.6 (16-20)		1								1		1	1	
3.3-6.6 (>20)												1		
6.6-9.9 (4-8)	2	3			2				3	1		1	4	
6.6-9.9 (8-12)	1		1						1		1	1	1	
6.6-9.9 (12-16)	1	1						1				2		
6.6-9.9 (16-20)	1	1										1		
6.6-9.9 (>20)								1	1			1		
9.9-13.2 (4-8)	5	2			1	1			2	2		1		
9.9-13.2 (8-12)									1		1	1		
9.9-13.2 (12-16)					1						1	2		
9.9-13.2 (16-20)					1					2		2	1	
9.9-13.2 (>20)					2			1				2		
>13.2 (4-8)	1	4			5				3	1	2	2		10
>13.2 (8-12)		3			5				3			3		
>13.2 (12-16)		1			2						1	2		
>13.2 (16-20)					2		1			1		3		
>13.2 (>20)					1			1	1	1	1	3	1	2
Total	12	18	1	2	22	1	1	5	26	13	15	32	14	12

APPENDIX B

Compliance-audited Sale Current Condition of Shade and Canopy Cover:

Solar Pathfinder (% Shade) Versus Densiometer (% Cover), % Shade by Warmest Months and Transect Average, and % Cover by Transect

Figure c. Compliance-audited sales % shade versus % canopy cover.

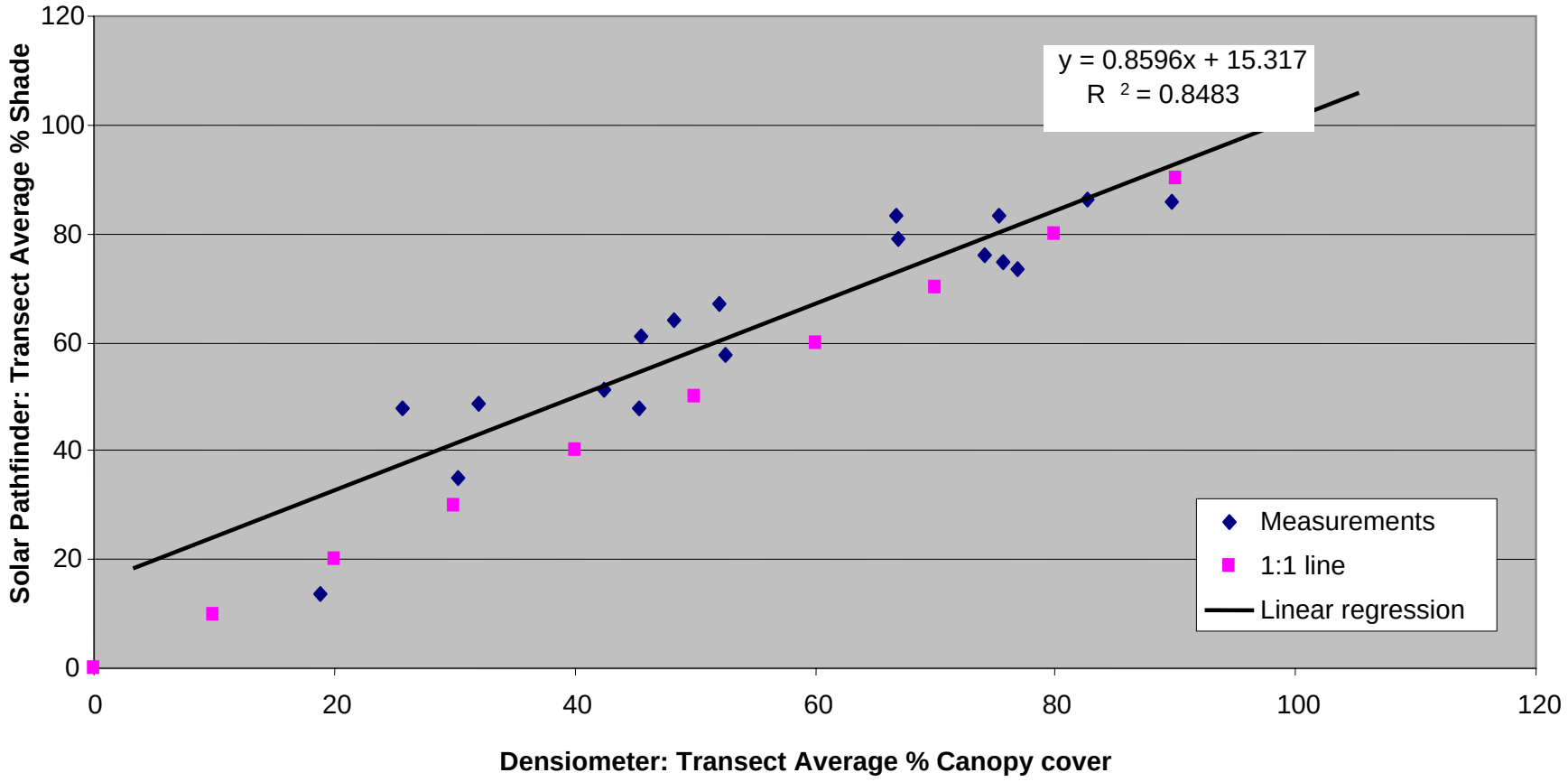


Table c. Compliance-audited sales % shade by warmest months and transect average

Solar Pathfinder: % Shade

Stream	May	June	July	August	September	Months Avg.
Ophir	30.6	27.2	28.4	35	46.2	47.7
Bane	75.25	80	76.25	76.25	71	75.9
Big Cedar	76.2	78.6	76.4	74.6	68.2	74.8
Bond	74.8	73.4	74.6	80.4	90.8	79
E.Fk. Fishhook	42	42.8	42.2	57	59.2	48.6
Little Mud	34	34.2	31.8	33.8	40.8	34.9
Whiskey	62	59.8	60	64.6	74.6	64.2
Alder	74.8	70.6	72.4	74.4	74.2	73.3
Cold Spring	58.4	62.8	60.6	59.6	60.6	61.2
Granite	11.6	9.6	11	15.2	20.4	13.6
Humboldt	59	55.84	56.34	53.84	64	57.8
Randall Flat	46.2	49.2	45	48.2	67	51.1
Roush	85.2	90.6	87.4	85.2	82.2	86.1
Hazendorf	80.8	88.6	83.8	88.4	88.4	86
Hornet	80.2	79.2	77.2	90	90.4	83.4
Hunt	77.6	75.2	75.4	90.4	98	83.3
N.Fk. Tyson	65.4	61.2	63.4	69	76.6	67.1
Orofino	40.8	38.8	39.8	52.2	67.2	47.8

Table d. Compliance-audited sales % canopy cover values by transect.

Densiometer: % Canopy Cover

Stream Name	Transect Av.	Reach Av.
Whiskey	47.1	48.2
	45.6	
	32.4	
	47.1	
	69.1	
Little Mud	7.4	30.3
	47.1	
	20.6	
	52.9	
	23.5	
Roush	82.4	82.7
	83.8	
	88.2	
	80.9	
	77.9	
Randall Flat	44.1	42.4
	52.9	
	8.8	
	19.1	
	86.8	
Orofino	54.4	45.3
	30.9	
	50	
	39.7	
	51.5	
Ophir	7.4	25.6
	85.3	
	11.8	
	23.5	
	0	
N. Fk. Tyson	75	52.1
	64.7	
	27.9	
	61.8	
	30.9	

Stream Name	Transect Av.	Reach Av.
Hunt	73.5	75.3
	80.9	
	88.2	
	75	
	58.8	
Humboldt	54.4	52.5
	76.5	
	36.8	
	52.9	
	63.2	
	30.9	
Hornet	66.2	66.8
	66.2	
	54.4	
	60.3	
	86.8	
Hazendorf	95.6	89.7
	97.1	
	82.4	
	82.4	
	91.2	
E.Fk.Fishhook	51.5	32.1
	50	
	7.4	
	22.1	
	29.4	
Cold Spring	73.5	45.6
	16.2	
	77.9	
	35.3	
	25	

Stream Name	Transect Av.	Reach Av.
Bond	57.4	67.1
	60.3	
	75	
	73.5	
	69.1	
Alder	89.7	76.8
	19.1	
	95.6	
	89.7	
	89.7	
Bane	58.8	74.2
	82.4	
	73.5	
	77.9	
	77.9	
Big Cedar	82.4	75.6
	85.3	
	76.5	
	69.1	
	64.7	
Little Sand	26.5	37.1
	30.9	
	23.5	
	54.4	
	50	
Granite	30.9	18.8
	23.5	
	14.7	
	4.4	
	20.6	

APPENDIX C

Other Compliance-audited Sale SPZ Information:

Percent of Trees Harvested in Zone 1, Trees per Acre and Basal Area per Acre, and BA Retained per 500 ft. and BA Removed per 500 ft.

Figure d. Percent of trees harvested in Zone1 (25 feet from the streams ordinary high water mark).

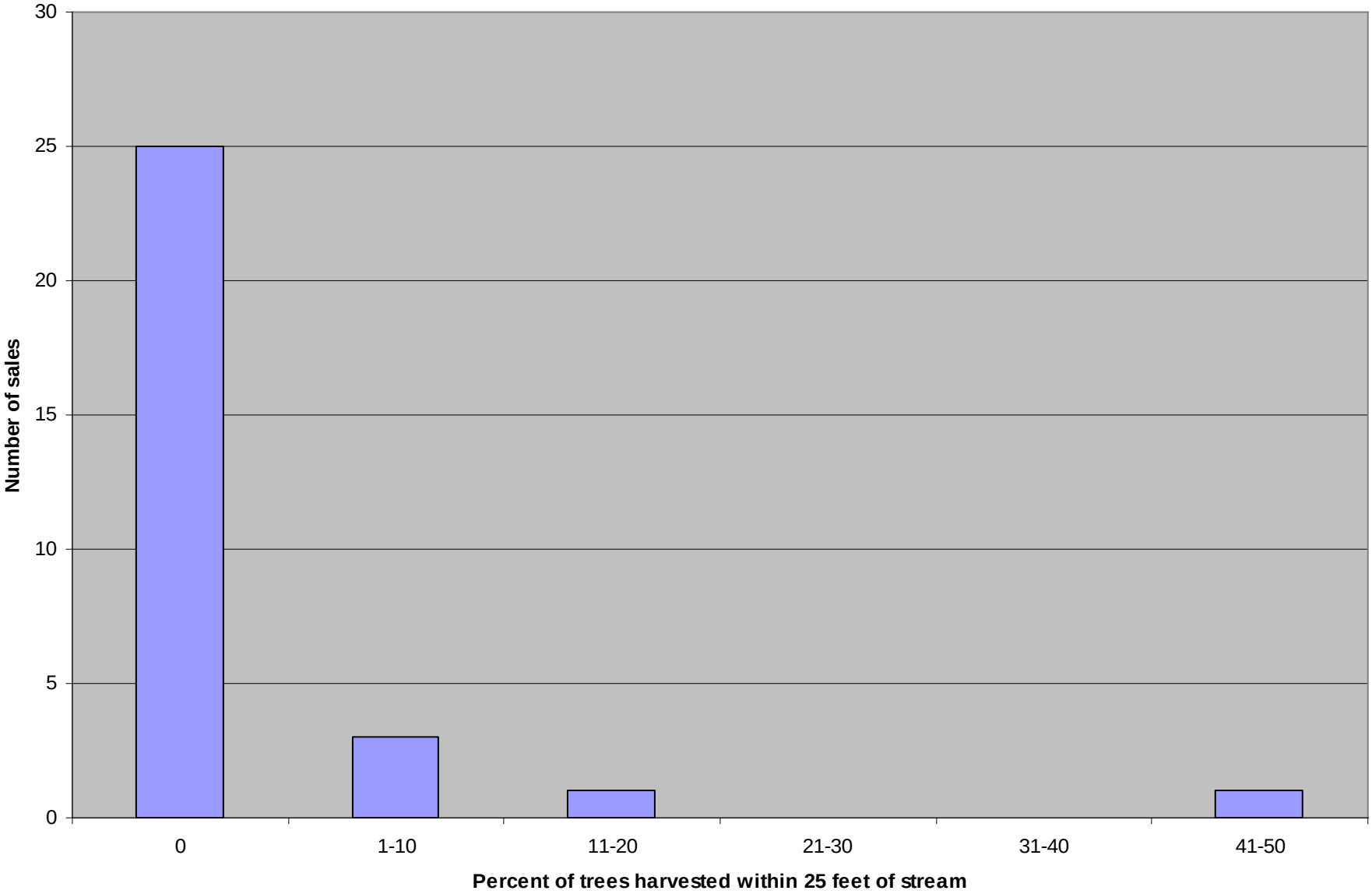


Table e. Compliance-audited sale trees per acre and basal area per acre in Zones 1 and 2.

Stream	TPA		BA/Acre		Comments
	Left Bank	Right Bank	Left Bank	Right Bank	
Cocolalla	No Data				
Corral	No Data				
Goose	No Data				
Knoll	No Data				
Ophir	13.9	13.9	4	3	Historical placer mining on both sides of stream.
Bane	264.8	N/A	122	N/A	Historical logging
Big Cedar	N/A	104.5	N/A	205	Historical logging
Bond	118.5	76.7	173	43	Historical logging
E. Fk. Fishhook	N/A	146.4	N/A	106	Historical logging
Little Mud	14	0	54	0	Right bank: existing road in SPZ.
Whiskey	N/A	97.6	N/A	188	Historical logging
Alder	139.4	118.5	266	115	Historical logging
Cold Spring	139.4	118.5	46	26	Historical logging
Granite	7	7	1	0.2	Right bank: road in SPZ. Historical placer mining.
Humboldt Gulch	92.9	203.3	56	292	Left Bank: rock outcrop in SPZ. Historical mining activity and logging in SPZ.
Little Sand	181.2	N/A	76	N/A	Historical Logging.
Randall Flat	76.7	243.9	43	57	Historical logging
Roush	111.5	223.0	259	386	Left Bank: existing road in SPZ
Hazendorf	188.2	174.2	172	306	Left Bank: abandoned, re-vegetated road in SPZ.
Hornet	253.3	236.9	106	292	Right bank: abandoned road in SPZ. Livestock activity in SPZ
Hunt	376.4	N/A	371	N/A	Historical logging
N. Fk. Tyson	257.9	N/A	158	N/A	Historical logging
Orofino	111.5	N/A	269	N/A	Left Bank: existing road in SPZ.

Table f. Compliance audit sale basal area retained and removed per 500 ft. stream reach.

Stream	BA Retained/500 ft.				BA Removed/500 ft.			
	Left bank		Right bank		Left bank		Right bank	
	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone2
Cocolalla	No Data							
Corral	No Data							
Goose	No Data							
Knoll	No Data							
Ophir	0	.6	0	.4	0	0	0	0
Bane	5.5	12	N/A	N/A	0	0	0	0
Big Cedar	N/A	N/A	15	14	N/A	N/A	1	5
Bond	14	11	2	5	0	5	0	0
E. Fk. Fishhook	N/A	N/A	10	5	N/A	N/A	0	0
Little Mud	1	6.7	0	0	0	0	0	0
Whiskey	N/A	N/A	23	4	0	1	0	0
Alder	20	19	10	6	0	3	0	0
Cold Spring	3	4	4	0	0	11	0	0
Granite	20	0	20	0	2	0	0	0
Humboldt Gulch	6	4	28	22	0	0	0	13
Little Sand	3	8	N/A	N/A	0	3	N/A	N/A
Randall Flat	5	2	3	6	0	6	0	0
Roush	24	14	45	11	6	0	0	5
Hazendorf	17	8	23	21	0	0	1	5
Hornet	8	7	17	25	0	0	0	1
Hunt	46	8	N/A	N/A	0	.5	N/A	N/A
N. Fk. Tyson	6	17	N/A	N/A	0	6	N/A	N/A
Orofino	23	15	N/A	N/A	0	0	N/A	N/A

APPENDIX D

Effectiveness Decision Flow Chart

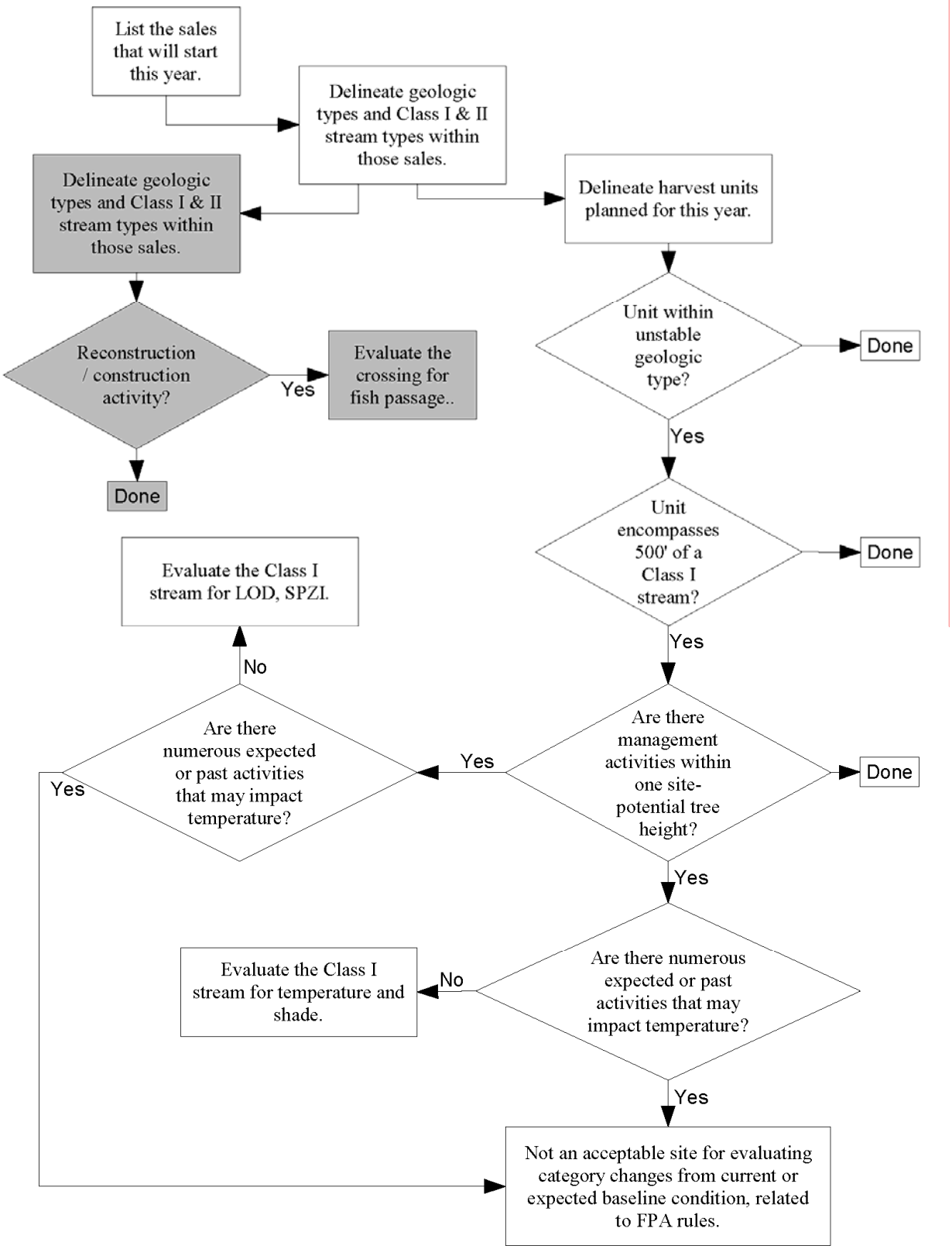


Figure e. Effectiveness decision flow chart.

APPENDIX E

Pre-Harvest (2004) Temperature Graphs:

Cascade Creek Pre-Harvest Temperatures (7/20-10/18), Little Wolf Creek Pre-Harvest Temperatures (7/7-10/21), Smith Creek Pre-Harvest Temperatures (7/10-10/5), and Trout Creek Pre-Harvest Temperatures (6/29-10/20)

Figure f. 2004 Cascade Cr. pre-harvest stream temperatures.

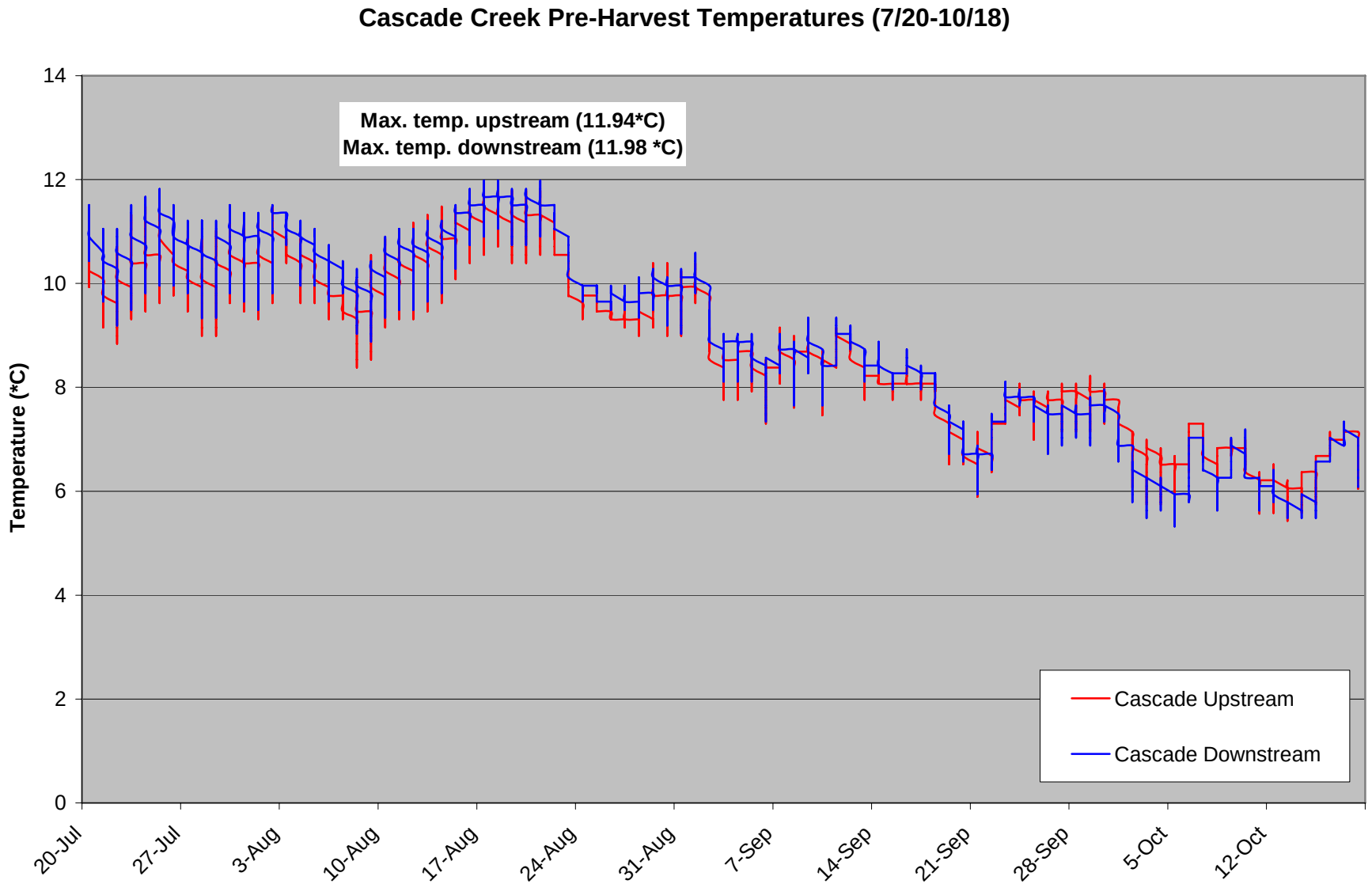


Figure g. 2004 Little Wolf Cr. pre-harvest stream temperatures.

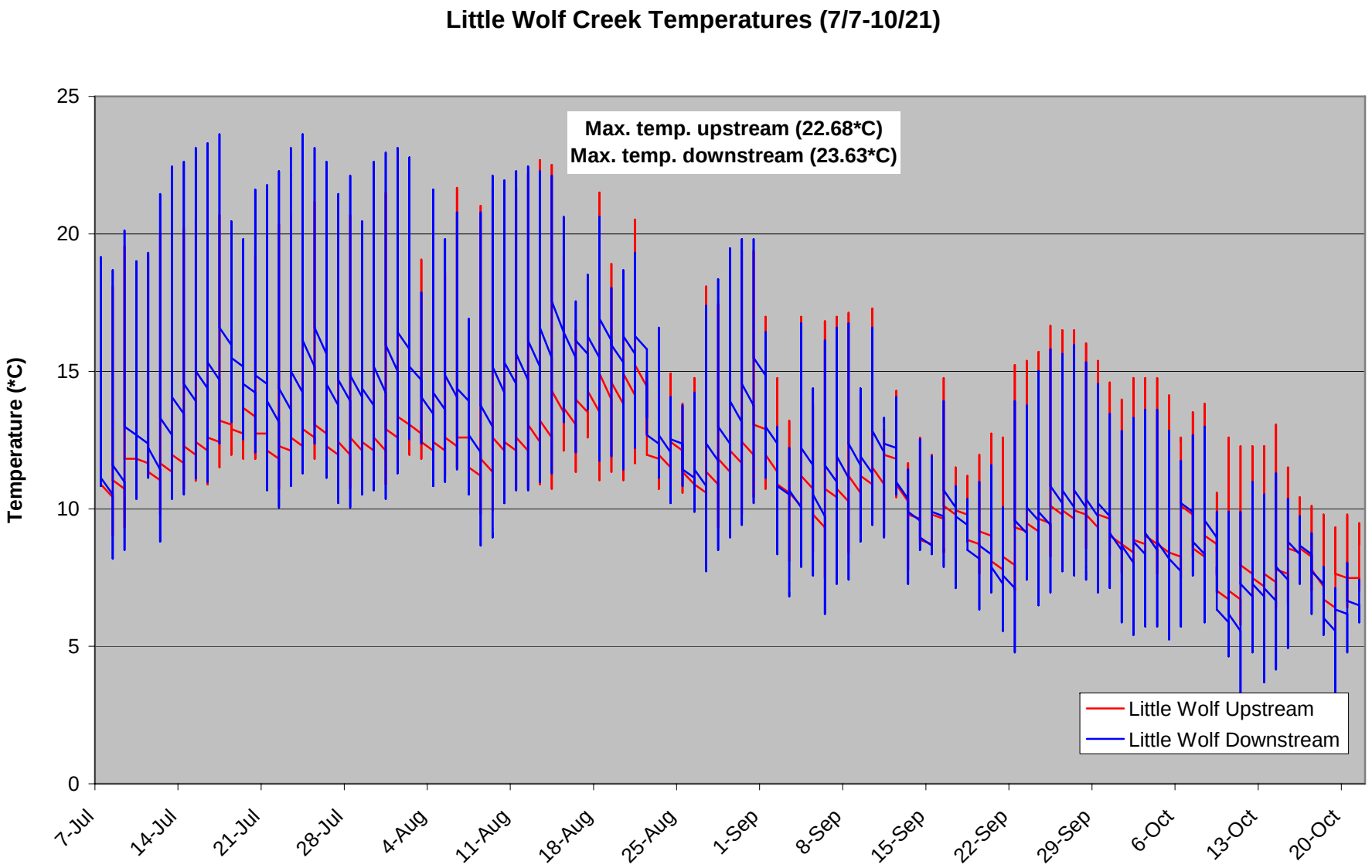


Figure h. 2004 Smith Cr. pre-harvest stream temperatures.

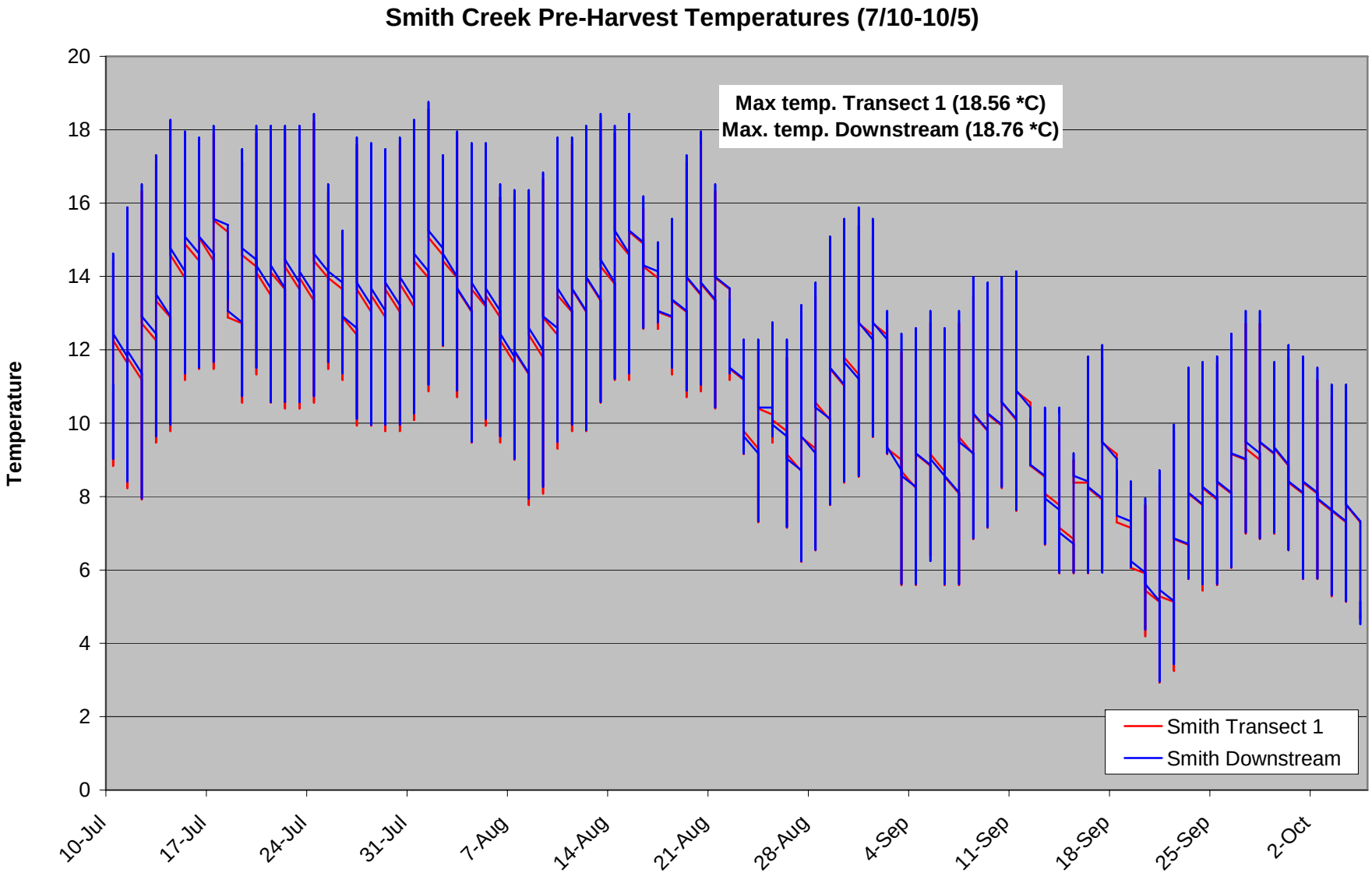
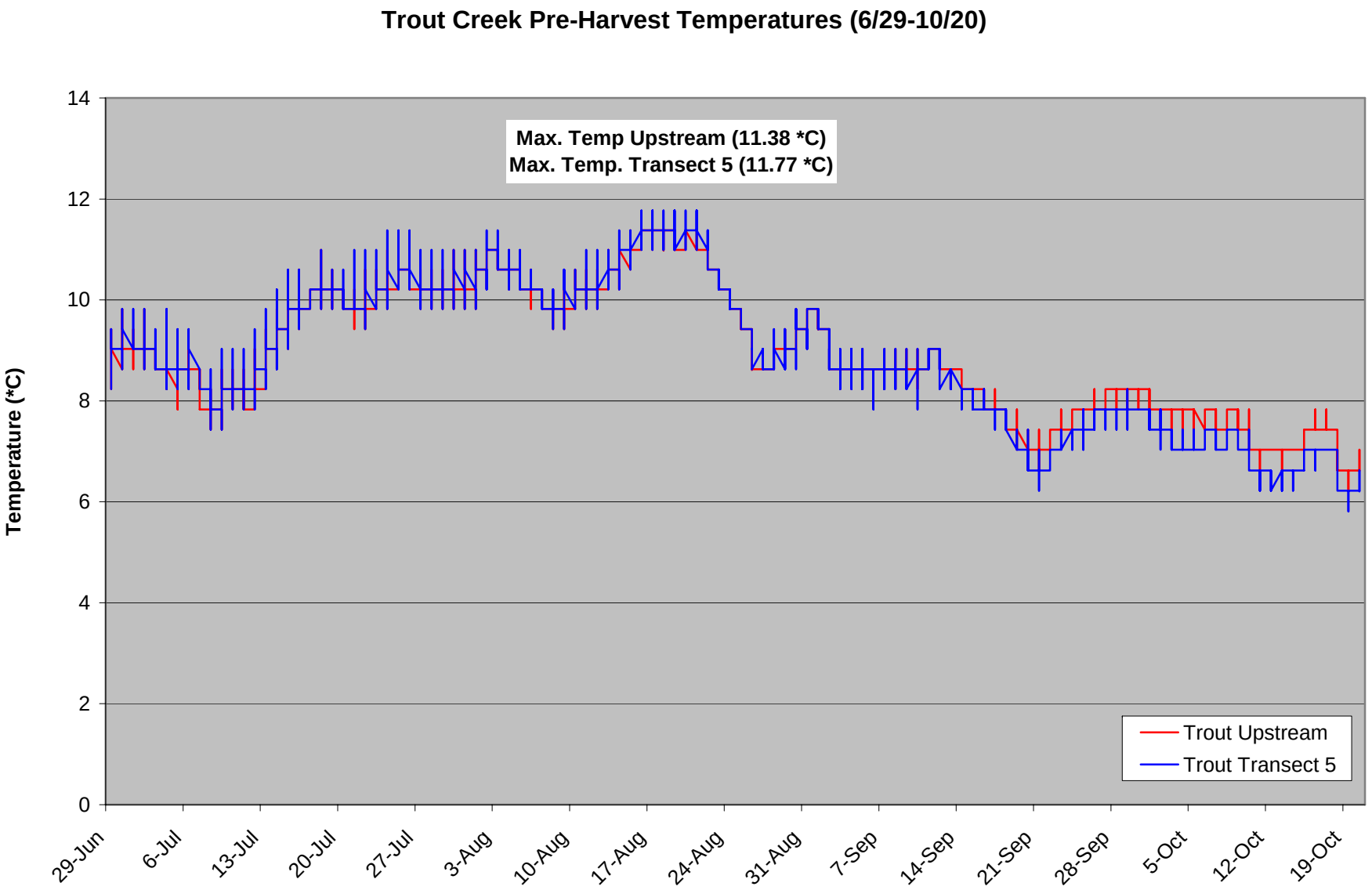


Figure i. 2004 Trout Cr. pre-harvest stream temperatures.



APPENDIX F

Solar Pathfinder Versus Densiometer

Introduction

The FPWQA Team used two tools, a solar pathfinder and a concave spherical densiometer, to measure shade and canopy cover over multiple Class I streams. These tools and their respective methods of use are explained previously in this report in the methods of shade evaluation section on page 26. The team wanted to compare these two tools to find similarities and differences in their measurement capabilities. By understanding the similarities and differences in values measured by these two tools, the team and other parties may begin to evaluate whether one or the other of the tools is a better indicator of vegetative conditions near and over the stream.

The FPWQA Team also intends to compare the values from the solar pathfinder and densiometer of the effectiveness audits with stream temperature data. The most valuable information from the comparisons between the two tools will come from the shade and cover values comparison to stream temperature. These comparisons will allow the team to evaluate effectiveness of implemented BMPs by assessing relationships between water quality and forest practices of the State of Idaho.

Methods -- Solar Pathfinder (% shade) Versus Densiometer (% cover)

Stream shade and canopy cover data collected from both compliance and effectiveness audit timber sales were used to compare the solar pathfinder and concave densiometer for similarities and variability in their measurement capabilities. Percent shade is a measurement of the total possible solar energy "obscured or reflected by vegetation or topography above a stream" (OWEB 2000). Percent cover is the measurement of "sky covered by vegetation or topography" (OWEB 2000). Collected data is presented in Table 17.

The FPWQA Team performed a regression analysis to identify whether measurements of canopy cover and shade are significantly related to each other. The data sets were graphed in an x-y scatter plot with densiometer (% cover) values as the independent variable and solar pathfinder (% shade) values as the dependent variable. The densiometer (% cover) values were reach averages and the solar pathfinder (% shade) values were summer shade (May-September) reach averages. Both a regression line ($y = mx + b$) and 1:1 line were graphed on the chart (see Figure 8) to aid in visual interpretation of the correlation between the two variables.

Results – Solar Pathfinder (% shade) Versus Densiometer (% cover)

Results from the regression analysis, as expected, show a significant linear relationship (and positive correlation) between the solar pathfinder and densiometer measurements. It may be intuitive that as % canopy cover increases, % shade increases, however, there is variability in the relationship.

The significant correlation between cover and shade is represented by a *p*-value of 0.001. With a 0.001 level of significance it may be concluded that there is greater than a 99% probability that the difference in values between shade and cover is reliable.

Variability between shade and cover is represented by R^2, which identifies variance in shade accounted for by cover. In this case 77% of variance in shade is explained by cover.

Ultimately, as these results show, the densiometer (% cover) can be used as an alternative to the solar pathfinder (% shade), by indication that the streamside vegetative composition dictates the amount of shade that will be cast on the stream (OWEB 2000). Despite this indication, considering the variability, the FPWQA Team suggests shade, from any source, is the most appropriate measure.

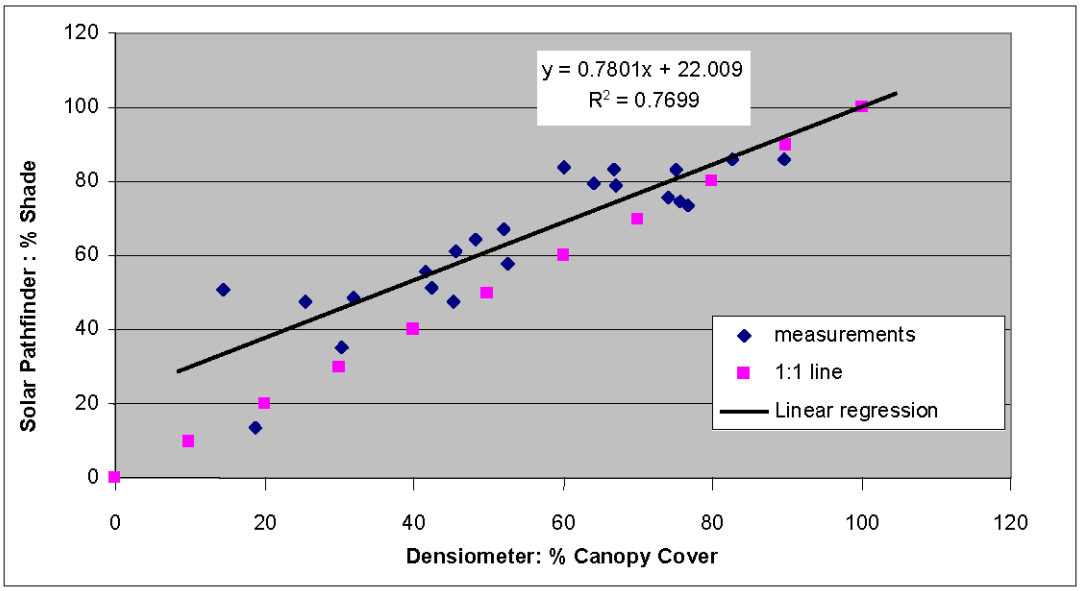


Figure 8. Solar pathfinder versus densiometer for compliance and effectiveness audit sales.

Table 17. Comparison of Solar Pathfinder (% shade) results with Densiometer (% cover) results

Solar pathfinder: (% shade)	83.8	50.7	55.7	79.3	47.7	75.9	74.8	79	48.6	34.9	64.2
	73.3	61.2	13.6	57.8	51.1	86.1	86	83.4	83.3	67.1	47.8
Densiometer: (% cover)	60	14.4	41.7	64.1	25.6	74.1	75.6	67	32	30.3	48.2
	76.8	45.6	18.8	52.5	42.4	82.6	89.7	66.8	75.3	52	45.3