Idaho
2012 Interagency
Forest Practices Water Quality Audit

Compliance and Effective Shade-Tree Density Assessment

State of Idaho
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Idaho 2012 Interagency Forest Practices Water Quality Audit

Rule Compliance and Effective Shade Assessment

2012 Forest Practices Audit Team

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March 2013

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Acknowledgments

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Executive Summary

The eighth statewide Forest Practices Water Quality Audit (Audit) was conducted between June and October 2012. The Audit was conducted to (1) assess compliance with the 2009 "Rules Pertaining to the Idaho Forest Practices Act" (IDAPA 20.02.01), under Idaho Code 38-13 (FPA Rules) and (2) gather data to help describe the empirical relationship between effective shade and metrics of tree density. The 2012 audit team was comprised of representatives from the Idaho Department of Environmental Quality (DEQ) and Idaho Department of Lands (IDL). Candidate timber sales to be audited were randomly selected based on the following criteria:

- Sale operations were conducted under the 2009 FPA rules.
- Cutting units bordered or included at least 500 feet of a Class I (fish-bearing) stream.
- Cutting units included at least 5 cumulative acres of harvested area.
- Operations occurred on Federal, private industrial, private nonindustrial, and state ownerships.
- Operations represented each IDL Supervisory Area containing qualifying sales.
- Operations were active or completed within the last two harvesting seasons.
- Preferred operations included road construction or reconstruction.

Rule Compliance

Overall, the audit team assessed rule compliance on 43 timber sales, observed 1,946 instances where Idaho FPA Rules were applicable, and of those observed, 1,920 instances (99%) where the rules were met or exceeded. Compliance rates were higher for all ownerships than the eight-audit averages (1984–2012) and exceeded the 2004 compliance rate (97.75%); the highest overall rate prior to 2012. The greatest rise in compliance rate was observed in the private-nonindustrial ownership category, increasing from 91% in 2008 to 96% in 2012. The individual rule with the lowest compliance rate (90%) was IDAPA 20.02.01.030.07.c, the stream protection zone (SPZ) equipment-exclusion rule.

Rule Compliance and Policy Recommendations

The DEQ recommends the following rule and administrative changes:

- Clarify rules 030.07.c and/or 040.02.h to address the question "does reuse of an existing SPZ road to move equipment require a variance?"
- In collaboration with DEQ, enhance the capability of area IDL offices to inform owners/operators of the stream classification and total maximum daily load status within or adjacent to proposed forest practices at the time of the notification.
- Pursue solutions to recreation- and grazing-induced damage to erosion control features.
- Continue work on revision of the existing shade rule (030.07.e.ii) as described in the 2000 (Hoelscher et al. 2001) and 2004 (McIntyre et al. 2007) audit reports.

Effective Shade-Tree Density Assessment

The audit team measured mid-channel effective shade and adjacent riparian tree density during the 2012 audit as a pilot study for assessing the future revised shade rule. We measured effective

shade in stream channels within or adjacent to cutting units and measured diameter at breast height for all trees 4 inches and greater in 25 x 75-foot fixed area plots perpendicular to each shade measurement point. We calculated correlations between effective shade and live trees per acre, relative density (Curtis 2010), relative stocking (Teply 2012), bank-full channel width and quadratic mean diameter (Curtis and Marshall 2000). We observed statistically significant (alpha < 0.05) correlations between effective shade and relative density (correlation = 0.624, *p-value* < 0.001), relative stocking (correlation = 0.542, *p-value* < 0.001), and live trees per acre (correlation = 0.445, *p-value* = 0.004). We observed statistically insignificant (alpha ≥ 0.05) correlations between effective shade and bank-full width and quadratic mean diameter.

Shade Rule Assessment Recommendations

Based on the findings from this pilot study, the audit team recommends the following to assess the effectiveness of the future shade rule:

- Design a study to address the question: What reductions of effective shade are observed when SPZ tree stands are thinned to rule limits?
- Design the study to associate cause and effect between cutting to the minimum allowed by the rule and resulting changes in effective shade. Replications will be needed for each proposed harvest prescription in each proposed forest type.
- Select study sites that have a 100-foot no-cut buffer as the initial condition (control plot), similar to the modeling used in rule development.
- Ensure the fixed-area plots are large enough to include all trees providing stream shade.
- Consider measuring all trees ≥ 3 inches diameter at breast height to potentially strengthen the association between effective shade and tree density.

1 2012 Idaho Forest Practices Water Quality Audit

The 2012 Audit had two components: (1) a compliance audit of the 2009 "Rules Pertaining to the Idaho Forest Practices Act" (IDAPA 20.02.01), under Idaho Code 38-13 (Forest Practices Act) and (2) collection of data to compare mid-channel effective shade to stream protection zone (SPZ) tree density. This report contains the audit team's findings and recommendations.

1.1 Background

The administrative basis for the 2012 audit includes the Clean Water Act, Forest Practices Water Quality Management Plan for the State of Idaho (Bauer et al. 1988), Idaho Nonpoint Source Management Plan (Dailey et al. 1999), and Memorandum of Understanding Implementing the Nonpoint Source Water Quality Program in the State of Idaho (DEQ 2008).

1.2 Purpose and Objectives

The 2012 audit was conducted to address two questions: (1) What is the rate of compliance with the Idaho forest practices rules that pertain to water quality and (2) What associations are observed between mid-channel effective shade and tree density in areas where timber harvesting has occurred? To address the first question, our objectives were to identify individual rules that have a bearing on water quality (Appendix A), assess each rule as it applies to an individual timber sale, and formulate recommendations for rule or administrative changes. To address the second question, our objectives were to measure mid-channel effective shade and to count and measure trees [$\geq$ 4 inches diameter breast at height (DBH)] in fixed-area plots adjacent to each shade measurement point.

2 Rule Compliance

2.1 Compliance Assessment Scope

The audit's compliance component was conducted as a statewide assessment of whether the FPA Rules (IDAPA 20.02.01) are being implemented and maintained. Therefore, our recommendations are statewide in scope. We make no recommendations concerning individual timber sales.

2.2 Compliance Assessment Methods

2.2.1 Audit Team

The audit team was comprised of representatives from the IDL and DEQ. Additionally, DEQ staff assisted the by collecting SPZ tree data within or adjacent to audited sales. For each site visit, the IDL or federal compliance inspector was present to provide background information but was not involved in rating the operation. Landowners, operators, and interested parties were

invited to attend. Idaho Forest Owners Association representatives occasionally joined the audit team.

2.2.2 Timber Sale Selection

Candidate timber sales were identified using the following criteria:

- Timber harvesting operations were conducted under the 2009 version of the FPA Rules.
- Cutting units within the timber sale boundary bordered or included at least 500 feet of a Class I stream.
- Cutting units included at least 5 cumulative acres of harvested area.
- Timber sales from each of the four ownership categories (federal, private industrial, private nonindustrial, and state) were included.
- Operations represented each IDL Supervisory Area containing qualifying sales.
- Operations were active or completed within the last two harvesting seasons.
- Operationss that included road construction or reconstruction were preferred.

From the pool of timber sales that met these criteria, individual sales to be audited were selected based on access availability and proximity to other sales for logistical reasons. Forty-three timber sales were evaluated for compliance in the 2012 audit (Figure 1).

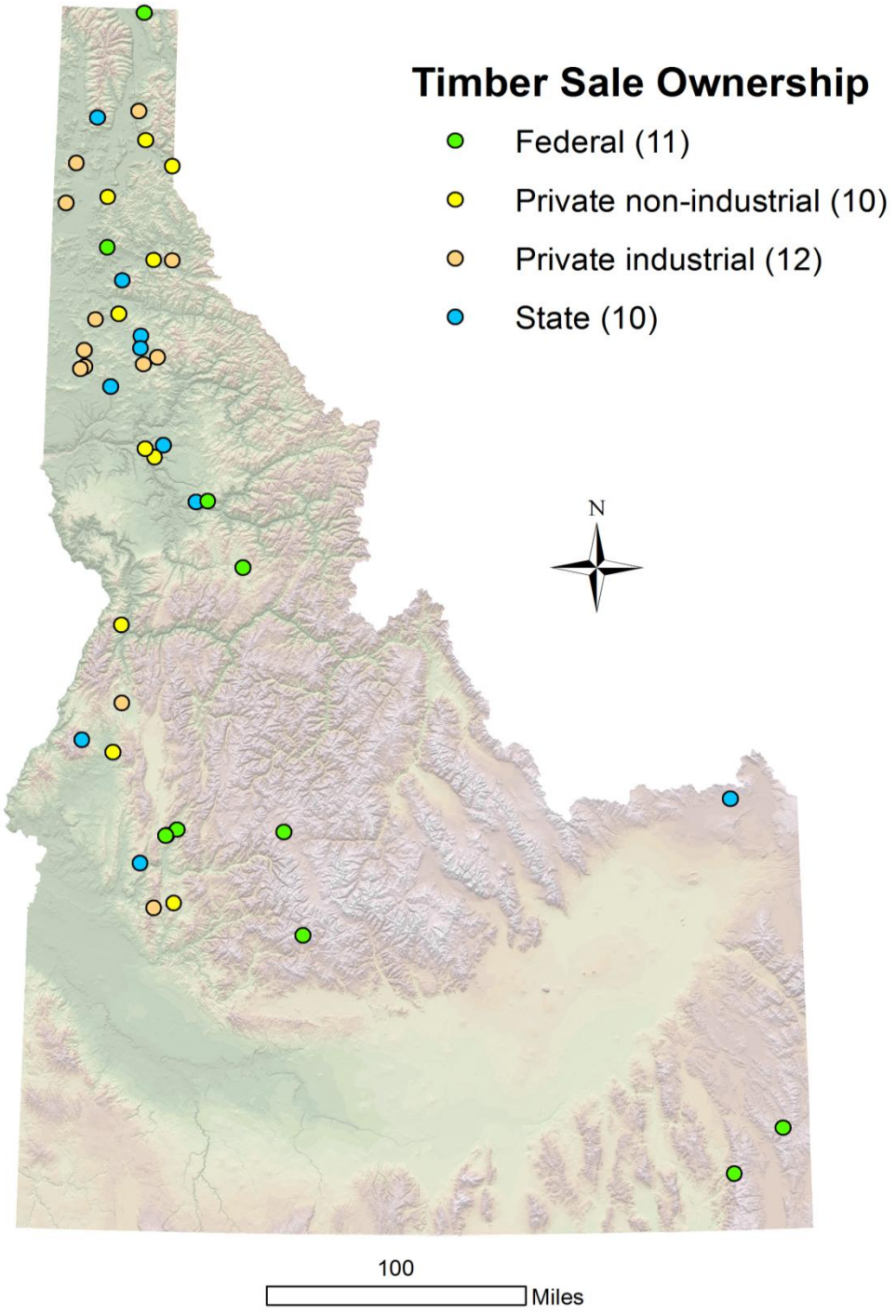

Figure 1. Locations of timber sales audited for rule compliance during the 2012 Idaho Forest Practices Water Quality Audit.

2.2.3 Rule Compliance Audit Process

Upon arrival at a timber sale, the audit team split into a compliance team and a stream team. The compliance team assessed compliance with applicable rules by conducting a qualitative assessment based on visual observations. The stream team measured mid-channel effective shade and cruised timber in a fixed-area plot adjacent to the shade measurement point. The stream team methods, results, and recommendations are described in section 3.

The compliance team, along with any observers (agency foresters, sale administrators, and other interested individuals), toured a number (but not all) of the cutting units within the timber sale boundaries to inspect skid trails, roads, culverts, stream crossings, slash distribution, and any pre- and post-harvest erosion-control practices present. Following their inspection, the compliance team met and evaluated the sale in terms of compliance with applicable forest practices rules. As needed, the compliance team solicited information from the observers. Compliance ratings were discussed and analyzed with all participating members of the audit team. Ultimately, the rating of compliance was made by DEQ.

2.2.4 Rule Compliance Data Assessment

Once all of the timber sale visits were completed, the findings were compiled for each of the 82 individual rules audited (Appendix A). Compliance percentages for individual rules across all timber sales were calculated by dividing the number of times a rule was complied with by the total number of instances the rule was applicable. Compliance rates were assessed across landownership categories, rule groups, and individual rules.

2.3 Compliance Assessment Results

In this section, the audit's rule compliance results are presented. The overall compliance results are reported first and are then broken down by landownership, rule group, and individual rule. The section concludes with discussion of these results.

2.3.1 Overall Rule Compliance

The audit team observed 1,946 instances in which the Idaho FPA Rules were applicable within the 43 timber sales audited. Of these, 1,920 instances exhibited rule compliance, resulting in an overall compliance rate of 98.25%. The overall compliance rates within each of the four landownership categories were above 96% (Table 1). Compared to previous audits (Bauer et al. 1985; Harvey et al. 1989; Hoelscher et al. 1993, Zaroban et al. 1997; Hoelscher et al. 2001; McIntyre et al. 2007; Zaroban and Prisock 2009), overall compliance rates increased or remained relatively unchanged (Table 2 and Figure 2). The greatest increase in compliance rate was observed in the private-nonindustrial ownership category, compared to the 2008 audit results (Zaroban and Prisock 2009). We observed no compliance rate decreases.

Table 1. Summary of 2012 overall rule compliance by landownership category.

Ownership	Instances	Complied	Percent
Federal	499	495	99
Private industrial	566	562	99
Private nonindustrial	373	358	96
State	508	505	99
Overall	1,946	1,920	98

Table 2. Overall rule compliance rates by landownership category across audit years.

Audit	Federal	Private industrial	Private nonindustrial	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	100	99	93	99
2008	98	96	91	99
2012	99	99	96	99

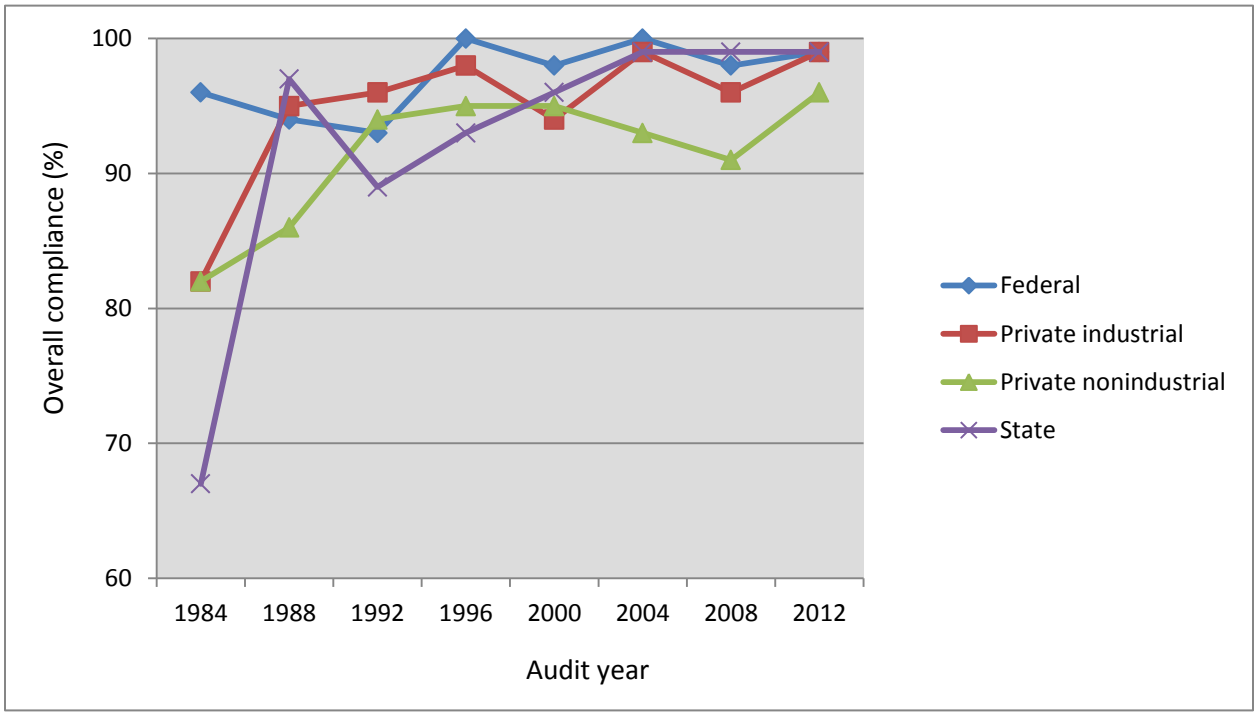

Figure 2. Overall compliance rates by landownership category across audit years.

2.3.2 Compliance By Rule Group

Compliance percentages ranged between 94%–100% across rule groups (Table 3). Compared to 2008 audit results (Zaroban and Prisock 2009), increased compliance was observed in the general (88% to 97%), harvest and stream protection (95% to 99%) and road construction (98% to 100%) rule groups. The compliance rate in the road maintenance rule group remained the same, while the compliance rate fell (98% to 94%) in the chemicals rule group.

Table 3. Compliance rates by rule group.

IDAPA 20.02.01 Rule Group	Description	Instances	Complied	Percent
General (020.01)	Variance procedures	29	28	97
Harvest and stream protection (030)	Tails, slash, and landings	1,170	1,159	99
Road construction (040.02–03)	Plans and stability	325	325	100
Road maintenance (040.04–05)	Active, inactive, abandoned, and winter operations	372	361	97
Chemicals (060)	Chemicals and petroleum products	50	47	94

2.3.3 Compliance By Individual Rule

General Rules (IDAPA 20.02.01.020.01)

The audit team assessed compliance with four variance rules and observed one instance of noncompliance (Table 4). This instance of noncompliance involved using an existing road within the SPZ without a variance.

Table 4. Summary of compliance with general rules.

IDAPA 20.02.01 Rule	Description	Instances	Complied	Percent
020.01.a.i	Variance request	8	7	88
020.01.a.ii	Request response	7	7	100
020.01.a.iii	Afford equal or better protection	7	7	100
020.01.b	Comply with other rules	7	7	100

Timber Harvesting and Stream Protection Rules (IDAPA 20.02.01.030)

We assessed compliance with 31 harvest and stream protection rules and observed 11 instances of noncompliance involving seven of these rules (Table 5). Four of these noncompliance instances involved the SPZ equipment-exclusion rule (030.07.c). We observed one instance of noncompliance with rules pertaining to keeping landings and trails outside the SPZ (030.04.a), processing trees outside the SPZ (030.06.a), keeping landing and trail waste outside the SPZ (030.06.c), no skidding in streams (030.07.b), and no mechanical slash piling in SPZ (030.07.f.ii). We observed two instances of noncompliance with the trail stabilization rule

(030.05.a). None of the timber sales audited in 2012 bordered a lake. Therefore, rule 030.07.a did not apply.

Table 5. Summary of compliance with harvest and stream protection rules.

IDAPA 20.02.01 Rule	Description	Instances	Complied	Percent
030.03.a	Soil disturbance	39	39	100
030.03.b	Skid trail grade ≤ 30%	39	39	100
030.03.c	Skid trail number and size	40	40	100
030.03.d	Downhill yarding	24	24	100
030.04.a	Landings, trails outside SPZ	42	41	98
030.04.b	Landing size	42	42	100
030.04.c	Stumps, slash in fill	42	42	100
030.05.a	Trail stability	41	39	95
030.05.b	Landing drainage	42	42	100
030.06.a	Tree processing in SPZ	41	40	98
030.06.b	Slash in Class II streams	39	39	100
030.06.c	Landing, trail waste outside SPZ	42	41	98
030.07.a	Lake SPZ plan	0	0	NA
030.07.b	Skidding in streams	41	40	98
030.07.c	SPZ equipment exclusion	41	37	90
030.07.d	SPZ cable yarding	24	24	100
030.07.e.i	Hardwoods, shrubs, etc. retention	41	41	100
030.07.e.ii	Leave 75% Class I existing shade	41	41	100
030.07.e.iii	SPZ shade and filtering	41	41	100
030.07.e.iv	LOD maintenance	41	41	100
030.07.e.v	Non-LOD removal	40	40	100
030.07.e.vi	SPZ tree-retention table	41	41	100
030.07.e.vii	Snag accounting	41	41	100
030.07.e.viii	Tree retention, shade variance	24	24	100
030.07.f	SPZ burning	38	38	100
030.07.f.i	Hand piles ≥ 5 feet from OHWM	40	40	100
030.07.f.ii	Mechanical piling in SPZ	41	40	98
030.08.a	Scenic values	42	42	100
030.08.b	Critical habitat	43	43	100
030.08.c	Wet-area avoidance	43	43	100
030.08.d	Wildlife escape cover	34	34	100

Notes: streamside protection zone (SPZ); large organic debris (LOD), ordinary high-water mark (OHWM)

Road Specifications and Plans and Road Construction Rules (IDAPA 20.02.01.040.02 and 040.03)

We assessed compliance with 19 road planning and construction rules (Table 6) and observed no instances of noncompliance.

Table 6. Summary of compliance with road planning and construction rules.

IDAPA 20.02.01 Rule	Description	Instances	Complied	Percent
040.02.a	SPZ avoidance planning	21	21	100
040.02.b	Minimal road-size planning	22	22	100
040.02.c	Road drainage planning	22	22	100
040.02.d	Culvert and ditch planning	21	21	100
040.02.e.i	Fish passage planning	6	6	100
040.02.e.ii	50-year peak flow design	14	14	100
040.02.e.iii	Relief culverts ≥12 inch planning	15	15	100
040.02.g	Stream-crossing planning	14	14	100
040.02.h	SPZ road reconstruction planning	18	18	100
040.03.a	Plan compliance	20	20	100
040.03.b	Drainage/water quality maintenance	21	21	100
040.03.c	Exposed material stability	21	21	100
040.03.d	Road-fill compaction	21	21	100
040.03.e	Outslope drainage retention	21	21	100
040.03.f	Quarry drainage	3	3	100
040.03.g	Embankment erosion	19	19	100
040.03.h	Wet-period work	21	21	100
040.03.i	Cutslope stability	21	21	100
040.03.j	Construction on slopes > 60%	4	4	100

Note: streamside protection zone (SPZ)

Road Maintenance and Winter Operation Rules (IDAPA 20.02.01.040.04 and 040.05)

We assessed compliance with 19 road maintenance and winter operation rules and observed 11 instances of noncompliance involving six of these rules (Table 7). We observed three instances of noncompliance with rules pertaining to debris entry into streams (040.04.a) and sediment source stability (040.04.b) and two instances of noncompliance with active road surface drainage (040.04.c.ii). We observed one instance of noncompliance with rules pertaining to active road surface maintenance (040.04.c.iii), active road surface materials (040.04.c.v), and winter road maintenance (040.05.b).

Table 7. Summary of compliance with road maintenance and winter operation rules.

IDAPA 20.02.01 Rule	Description	Instances	Complied	Percent
040.04.a	Debris entry to streams	40	37	93
040.04.b	Sediment source stability	40	37	93
040.04.c.i	Active road—culverts and ditches	40	40	100
040.04.c.ii	Active road—surface drainage	40	38	95
040.04.c.iii	Active road—surface maintenance	40	39	98
040.04.c.iv	Active road—wet-period hauling	39	39	100
040.04.c.v	Active road—surface materials	39	38	97
040.04.e.i	Inactive road—drainage	6	6	100
040.04.f.i	Long-term inactive road—drainage	4	4	100
040.04.f.ii	Long-term inactive road—blockage	4	4	100
040.04.f.iii	Long-term inactive road—fill stability	4	4	100
040.04.g.i	Abandoned road—drainage structures	5	5	100
040.04.g.ii	Abandoned road—compaction	4	4	100
040.04.g.iii	Abandoned road—fill slopes	4	4	100
040.04.g.iv	Abandoned road—sidehill fills	4	4	100
040.04.g.v	Abandoned road—ditches	4	4	100
040.04.g.vi	Abandoned road—bare areas	4	4	100
040.05.a	Winter road—drainage	25	25	100
040.05.b	Winter road—maintenance	26	25	96

Chemical and Petroleum Product Rules (IDAPA 20.02.01.060.02, 060.05, and 060.11)

We assessed compliance with nine chemical and petroleum product rules (Table 8). We observed three instances of noncompliance involving failure to remove petroleum or nonbiodegradable waste (060.02.c), oil, and grease containers.

Table 8. Summary of compliance with chemical and petroleum product rules.

IDAPA 20.02.01 Rule	Description	Instances	Complied	Percent
060.02	Petroleum storage	1	1	100
060.02.a	Petroleum transfer	1	1	100
060.02.b	Petroleum equipment maintenance	1	1	100
060.02.c	Petroleum waste products	50	47	94
060.05.a.i	Chemical-mixing water gap	1	1	100
060.05.b.i	Chemical-mixing location	1	1	100
060.05.b.ii	Chemical mixing on landings	1	1	100
060.05.b.iii	Chemical rinse and wash water	1	1	100
060.11	Chemical container disposal	1	1	100

2.3.4 Compliance Results Summary

The 2012 Audit data indicate that overall compliance rates remain high (99%) in the state and federal ownership categories and have increased in the private-industrial (99%) and private-nonindustrial categories (96%). In the 43 operations visited, the intent of the Idaho FPA Rules was surpassed in 17, met in 25, and not met in one due to lack of road maintenance. Factors contributing to sales exceeding the intent of the Idaho Forest Practices Act are the Sustainable Forestry Initiative and Forest Stewardship Council certification programs and the 300-foot buffers on federal lands. Shade and leave-tree requirements were observed to be met on all of the timber sales we visited.

2.4 Compliance Results Discussion

The erosion-control practices we observed were effective when implemented and maintained. We observed sediment delivery to streams in two timber sales. In both instances, the delivery was from roads and occurred at or near stream crossings. Overall however, road surfacing with gravel or crushed rock, drainage features such as rolling dips and water bars, and SPZ road abandonment were observed to be effective erosion-control practices, particularly in areas with granitic soils. Slash mats were observed to be effective in controlling erosion on trails. Recreation activities (e.g., off-road vehicles and camp sites) and grazing were observed to compromise erosion-control features in approximately one-half of the timber sales we visited.

Stream classification under the Idaho FPA Rules and stream status under the Clean Water Act were topics discussed on a number of occasions during the audit. The primary issue involved the availability and dissemination of this information to landowners or operators at the time a forest-practices notification is submitted. The IDL Supervisory Area staff should have enhanced capability to notify landowners and operators that streams within their operation are Class I or II and whether or not they have a total maximum daily load for a particular pollutant.

2.4.1 Rule Interpretation Question

Does reuse of an existing SPZ road to move equipment require a variance? Rule 030.07.c states "operation of ground-based equipment shall not be allowed in the stream protection zone except for approaches to stream crossings." Rule 040.02.h states in part "…reusing existing roads in the stream protection zones for hauling fully-suspended logs only, where no reconstruction will occur, does not require a variance." Clarification to address this question would be useful in instances where an existing SPZ road was used to move equipment on a trailer and no variance was obtained.

2.5 Compliance Recommendations

The audit team recommends the following based on observations made during the rule-compliance portion of the 2012 audit:

1. Enhance the capability of IDL Supervisory Area staff to inform landowners and operators of the stream classification and total maximum daily load status of streams within or bordering their proposed forest practice at the time the notification is submitted. This classification and stream status notification will require collaboration between IDL and DEQ.

2. Address whether a variance is needed in instances where an existing SPZ road is used to haul equipment.
3. Pursue solutions to recreation- and grazing-induced damages to erosion-control features.
4. Continue work to revise the existing shade rule.

3 Effective Shade-Tree Density Assessment

3.1 Shade Assessment Scope

During the February 2012 meeting of the Idaho Forest Practices Act Advisory Committee, it was proposed that measurements of effective shade and adjacent tree density be made to support shade rule revision efforts. This proposal was endorsed, and these measurements were made as part of the 2012 Audit. These data were gathered by the audit stream team while the compliance team inspected the sale area. We view this work as a pilot study for assessing the future revised shade rule.

3.2 Shade Assessment Methods

3.2.1 Data Collection

The 2012 audit team used the same methods for data gathering that were used in the 2008 audit to allow potential combinations of the data sets. We gathered mid-channel effective shade and riparian tree data within the SPZ on Class I streams. Once inside a timber sale cutting unit, we located the Class I stream and cutting-unit boundary. From the cutting-unit boundary, roughly 25 feet were paced off to systematically establish the initial effective shade measurement point and transect location (labeled transect A). Left and right banks were designated facing upstream. After identifying the ordinary high-water mark on each streambank, bank-full channel width was measured perpendicular to the direction of stream flow and recorded. Based on the bank-full width, effective shade was measured at the channel midpoint using a Solar Pathfinder. The Solar Pathfinder was placed as close as possible to the ordinary high-water mark height, leveled, and aligned facing magnetic south (Solar Pathfinder 2008). Once situated, the reflection on the Solar Pathfinder dome was cleared of equipment and personnel. A digital photograph of the reflective dome was then taken and the date, latitude, and longitude coordinates were recorded. Percent effective shade for April through September was estimated using Solar Pathfinder Assistant Software version 5.0.10 (Solar Pathfinder 2011). Photographs of the left and right bank were taken to document the riparian vegetation at the transect location. An azimuth reading perpendicular to the flow of the stream was obtained and recorded to determine the direction of the linear transect. At the ordinary high-water mark on each bank, a measuring tape was run 75 feet along the azimuth reading, marking off three zones of 25 feet (zone 1: 0–25; zone 2: 25–50; zone 3: 50–75 feet). Each of the three zones measure 25 x 25 feet, 25 feet along the tape, and 12.5 feet on either side for a total fixed-area plot of 75 feet long x 25 feet wide. In the first two sales audited, we only established a transect on the side of the stream where cutting units were located as was done in 2008. However, questions posed by audit team members and observers demonstrated the need to establish transects on both stream sides regardless of whether timber harvesting had occurred or not. All trees (conifers and hardwoods) with a DBH $\geq$ 4 inches within

the three zones were measured to the nearest tenth of an inch DBH, identified to species, and classified by health (e.g., live, dead, or stump). Trees with a center mass at 12.5 feet from the tape were included as were freshly cut stumps. From the initial mid-channel point, we measured 125 feet following stream to establish the next transect, and the process was repeated until 5 transects had been completed (500 feet of stream was covered).

3.2.2 Data Assessment

Our objective in this assessment was to identify associations between mid-channel effective shade and tree density within the SPZ. We quantified tree density as trees per acre, relative tree density (Curtis 2010), and relative stocking (Teply 2012). We presumed a timber sale approximates a mixed-age stand of trees. Relative tree density per acre, expressed as RD_{sum}, is calculated using the equation: $RD_{sum} = 0.00545415 * \Sigma(d_i^{1.5})/\text{area}$, where d_i is the DBH of an individual tree, summed for all trees ≥ 4 inches DBH within the fixed-area plots, and the area is total area sampled in acres (Curtis 2010). Relative stocking (Teply 2012) is the percent of theoretical maximum tree density expressed as RD_{sum} (Curtis 2010). Effective shade and tree data from 37 timber sales audited in 2012 were combined with three sales audited in 2008. To achieve equal sample sizes, we only included data from live trees on timber sales where both streambanks were assessed with five transects (Figure 3). Data gathered from the five transects were averaged to produce a sale mean. We then calculated Pearson correlation coefficients between effective shade and three tree-density metrics to identify statistically significant (alpha < 0.05) associations and produced scatterplots of these data. We compared April-September effective shade, RD_{sum}, live trees per acre, relative stocking, quadratic mean diameter (Curtis and Marshall 2000), and bank-full channel width. Quadratic mean diameter is calculated using the equation: quadratic mean diameter $= \sqrt{(\Sigma d_i^2)/n}$, where d_i is the DBH of an individual tree, summed for all trees ≥ 4 inches DBH within the fixed-area plots and n is the count of individual trees (Curtis and Marshall 2000). Quadratic mean diameter and bank-full channel width were included as potential covariates.

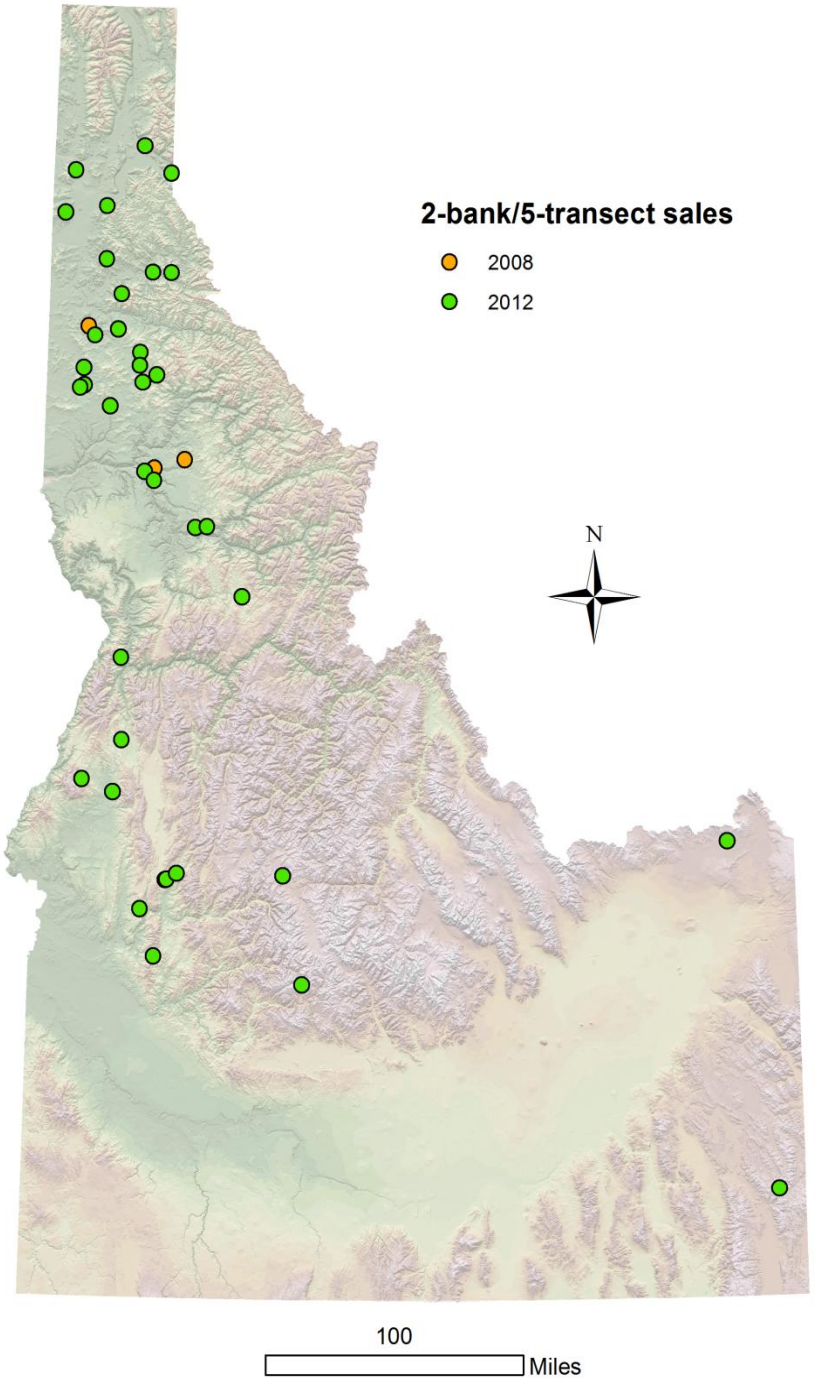

Figure 3. Locations of 2008 and 2012 timber sale data collection events used in assessing effective shade and SPZ tree associations.

3.3 Shade Assessment Results

The audit team observed statistically significant, positive associations between effective shade and RD_{sum} (Figure 4), relative stocking (Figure 5), and live trees per acre (Figure 6). Nonsignificant associations were observed between effective shade and quadratic mean diameter (correlation = 0.262, *p-value* = 0.103) and average bank-full width (correlation = -0.277, *p-value* = 0.084). Of these comparisons, the strongest correlation was between effective shade and RD_{sum}.

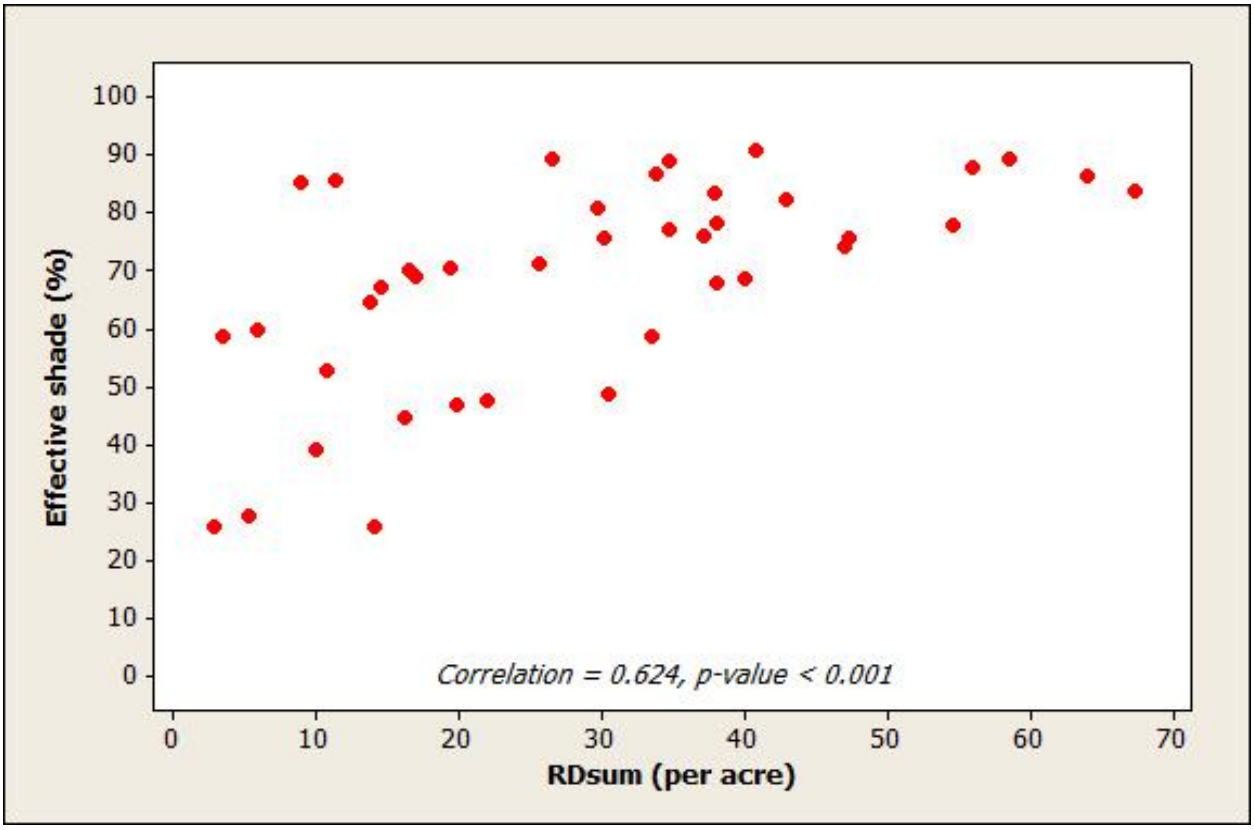

Figure 4. Scatterplot of April–September percent effective shade versus RD_{sum} (Curtis 2010).

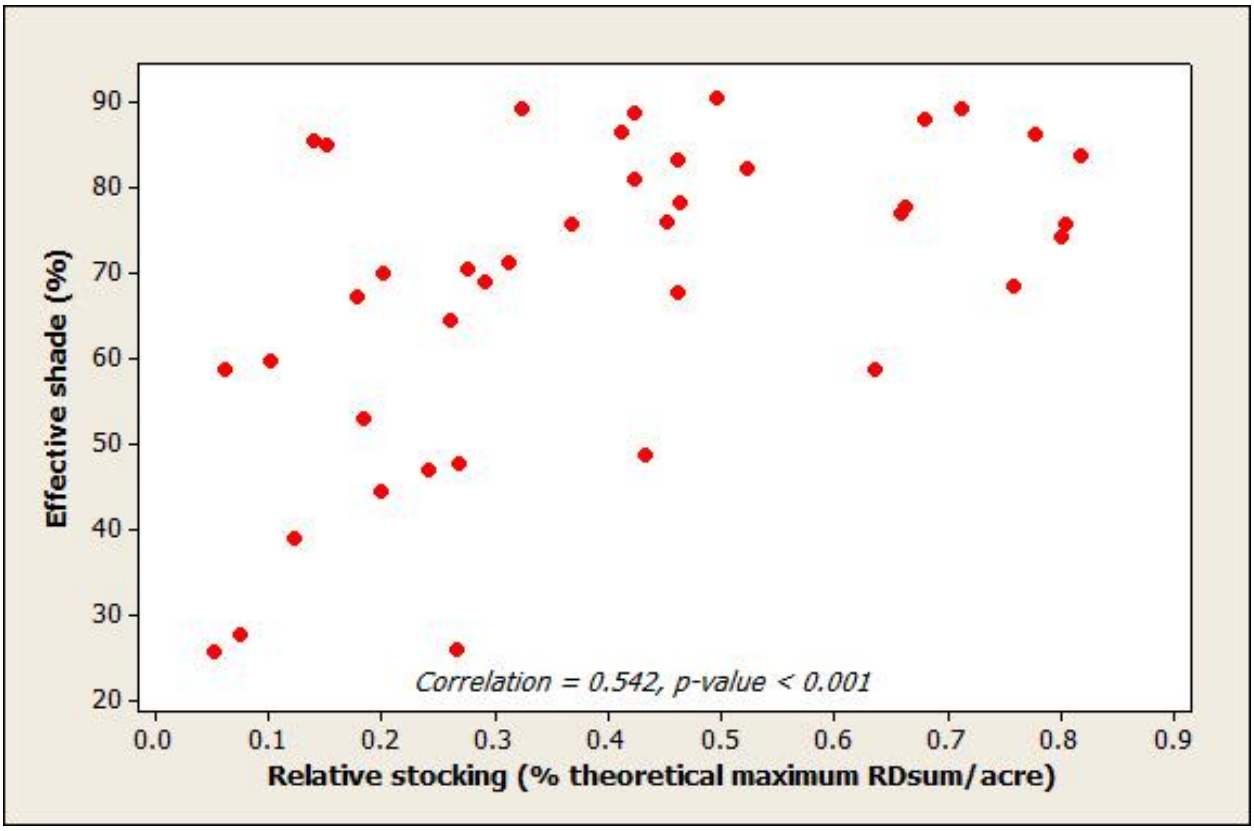

Figure 5. Scatterplot of April–September percent effective shade versus relative stocking (Teply 2012).

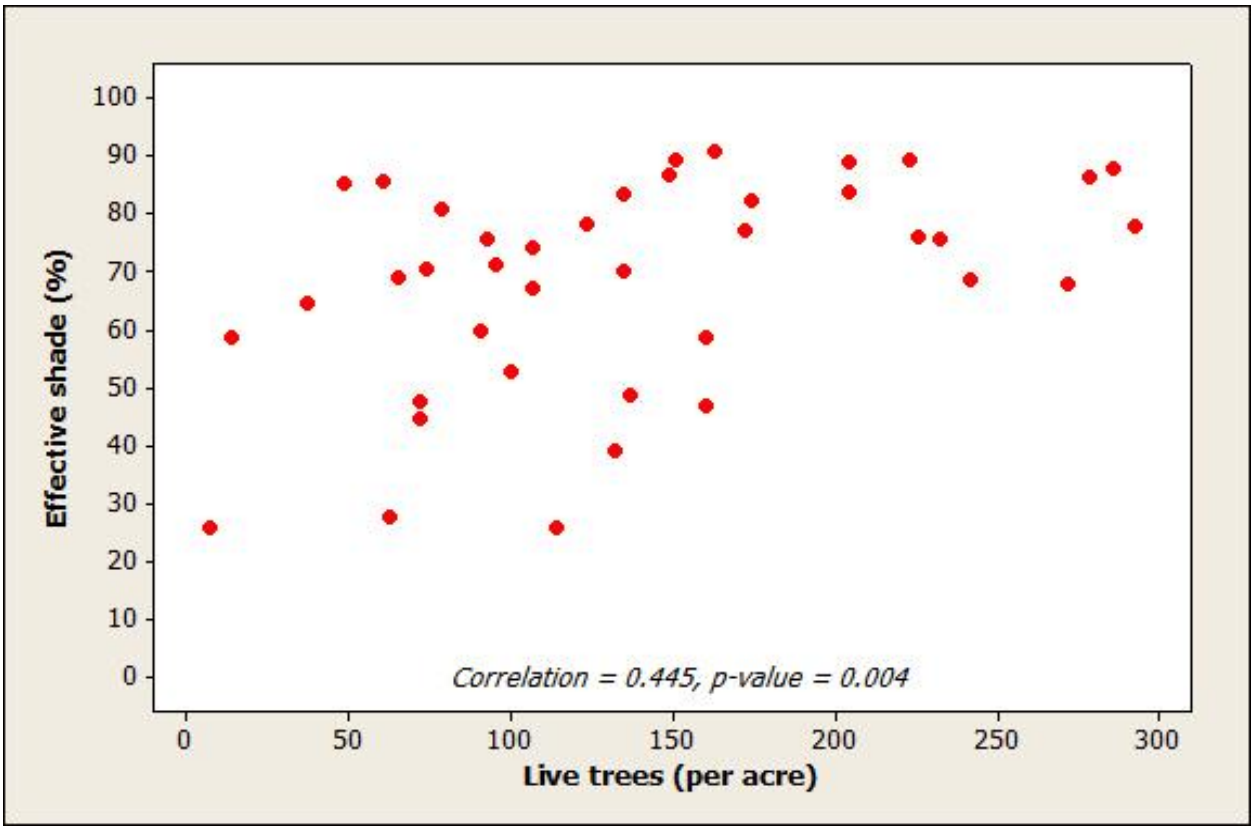

Figure 6. Scatterplot of April–September percent effective shade versus live trees per acre.

3.4 Shade Assessment Discussion

3.4.1 Data Limitations

A number of limitations must be recognized to appropriately interpret these data. All of these sampling events are associated with timber harvest. Therefore few, if any, natural background conditions are represented in these data. We have no preharvest data. These data represent only four of the five Idaho forest types described by Teply (2012). The forest types (number of sales) represented are the northern Idaho grand fir–western redcedar (23), central Idaho grand fir–western redcedar (4), southern Idaho grand fir–western redcedar (8) and Douglas-fir (5). The western hemlock–subalpine fir forest type is not represented in these data. These data are predominantly from the relatively wet northern Idaho grand fir–western redcedar forest type and do not adequately represent the drier southern Idaho forests.

3.4.2 Confounding Factors

While compiling these data, we noticed a number of transects where no trees ≥ 4 inches DBH were located within the fixed-area plot, but effective shade was measured. This shade was provided by such features as trees outside the 25 x 75 foot plot, smaller (< 4 inches DBH) trees, shrubs, grass, streambanks, or hillsides. Two timber sales have particularly high effective shade and low tree density. On one of these, shade was from shrubs on three transects, and rocky cliffs

provided shade on a fourth. On the other, small trees or brush provided the shade and each transect was influenced by a road (Figure 7).

3.5 Shade Assessment Recommendations

The audit team recommends the following for assessing the effectiveness of the future shade rule once it is implemented:

- Design a study to address the question: what reductions of effective shade are observed when SPZ tree stands are thinned to rule limits?
- Design the study to associate cause and effect. Replications will be needed for each harvest prescription in each forest type.
- Select study sites that have a 100-foot no-cut buffer as the initial condition (control plot), similar to the modeling used in rule development.
- Ensure the fixed-area plots are large enough to include the trees providing the stream shade.
- Consider measuring all trees ≥ 3 inches DBH to potentially strengthen the association between effective shade and tree density.

Figure 7. Photo of right streambank, transect A from the Payette_35578D timber sale audited in 2012.

4 References

Bauer, S., D. Almas, M. Johnson, P. Stender, and D. Martin. 1988. *State of Idaho Forest Practices Water Quality Management Plan*. Boise, ID: Idaho Department of Health and Welfare, Division of Environment.

Bauer, S., D. Jones, D. Almas, V. Moore, D. Obee, J. Griffith, D. McGreer, M. Cook, and P. Jahn. 1985. *Silvicultural Nonpoint Source Task Force Final Report*. Boise, ID: Idaho Department of Health and Welfare, Division of Environment.

Curtis, R.O. 2010. "Effect of Diameter Limits and Stand Structure on Relative Density Indices: A Case Study." *Western Journal of Applied Forestry* 25:169-175.

Curtis, R. O. and D. D. Marshall. 2000. Why Quadratic Mean Diameter? *Western Journal of Applied Forestry* 15:137-139.

Dailey, G., C. Bidondo, and T. Maguire. 1999. *Idaho Nonpoint Source Management Plan*. Boise, ID: Idaho Division of Environmental Quality.

DEQ (Idaho Department of Environmental Quality). 2008. Memorandum of Understanding Implementing the Nonpoint Source Water Quality Program in the State of Idaho. Boise, ID: DEQ.

Harvey, G., S. Hess, L. Jones, D. Krutina, D. McGreer, W. Reid, D. Stockton, and J. Thornton. 1989. *Final Report: Forest Practices Water Quality Audit – 1988*. Boise, ID: Idaho Department of Health and Welfare, Division of Environmental Quality.

Hoelscher, B.G., J. Colla, M. Hanson, J. Heimer, D. McGreer, S. Poirier, and J. Rice. 1993. *Forest Practices Water Quality Audit – 1992*. Coeur d'Alene, ID: Idaho Department of Health and Welfare, Division of Environmental Quality.

Hoelscher, B.G., J. DuPont, J. Hinson, D. McGreer, C. Robertson, and D. Schult. 2001. *Forest Practices Water Quality Audit – 2000*. Boise, ID: Idaho Department of Environmental Quality.

Idaho Code. 2009. "Forest Practices Act." Idaho Code 38-13.

IDAPA. 2009. "Rules Pertaining to the Idaho Forest Practices Act." Idaho Administrative Code. IDAPA 20.02.01.

McIntyre, M.J., J. Colla, and A. Moody. 2007. *2004 Interagency Forest Practices Water Quality Audit Final Report*. Boise, ID: Idaho Department of Environmental Quality.

Solar Pathfinder. 2008. *Instruction Manual for the Solar Pathfinder™*. Linden, TN. Available at *www.solarpathfinder.com*.

Solar Pathfinder. 2011. *Solar Pathfinder™ Assistant Software Users Manual.* Version 5. Linden, TN.

Teply, M. 2012. *Using Stream Shade and Large Wood Recruitment Simulation Models to Inform Forest Practices Regulations in Idaho*. Lacey, WA: Cramer Fish Sciences.

Zaroban, D.W. and B. Prisock. 2009. *Idaho 2008 Interagency Forest Practices Water Quality Audit: Rule Compliance and Stream Crossing Assessments*. Boise, ID: Idaho Department of Environmental Quality.

Zaroban, D.W., B. Love, J. Colla, G. Lesch, J. Heimer, J. Lehner, B. Lukens, S. Poirier, B. Lee, and K. David. 1997. *Forest Practices Water Quality Audit – 1996*. Boise, ID: Idaho Department of Health and Welfare, Division of Environmental Quality.

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Appendix A: Idaho Forest Practices Rules Audited in 2012

IDAPA 20.02.01 Rule	Rule Group	Description
020.01.a.i	General	Variance request
020.01.a.ii	General	Variance determination (within 14 calendar days)
020.01.a.iii	General	Equivalent or better productivity, water quality, and habitat results
020.01.b	General	Compliance with Stream Protection Act, water quality standards, pesticide, and hazardous waste
030.03	Harvest	Soil protection
030.03.a	Harvest	Ground-based skidding on gradients > 45%
030.03.b	Harvest	Maximum 30% grade on constructed skid trails
030.03.c	Harvest	Minimize skid trail width and number
030.03.d	Harvest	Downhill cable-yarding limitation
030.04	Harvest	Location of landings, skid, and fire trails
030.04.a	Harvest	Locate landings, trails on non-stream protection zone (SPZ) stable areas; minimize sidecasting
030.04.b	Harvest	Minimize landing size
030.04.c	Harvest	Landing fill free of loose stumps and slash
030.05	Harvest	Provide and maintain drainage system for landings, skid, and fire trails
030.05.a	Harvest	Stabilize and maintain skid and fire trails
030.05.b	Harvest	Reshape and stabilize landings
030.06	Harvest	Prevent road maintenance debris from entering streams
030.06.a	Harvest	Slash removal from Class I streams
030.06.b	Harvest	Slash removal from Class II streams
030.06.c	Harvest	Deposit landing and trail waste outside of SPZ
030.07	Harvest	Streambed and riparian vegetation protection
030.07.a	Harvest	Site-specific lake riparian management prescription
030.07.b	Harvest	No skidding through streams without temporary crossing
030.07.c	Harvest	No ground-based operations in SPZ
030.07.d	Harvest	Minimize streambank and channel disturbance in SPZ
030.07.e	Harvest	Provide for large organic debris (LOD), shade, and cover along streams
030.07.e.i	Harvest	Leave hardwood trees, shrubs, grasses for stream shade
030.07.e.ii	Harvest	Leave 75% current shade over Class I streams; limit re-entry
030.07.e.iii	Harvest	Maintain LOD over Class I streams
030.07.e.iv	Harvest	Leave p ortions of naturally fallen trees over Class I streams
030.07.e.v	Harvest	Remove non-LOD slash from streams—030.06 consistent
030.07.e.vi	Harvest	Standing tree requirement
030.07.e.vii	Harvest	Leave snags

IDAPA 20.02.01 Rule	Rule Group	Description
030.07.e.viii	Harvest	Standing tree, shade variance
030.07.e.ix	Harvest	Opposite side standing tree requirement
030.07.f	Harvest	Hand pile burns only in SPZ
030.07.f.i	Harvest	Hand piles 5 feet from ordinary high-water mark
030.07.f.ii	Harvest	No mechanical slash piles in SPZ
030.08	Harvest	Harvest practices protect productivity, soil, air, water, wildlife resources
030.08.a	Harvest	Maintain scenic values
030.08.b	Harvest	Preserve critical habitat
030.08.c	Harvest	Avoid wet areas
030.08.d	Harvest	Clear cuts with adequate wildlife escape cover within 0.25 mile
040.02.a	Road construction	Plan to avoid roads in SPZ
040.02.b	Road construction	Plan roads no wider than necessary
040.02.c	Road construction	Plan roads to drain naturally
040.02.d	Road construction	Plan culverts and ditches to protect running surface
040.02.e	Road construction	Temporary culvert removal
040.02.e.i	Road construction	Culverts provide fish passage
040.02.e.ii	Road construction	Culverts designed for 50-year peak flow
040.02.e.iii	Road construction	Minimum 12-inch culvert diameter
040.02.g	Road construction	Minimum number of stream crossings; comply with Stream Channel Protection Act
040.02.h	Road construction	Variance required for reconstruction of existing road in SPZ
040.03	Road construction	Prevent road debris from entering streams
040.03.a	Road construction	Constructed roads comply with 040.02 (planning guidelines)
040.03.b	Road construction	Clear road construction debris and deposit outside the SPZ
040.03.c	Road construction	Stabilize exposed areas
040.03.d	Road construction	Compact road fill
040.03.e	Road construction	Retain outslope drainage; remove berms
040.03.f	Road construction	Provide quarry drainage
040.03.g	Road construction	Minimize erosion of embankments; at least 1% grade in relief culverts
040.03.h	Road construction	Postpone earthwork or hauling during wet periods
040.03.i	Road construction	Minimize cutslope sloughing
040.03.j	Road construction	> 60% grade roads full benched; variance required if not full-benched
040.04	Road maintenance	Conduct regular maintenance
040.04.a	Road maintenance	Prevent road maintenance debris from entering streams
040.04.b	Road maintenance	Repair/stabilize slumps and slides
040.04.c.i	Road maintenance	Active roads: culverts/ditches functional
040.04.c.ii	Road maintenance	Active roads: surface maintenance at end of season

IDAPA 20.02.01 Rule	Rule Group	Description
040.04.c.iii	Road maintenance	Active roads: maintain proper drainage; minimize subgrade erosion
040.04.c.iv	Road maintenance	Active roads: postpone hauling during wet periods
040.04.c.v	Road maintenance	Active roads: prevent surface materials from entering streams
040.04.e.i	Road maintenance	Inactive roads: ditches, culverts, surface and drainage maintained
040.04.f.i	Road maintenance	Long-term inactive roads: control erosion
040.04.f.ii	Road maintenance	Long-term inactive roads: blocked
040.04.f.iii	Road maintenance	Long-term inactive roads: landowner maintain bridges/culverts
040.04.g	Road maintenance	Abandoned roads: remove drainage structures and minimize erosion
040.04.g.i	Road maintenance	Abandoned roads: restore stream gradient to natural slope
040.04.g.ii	Road maintenance	Abandoned roads: break up compacted areas
040.04.g.iii	Road maintenance	Abandoned roads: SPZ fill slopes pulled back to stable
040.04.g.iv	Road maintenance	Abandoned roads: sidehill fills pulled back to stable
040.04.g.v	Road maintenance	Abandoned roads: control ditch line erosion
040.04.g.vi	Road maintenance	Abandoned roads: stabilize bare earth areas
040.05.a	Winter operations	Install drainage prior to winter
040.05.b	Winter operations	Maintain surface drainage during thaws and breakup
060.02	Chemicals	Keep containers > 200 gallons more than 100 feet from open water
060.02.a	Chemicals	Transfer operations shall be attended and should not be near open water
060.02.b	Chemicals	Maintain petroleum equipment in leak proof condition
060.02.c	Chemicals	Petroleum waste shall be removed and properly disposed
060.05.b.i	Chemicals	Mix where spills will not enter streams
060.05.b.ii	Chemicals	Locate landings where spills will not enter streams
060.05.b.iii	Chemicals	Recover/reuse wash water or dispose according to state/federal law
060.11	Chemicals	Containers cleaned and removed from the forest; no burning