MONITORING FINE SEDIMENT: GRANDE RONDE AND JOHN DAY RIVERS

Annual Report for 1998

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INTRODUCTION

Fine sediment levels in spawning substrate have a major effect on salmon survival from egg to smolt (Bjornn and Reiser, 1991). Assessments have consistently concluded that fine sediment is a major problem for salmon in the Grande Ronde (Anderson et al., 1993; NMFS, 1993; Huntington, 1994; Mobrand et al., 1995) and, to a lesser extent, the John Day rivers (OWRD, 1986). It is likely that fine sediment levels in these rivers must be reduced if salmon survival from egg to smolt is to be increased. The NMFS Biological Opinion for the USFS Land and Resource Management Plans (LRMPs) (NMFS, 1995) and the salmon recovery plan of Columbia River basin Treaty Tribes (CRITFC, 1995) both set goals for surface fine sediment in spawning habitat at <20%. The NPPC's (1994) recovery plan sets a goal of <20% fine sediments in salmon redds. However, despite these goals for fine sediment and the documented sediment-related problems, baseline and trends in surface fine sediment are not being monitored in these rivers. This project was initiated, with funding from the Bonneville Power Administration in 1998, to monitor surface fine sediment levels and overwinter intrusion of fine sediment into cleaned gravels in artificially constructed redds in spawning habitat. The project is also investigating the potential relationship between surface fine levels and overwinter sedimentation in cleaned gravel, possibly resulting in a more cost-effective monitoring tool than coring or other extractive, bulk substrate sampling methods.

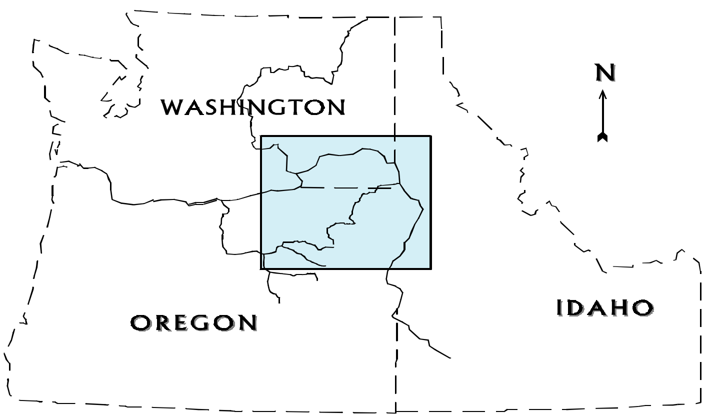
For five years, the project will annually measure surface fines and overwinter sedimentation during the incubation period in spawning gravels in the John Day and Grande Ronde Rivers. This will allow assessment of the following: 1) whether there is a trend in substrate conditions in spawning habitat in monitored reaches, and if so, whether it is consistent with efforts to reduce sedimentation and improve habitat conditions; 2) whether there is a relationship between levels of mobile surface fine sediment and the magnitude of fine sediment intrusion into cleaned spawning gravels; 3) whether substrate conditions and trends are in keeping with the quantitative substrate objectives of regional approaches to habitat restoration and protection (NPPC, 1994; NMFS; 1995; CRITFC, 1995).

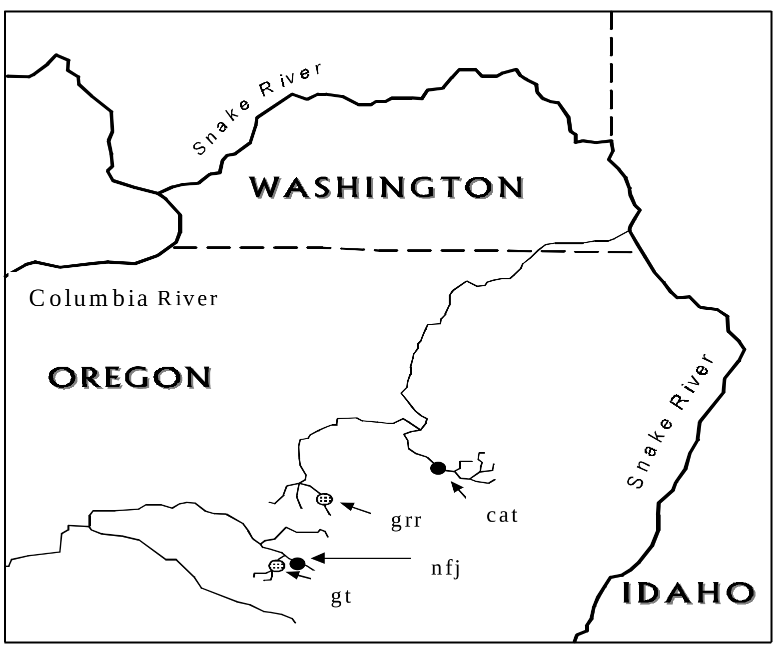
The proposal will also test the following additional hypotheses: 1) the aggregate effectiveness of land management is adequate to meet fine sediment/substrate goals, prevent degradation of substrate conditions, and allow improvement in substrate conditions; 2) overwinter sedimentation in salmon redds is not occurring at magnitudes that reduce salmon survival; 3) watersheds with differing magnitudes of land disturbance, such as logging and road construction, do not have significantly different levels of surface fine sediment nor significantly different levels of overwinter sedimentation in cleaned gravels in spawning habitat; 4) temporal trends in surface fine sediment levels and the magnitude of overwinter sedimentation are not significantly different in watersheds with differing levels of land disturbance. Additionally, the project will also quantify the magnitude of overwinter sedimentation in cleaned gravels and use this data to estimate salmon survival from egg to emergence.

DESCRIPTION OF PROJECT AREA

The study reaches are in spawning habitat for spring chinook salmon in the Grande Ronde River, Catherine Creek (a Grande Ronde River tributary), the North Fork John Day River (NFJDR) and Granite Creek (tributary to the NFJDR). The general locations of the monitored streams and the study areas are shown in Figure 1.

Figure 1. General location of monitored reaches. Codes are as follows: grr = Grande Ronde River; cat = Catherine Cr.; nfj = NFJDR; gt = Granite Cr.





The area of Grande Ronde River watershed above the monitoring locations is about 90 km^2 and ranges in elevation from about 1200 m to 2400 m. The watershed is predominantly forested with mixed conifers. Soils are primarily derived from granitic parent materials. Snow is the dominant form of precipitation and spring snowmelt comprises the bulk of the annual hydrograph. The watershed of the upper Grande Ronde River has been extensively grazed, logged, and roaded over the past 30 years (Anderson et al., 1993; McIntosh et al., 1994). Portions of the floodplain and river were dredge-mined, in the early 1900s (McIntosh et al., 1994). Parts of the watershed have been burned by wildfire over the past 10 years; flash floods from thunderstorms have also affected spawning and rearing areas. Most of the watershed above the sampling areas is on the Wallowa-Whitman National Forest (WWNF).

The monitoring sites for surface fine sediment and overwinter sedimentation in the Grande Ronde River are located upstream of the decommissioned Woodley Creek Campground to the west of USFS Road 5125 on the WWNF. The latitude and longitude, as measured using a global positioning system (gps) unit, of the monitored transects within the study reaches in the upper Grande River are shown in Tables 1 and 2.

The watersheds of the other three streams monitored are broadly similar to the Grande Ronde with respect to vegetation, geology, and climate. However, the ownership patterns, watershed area, and intensity of land use vary among watersheds.

The watershed area of Catherine Creek, above the most downstream monitoring site, is about 240 km^2. Much of the Catherine Creek watershed is within wilderness. Most of the watershed is grazed. Outside of the wilderness, the watershed has been logged and roaded but to a lesser extent than the Grande Ronde River watershed. The most downstream monitoring sites on Catherine Creek are located to the east of state highway 203 at a latitude of 45^o 4.17’ N and longitude of 118^o 42.55’ W. The most upstream monitoring sites are on the North Fork, upstream of the confluence of the South Fork of Catherine Creek, south of USFS Road 7785. The latitude and longitude of the monitoring sites in the study reaches in Catherine Creek are shown in Tables 1 and 2. Most of the watershed is on the WWNF.

The watershed area of the NFJDR above the most downstream monitoring site is approximately 80 km^2. Most of this watershed area is on the WWNF. The watershed has been extensively logged. Most of the watershed is also grazed by livestock. Some sections of floodplains and the stream have been intensively altered by gravel spoils from historic dredge mining. The most downstream monitoring site is to the south of county road 73, on the WWNF, about 0.8 km east of the junction of county road 73 and county road 52. The most upstream sites are also on the WWNF, south of county road 73, about 1.5 km east of the junction of county road 73 and county road 52, at about 44^o 54.63’ N and 118^o23.22’ W.

The watershed area of Granite Creek, above the most downstream monitoring site, is approximately 200 km^2. The watershed of Granite Creek has been extensively roaded and logged. Significant portions of the floodplain and stream, including the areas flanking the monitoring sites, have been intensively altered by dredge mining. Most of the watershed is grazed. Ownership of the watershed is interspersed and includes private land, the WWNF, and the Umatilla National Forest (UNF). The most downstream monitoring site is on the UNF to the south of USFS Road 1035, approximately 1.2 km to the west of the junction with state highway 24. The most upstream monitoring sites are to the south of USFS Road 1035 approximately 0.8 km from the junction with state highway 24. The locations of the monitoring sites are shown in Tables 1 and 2.

Table 1. Locations and site characteristics of areas excavated in Sept. 1998 to mimic redds for monitoring of overwinter sedimentation in clean gravels. "Redd" numbers marked with an asterisk (*) indicate that 3 buckets of cleaned gravels were placed within the excavated site, with one bucket collected in Dec. 1998. Sites marked with quotation marks (") had bulk substrate samples collected by shovel in Sept. 1998.

Stream	"Redd"	Latitude		Longitude		Channel Width	Water Column Depth	Visually estimated surface fine sediment	Notes/Site Description
	No.	degrees	min	degrees	min.	(m)	(m)	(%)	
Grande Ronde	GR1	45	4.28	118	18.82	6.0	0.15	37	Glide tailout downstream of pool @ river bend
Grande Ronde	GR2*"	45	4.18	118	18.83	10.2	0.13	40	Glide tailout below log weir ~200 m upstream of G1
Grande Ronde	GR3	45	4.12	118	18.79	9.9	0.20	10	Tailout below pocket pool
Grande Ronde	GR4*"	45	4.06	118	18.79	6.5	0.10	35	Glide tailout
Grande Ronde	GR5	45	3.99	118	18.8	10.4	0.12	30	Shallow glide tailout.
Catherine Cr.	C1	45	7.92	117	42.55	7.7	0.05	5	Glide tailout downstream of exclosure fence
Catherine Cr.	C2*"	45	7.92	117	42.55	7.7	0.05	5	Glide tailout downstream of exclosure fence
Catherine Cr.	C3*"	45	7.44	117	41.99	13.3	0.12	2	Glide tailout
Catherine Cr.	C4	45	7.48	117	38.78	9.7	0.10	7	Shallow glide tailout
Catherine Cr.	C5	45	7.48	117	41.99	1.2	0.10	7	Shallow glide tailout, ~3 m upstream of C4
NFJDR	N1	gps unit battery down				10.6	0.14	25	Glide tailout below overhanging LWD
NFJDR	N2	gps unit battery down				8.05	0.10	20	Glide tailout
NFJDR	N3	gps unit battery down				11.3	0.10	15	Shallow glide tailout at riffle transition
NFJDR	N4"	gps unit battery down				10.3	0.10	30	Shallow glide tailout near N. bank
NFJDR	N5	gps unit battery down				10.1	0.07	30	Shallow glide tailout near N. bank
Granite Cr	GT1	44	49.75	118	27.43	7.7	0.15	6	Glide tailout
Granite Cr	GT2	44	49.49	118	27.3	10.0	0.10	10	Glide tailout
Granite Cr	GT3""	44	49.5	118	27.24	9.6	0.10	10	Glide tailout
Granite Cr	GT4	none taken				7.5	0.13	8	Shallow glide tailout at riffle transition
Granite Cr	GT5	none taken				7.5	0.13	8	Shallow glide tailout at riffle transition

METHODS AND MATERIALS USED

<u>Previous monitoring: 1992-1995</u>

Previous to the onset of the present, funded project, we monitored of overwinter sedimentation of fine sediment and surface fine sediment in the Grande Ronde River, Catherine Creek, and NFJDR, during the incubation periods of 1992-1993, 1993-1994, and 1994-1995. Sample collectors were installed in artificial redds after salmon spawning in the fall, and collected after fry emergence. Overwinter sedimentation was monitored by placing cleaned gravels in solid-walled containers in spawning habitat in sites constructed to mimic salmon redds. . This method has been used successfully to monitor fine sediment accumulation in channel substrate in northern California (Lisle, 1989) and provides an indication of the ultimate sediment conditions in salmonid redds (Lisle and Eads, 1991). The relative merits and precision of this method of sampling fine sediment accumulation are discussed by Lisle and Eads (1991). Solid-walled containers prohibit lateral infiltration of very fine sediment into cleaned gravels, and, therefore, the amount fine sediment collected in cleaned gravels solid-walled containers has been considered a minimum estimate of actual amounts (Lisle, 1989). Cleaned gravels typically have larger pores than ambient channel substrate, which tends to increase the depth and amount of infiltration by fine sediment (Lisle, 1989). Although Lisle and Eads (1991) suggested the method may approximate conditions in redds, it is not known to what extent the gravels placed in the containers deviate from those found in actual redds in the streams we monitored.

The solid-walled containers were tapered cylinders with an average diameter of 0.102 m and a height of 0.127 m. The "redds" were constructed in pool or glide tailouts in spawning habitat. The constructed redds had an average area of about 4 m^2 and were designed according to the dimensions described in Bjornn and Reiser (1991). Specialists trained in the identification of redds, provided additional advice on the location and construction of the artificial redds and confirmed that the geometry and size were within the range found in natural salmon redds in the Grande Ronde River (Jeff Zakel, Oregon Dept. of Fish and Wildlife, pers. comm.). Three to six artificial redds were constructed in each stream reach monitored. Gravels with diameters >6.3 mm were taken from the ambient substrate and randomly packed into the containers. Two solid-walled containers of cleaned gravels were emplaced in each constructed redds in the fall after the cessation of spawning and retrieved in the subsequent spring after salmon emergence. The tops of containers were placed about 30 mm below the channel bed surface with a surface layer of gravel over the containers; the containers were placed in locations within the constructed redd where egg centrums are typically encountered, according to Chapman (1988). However, the egg centrums of spring chinook are typically at depths ranging from 0.2-0.3 m (Chapman, 1988), while the deepest part of the containers was at a depth of about 0.16 m

We used a particle diameter of <6.3 mm to define the fine sediment fraction detrimental to salmon survival, after Stowell et al. (1983). However, many descriptors of fine sediment sizes and distribution have been used by a variety of researchers (Young et al., 1991).

The fraction of the streambed covered by fine sediment was visually estimated (Platts et al., 1983), in all monitored reaches during the placement and retrieval of samples. Bauer and Burton (1993) noted that ocular estimates of surface fine sediment can have significant observer bias. Therefore, in the summer of 1995, we tested the accuracy and precision of the ocular estimates of the percent of the streambed covered by surface fine sediment against measurements of surface fine sediment by the "grid method" (Bauer and Burton 1993). The grid method entails placing a sample grid on the channel substrate at equidistant points along a transect across the stream reaches and counting the number of grid intersections that are directly over surface fine sediment and dividing by the total number of intersections to determine the fraction of the surface occupied by fine sediment. In each reach monitored via the grid method, three to five transects were monitored and three to five measurements were taken at each transect. We found that visual estimates of the amount of the substrate surface occupied by fine sediment were relatively accurate and showed no consistent bias. The slope of the linear regression line through points of visually estimated versus measured surface fine sediment (%) by the grid method was 1.0 and the relationship was statistically significant using a *t* distribution to test for the significance of the regression slope ($R^2 = 0.92$; $p < 0.01$); the absolute standard error was 5.0% (Rhodes and Purser, *in press*). Due to the accuracy and precision of the ocular estimates, we subsequently dropped measuring surface fine sediment in every monitored reach via the grid method. For the purpose of analysis, individual estimates of surface fine sediment (%) were combined and averaged for each river reach monitored because the mean represents a more areally-integrated descriptor of fine sediment conditions within the reach than individual estimates at the subreach/transect scale. Fine sediment accumulations within the solid-walled containers were determined using standard methods for particle size analysis. In the Grande Ronde River, streamflow was continuously measured at a stream-gaging station near the sampling points for overwinter sedimentation near the decommissioned Woodley Campground. Stream width, stream gradient, and depth was measured using standard methods (Dunne and Leopold, 1978). All sampling locations were sketched into a schematic map of the monitored reaches.

<u>Present Project: 1998-1999</u>

The present project used the same methods as in previous years, with minor modifications. To increase the accuracy and precision of measurements of overwinter sedimentation, we used larger containers than in previous years. The increased depth of the containers also ensured that the bottom of the containers were within the range of depths that egg centrums within natural redds are typically encountered, according to the data of Chapman (1988) and Bjornn and Reiser (1991).

The solid-walled containers were tapered cylinders with an diameter of 0.18 m at the opening, a bottom diameter of 0.16 m, and a height of 0.185 m. The larger size container increases the individual sample volume by more than four times, relative to previous years.

Delays in project funding resulted in the project being initiated in Jan. 1998. This precluded sampling during the 1997-1998 incubation season for three reasons. First, sampling overwinter sedimentation could not be accurately measured by sampling over only a portion of the incubation period. Second, placing samplers into the stream channel mid-winter presented significant logistical problems and safety risks. Third, during higher winter flows, there was a risk of disturbing incubating eggs during sampling in the incubation season. For these reasons, the delays in project funding forced us to defer sampling until the fall of 1998.

The artificial "redds" were excavated Sept. 5-6, 1998. The tops of the sample containers were placed about 30 mm below the surface of the channel substrate, as in previous years. Five "redds" were excavated in each stream monitored. Two containers of cleaned gravel were buried in each "redd," except for two "redds" each in the Grande Ronde and Catherine Creek, which had three containers so that one could be collected during the winter to provide some indication of the rate of sedimentation during the incubation period. These four samples were collected in early December 1997 and are being analyzed using standard particle size analysis methods. The latitude and longitude of the constructed "redds" were estimated using a hand-held gps unit. All other methods related to the monitoring of overwinter sedimentation remained the same as in prior years.

While the method for determining the particle sizes in samples of overwinter sedimentation is unchanged, we are analyzing all samples of overwinter sedimentation and bulk substrate for the percent composition in four particle size classes, rather than just the percent by weight < 6.35 mm in diameter, as in previous years. The results of monitoring will be reported as percent by weight in the following four size classes: 1) diameter >6.35 mm; 2) diameter <6.35 mm; 3) diameter <2.0 mm; 4) diameter <0.85 mm. These size fractions are being analyzed to provide greater detail on sedimentation and to use the data of Reiser and White (1988) to estimate the survival of salmon from egg-to-fry.

Surface fines were monitored concurrent with excavation and construction of artificial redds in Sept. 1998. In each stream monitored, the grid method was used at 10 transects across riffles at locations upstream the sites for monitoring overwinter sedimentation. At each transect, five measurements were taken at equidistant points across the channel width. Surface fines at each transect were visually estimated prior to measurement. To improve the accuracy of the grid counts, a below-water viewer was used for counting grid intersections. The latitude and longitude of transects where surface fines were measured, were recorded using a gps unit. Where latitude and longitude readings from the gps were not taken due low batteries, readings will be taken in the spring after the incubation period, when samples are collected. All other methods for estimating and measuring surface fines were as in previous years. In the forthcoming year, we will also use the pebble count method of Wolman (1954) to assess particle sizes at the surface of the channel substrate. The results of all three methods for assessing surface fine levels will be reported, analyzed, and compared in future reports.

In each stream, two bulk samples of substrate were collected in each stream concurrent with the placement of containers of cleaned gravels in artificial redds and monitoring of surface fine sediment. The bulk samples were collected to provide an indication of particle size distributions at depth, prior to the incubation period. The bulk samples were collected using the shovel. Sampling bulk substrate by shovel in small streams, such as the ones we monitored (3-10 m wide), can be as accurate as other methods, but far less difficult and time-consuming (Grost et al., 1991). The bulk samples are being analyzed using standard particle size methods and will be reported in a forthcoming report.

Sediment accumulations and the particle size of accumulated sediment within the containers of cleaned gravels will be also determined using standard particle size methods. Salmon survival from egg to fry will be estimated from the fine sediment and overwinter sedimentation data via the methods of Stowell et al. (1983), the data of Scully and Petrosky (1991), and the data of Reiser and White (1988).

The results of the monitoring of overwinter sedimentation and surface fines will be investigated using regression analysis and a *t*-distribution to test the hypothesis that surface fines and the magnitude of overwinter sedimentation are related in a statistically significant fashion. This potential relationship will be investigated for two reasons: 1) it can be performed without any additional collection effort; and 2) to investigate whether monitoring of surface fines can be a useful surrogate for monitoring of bulk bed composition to estimate the effects of fine sediment on salmon survival. Bulk sampling of substrate is time-consuming (Grost et al., 1991). In contrast, surface fines within a reach can be measured using the grid method in approximately 25 minutes using five randomly spaced measurement points across three transects within a reach. Further, in order to estimate effects on redds during incubation via bulk sampling of substrate, repeated sampling and subsequent analysis is required (Lisle and Eads, 1991. Therefore, if there is a valid relationship between surface fines and intrusion levels in some streams, measuring surface fines alone may be adequate to assess relative trends in habitat condition and salmon survival at a fraction of the expense and effort related to repeated bulk substrate sampling.

The results of surface fine measurements and visual estimates were analyzed via linear regression and *t*-distribution to perform a one-tailed test of the hypothesis that they are related in a statistically significant fashion. Confidence intervals generated at given probability levels were used to test whether it appears that the surface fine sediment goals of CRITFC (1994) and NMFS (1995) are met, based on the measurements of surface fines in the monitored streams. Both of these tests were made treating transect means of measured surface fines as a single sample. Future analyses will include treatment of all measurements of fine sediment within the sample streams in tests of whether substrate goals appear to met, based on the monitoring data. Additionally, the surface fine sediment measurements will used to test whether the sample means in the four rivers appear to be statistically different.

Variability within and among sample sites will also be analyzed in the future using standard statistical methods. Initial estimates of variability will be used to estimate the number of samples needed in future investigations to generate a given level of statistical significance at given probabilities of "type I and II" errors using standard statistical methods (Benjamin and Cornell, 1970). Trend analysis will be analyzed via standard regression methods.

On the administrative end, a biological assessment (BA) of the project’s effects was prepared for use in project consultation with NMFS under the Endangered Species Act

(ESA). The BA was prepared using the same format and approach as the Catherine Creek Biological Assessment (La Grande Ranger District, 1994a) and the Upper Grande River Biological Assessment (La Grande Ranger District, 1994b). The project BA tiered to La Grande Ranger District (1994a; b) and described potential project effects within the context of project actions, information on the study streams, and scientific literature related to possible effects. The project BA was submitted to BPA and NMFS in August 1998.

RESULTS AND DISCUSSION

The results of the measurement and visual estimates of surface fines in Sept. 1998 are shown in Tables 2, 3, and 4. Based on these results, we again found that visual estimates of the amount of the substrate surface occupied by fine sediment were relatively accurate and showed no consistent bias. For the 1998 data, the slope of the linear regression line through points of visually estimated versus measured surface fine sediment (%) by the grid method was 0.99 and the relationship was statistically significant ($p < 0.01$), using a *t* distribution to test for whether the regression slope is positive. Figure 2 shows the relationship of the measured and visually estimated percent surface fine data collected in 1998. Relative to the results of the 1995 data, the absolute standard error was higher at 6.3% and the R^2 was considerably lower ($R^2 = 0.73$) indicating that visual estimates were not as accurate. Table 3 provides a comparison of the results of the analyses of measured and estimated surface fines in 1995 (Rhodes and Purser, *in press*) and from Sept. 1998. It is possible that visual estimates may not have been as accurate as in previous years due to the lack of calibration by trained observers. In 1995, the trained observers had consistently practiced and calibrated visual estimates for several years. In 1998, the observers had practiced and calibrated visual estimates to a much more limited degreee over the previous two years. Other potential explanation are that the accuracy of measurements of surface fine sediment were improved by the use of the below-water viewer and/or that greater sample numbers better reflected variability in surface fine sediment conditions.

The results of the surface fine sediment measurements (Table 4) indicate that the mean fine sediment levels in the monitored reaches of the Grande River are higher than the <20% surface fine sediment goal set in CRITFC (1995) and NMFS (1995). However, at $p = 0.10$, the calculated confidence interval (CI) around the mean overlaps with the <20% surface fine sediment goal. Therefore, the hypothesis that mean fine sediment levels in the Grande Ronde are higher than 20% is not statistically significant at $p = 0.10$, using transect means as independent sample points. However, at $p = 0.15$, the hypothesis that surface sediment levels in the Grande Ronde River are > 20% can be accepted as true. Other results for the other sampled reaches are shown in Table 4.

Table 2. Locations and results of monitoring of surface fine sediment in Sept. 1998. For locations of constructed "redds," see Table 1.

Stream	Transect	Latitude		Longitude		Channel Width	Mean measured surface fine sediment	Visually estimated surface fine sediment	Location of transect relative to constructed "redds" sites for monitoring overwinter sedimentation
	No.	degrees	min	degrees	Min	(m)	(%)	(%)	
Grande Ronde	1	45	4.17	118	18.81	7.2	42%	37%	7 m upstream of GR1
Grande Ronde	2	45	4.15	118	18.82	7.2	34%	40%	12 m upstream of GR2
Grande Ronde	3	45	4.14	118	18.81	7.2	19%	19%	43 m upstream of GR2
Grande Ronde	4	45	4.08	118	18.76	8.4	27%	13%	22 m upstream of GR3
Grande Ronde	5	45	4.09	118	18.76	6.0	20%	21%	44 m downstream of GR4
Grande Ronde	6	45	4.03	118	18.77	4.8	30%	45%	10 m upstream of GR4
Grande Ronde	7	45	4.02	118	18.77	7.2	10%	23%	36 m upstream of GR4
Grande Ronde	8	45	4.02	118	18.8	7.2	14%	23%	54 m upstream of GR4
Grande Ronde	9	45	3.98	118	18.79	8.4	43%	46%	25 m upstream of GR5
Grande Ronde	10	45	4.01	118	18.79	6.6	16%	23%	85 m upstream of GR5
Catherine Cr.	1	45	7.94	117	42.46	6.6	1.0%	3.0%	27 m upstream C2
Catherine Cr.	2	45	7.9	117	42.51	6.6	0.6%	3.0%	37 m upstream from C2
Catherine Cr.	3	45	7.86	117	42.48	6	0.8%	2.5%	75 m upstream from C2
Catherine Cr.	4	45	7.42	117	41.96	9.6	1.6%	1.3%	10 m upstream from C3
Catherine Cr.	5	45	7.4	117	42	12.6	1.0%	1.5%	63 m upstream from C3
Catherine Cr.	6	45	7.23	117	39.07	8.4	2.2%	1.5%	200 m downstream of C4
Catherine Cr.	7	45	7.23	117	39.07	36	2.6%	1.5%	165 m downstream of C4
Catherine Cr.	8	45	7.25	117	38.75	12	5.4%	1.5%	32 m upstream of C4
Catherine Cr.	9	45	7.24	117	38.73	8.4	1.4%	1.5%	72 m upstream of C5
Catherine Cr.	10	45	7.29	117	38.69	14.4	1.6%	1.5%	115 m upstream of C5
NFJDR	1	Gps battery down				8.4	13%	20.0%	5 m upstream of N1
NFJDR	2	Gps battery down				10.8	13%	17.0%	25 m upstream of N1
NFJDR	3	Gps battery down				7.8	10%	15.0%	20 m downstream of N2
NFJDR	4	Gps battery down				7.2	22%	20.0%	14 m upstream of N2
NFJDR	5	Gps battery down				6	22%	15.0%	75 m downstream of N3
NFJDR	6	Gps battery down				7.2	17%	20.0%	60 m downstream of N3
NFJDR	7	Gps battery down				12	21%	18.0%	30 m downstream of N3
NFJDR	8	44	54.63	118	23.22	10.2	31%	27.0%	8 m downstream of N3
NFJDR	9	44	54.64	118	23.22	9.6	16%	20.0%	11 m downstream of N4
NFJDR	10	44	54.67	118	23.17	10.8	4%	15.0%	8 m upstream of N5
Granite Cr.	1	44	49.51	118	27.32	6.6	6%	5.0%	100 m upstream of GT1
Granite Cr.	2	44	49.5	118	27.31	4.8	41%	25.0%	210 m upstream of GT1
Granite Cr.	3	44	49.49	118	27.3	9.0	17%	17.0%	240 m upstream of GT1
Granite Cr.	4	44	49.5	118	27.26	7.8	9%	12.0%	25 m downstream of GT3
Granite Cr.	5	44	49.5	118	27.26	9.6	5%	8.0%	3 m downstream of GT3
Granite Cr.	6	44	49.58	118	27.2	8.4	1%	6.0%	21 m upstream of GT3
Granite Cr.	7	44	49.42	118	27.19	11.4	3%	8.0%	150 m upstream of GT3
Granite Cr.	8	44	49.34	118	27.08	4.8	17%	12.0%	6 m upstream of GT4
Granite Cr.	9	44	49.34	118	27.08	8.4	0%	8.0%	3 m downstream of GT5
Granite Cr.	10	44	49.41	118	27.32	5.4	13%	17.0%	10 m upstream of GT5

Figure 2. Plot of measured and visually estimated surface fine sediment data collected in 1998 in the four study streams.

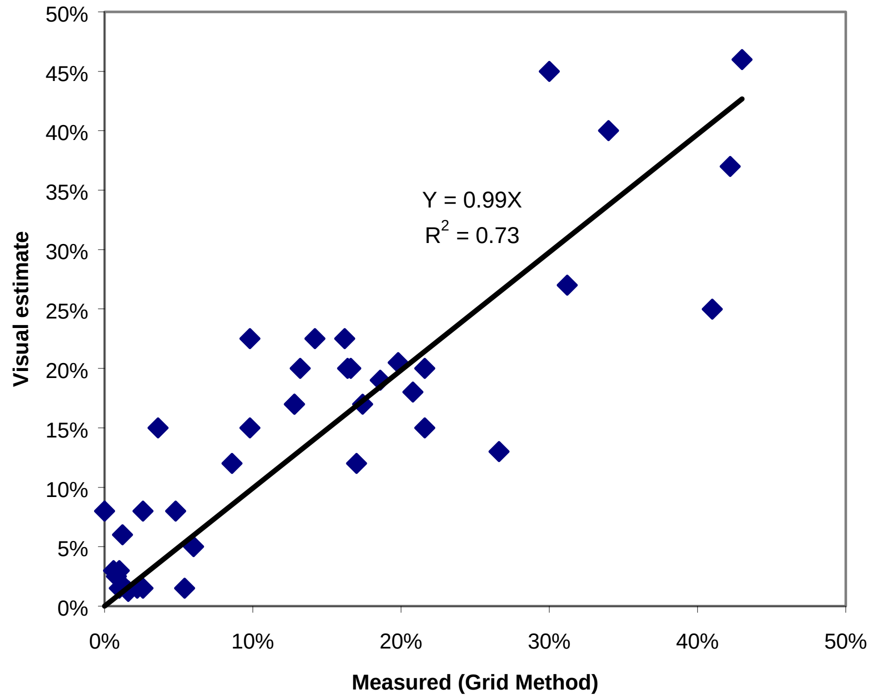


Table 3. Comparison of results of regression analysis of measured and visually estimated percent surface fine sediment in 1995 (Rhodes and Purser, *in press*) and 1998. Measured percent surface fine sediment was treated as the independent variable in the analyses in both years. See also Figure 2.

Attributes of analysis results	Year data collected	
	1995	1998
Number of samples	14	50
Slope and relationship statistically significant?	Yes, $p < 0.01$	Yes, $p < 0.01$
R^2 value from linear regression analysis	0.92	0.73
Slope of regression line	1.0	0.99
Y-intercept	0.0	0.0
Standard error of Y estimate	5.0%	6.3%

Table 4. Summary statistics and results of the measured percent surface data collected in 1998 by stream. A surface fine sediment level of < 20% is the substrate goal set in both CRITFC (1995) and NMFS (1995). Sample number is 10 for all four monitored streams.

Stream	Mean	Std. dev.	CI at p = 0.10	Mean < 20% (p = 0.10)	Mean > 20% (p = 0.10)
Grande Ronde	25.4%	11.6%	6.0%	Possibly No at p = 0.15	Possibly Yes at p = 0.15
Catherine Cr.	1.8%	1.4%	0.7%	Yes	No
NFJDR	16.8%	7.6%	4.0%	Possibly Yes at p = 0.15	Possibly No at p = 0.15
Granite Cr.	11.1%	12.2%	6.3%	Yes	No

On the administrative end, consultation with NMFS on the projects potential effects on spring chinook salmon and their habitats was completed in Sept. 1998. NMFS concluded that the project was not likely to adversely affect the salmon or their habitats.

We also received notification in 1998 that a summary of the findings from monitoring in previous years (Rhodes and Purser, *in press)* has been accepted for publication in a peer-reviewed conference proceedings. Results from previous years (Rhodes and Purser) include the following. Fine sediment accumulation was highly variable, but occurred consistently, indicating that fine sediment is transported invariably during the winter. The magnitude of sedimentation was related to surface fine sediment in a statistically significant fashion when data from all streams in all years were analyzed ($p < 0.01$); this was not the case in a single year among streams nor in the upper Grande Ronde River among all sampling years. Sedimentation was the highest in the upper Grande Ronde River where surface fine sediment levels were highest. The winnowing of fine sediment from redds by salmon is a transient condition in the monitored streams, especially where surface sediment is high. The magnitude of overwinter sedimentation collected in containers in constructed redds in the upper Grande Ronde River, was not related, in a statistically significant fashion, to stream discharge. In the upper Grande Ronde River, it appears that the magnitude of sedimentation during the incubation period is not limited by stream discharge or the availability of mobile fine sediment. This may be because surface fine sediment levels are high and stream discharge regularly occurs at magnitudes that are adequate to transport fine sediment. It appears that overwinter sedimentation is reducing salmon survival-to-emergence in the study area and especially in the upper Grande Ronde River. Surface fine sediment appears to provide a statistically significant index of the susceptibility of redds to overwinter sedimentation in streams.

CONCLUSIONS

Since the overwinter sedimentation samples have not been collected, our conclusions are limited to the analyses of surface fine sediment data collected during Sept. 1998. It appears that visual estimates of surface fine sediments by trained observers provide a rapid, but fairly accurate means of estimating surface fine sediment levels. In comparison with measurements surface fines, visual estimates show no apparent bias. However, in situations where accuracy is of greater concern than time, measurements are superior, as would be expected. The comparison of the relationships of estimated to measured surface fine levels in 1995 and 1998 might indicate that repeated practice and calibration by trained observers is critical to maintaining or improving the accuracy of visual estimates. After one year of limited practice at visually estimating surface fines, the accuracy of the estimates appeared to be reduced relative to past years. However, other potential explanations for the apparent reduction in the accuracy of visual estimates are increased accuracy in measurement due to improved techniques and increased variability caused by higher sample numbers. Based on the current analyses and results in this report, it is uncertain that the substrate goals (surface fine sediment < 20%) of CRITFC (1995) and NMFS (1995) are being met in the Grande Ronde and John Day, using a statistical significance level of $p < 0.10$. At this same level of statistical significance, it can be accepted that the substrate goals are met in the monitored reaches of Catherine and Granite Creeks, subject to the limitations of the sampling and analyses. At a lower levels of statistical significance ($p < 0.15$), the hypotheses can be accepted that the fine sediment substrate goal is met in the sampled reaches of the NFJDR and not met in sampled areas of the Grande Ronde River. Consistent with statistical considerations and the results of most studies, increased sample numbers would have improved the resolution of the results. These results will be incorporated into monitoring in the forthcoming season.

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