Coeur d'Alene Tribe
Fisheries Program

Implementation of Fisheries Enhancement Opportunities on the Coeur d'Alene Reservation

2006 ANNUAL REPORT

Coeur d'Alene Tribe Department of Natural Resources
Fisheries Program
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INTRODUCTION

BACKGROUND

Historically, the Coeur d'Alene Indian Tribe depended on runs of anadromous salmon and steelhead along the Spokane River and Hangman Creek, as well as resident and adfluvial forms of trout and char in Coeur d'Alene Lake, for survival. Dams constructed in the early 1900s on the Spokane River in the City of Spokane and at Little Falls (further downstream) were the first dams that initially cut-off the anadromous fish runs from the Coeur d'Alene Tribe. These fisheries were further removed following the construction of Chief Joseph and Grand Coulee Dams on the Columbia River. Together, these actions forced the Tribe to rely solely on the resident fish resources of Coeur d'Alene Lake for their subsistence needs.

The Coeur d'Alene Tribe is estimated to have historically harvested around 42,000 westslope cutthroat trout (*Oncorhynchus clarki*) per year (Scholz et al. 1985). In 1967, Mallet (1968) reported that 3,329 cutthroat trout were harvested from the St. Joe River, and a catch of 887 was reported from Coeur d'Alene Lake. This catch is far less than the 42,000 fish per year the tribe harvested historically. Today, only limited opportunities exist to harvest cutthroat trout in the Coeur d'Alene Basin.

The declines in native salmonid fish populations, particularly cutthroat and bull trout (*Salvelinus confluentus*), in the Coeur d'Alene basin have been the focus of study by the Coeur d'Alene Tribe's Fisheries and Water Resources programs since 1990. It appears that there are a number of factors contributing to the decline of resident salmonid stocks within Coeur d'Alene Lake and its tributaries (Mallet 1969; Scholz et. al. 1985, Lillengreen et. al. 1993). These factors include: construction of Post Falls Dam in 1906; major changes in land cover types, agricultural activities and introduction of exotic fish species.

In 1994, the Northwest Power Planning Council adopted the recommendations set forth by the Coeur d'Alene Tribe to improve the Reservation fishery (NWPPC Program Measures 10.8B.20). These recommended actions included: 1) Implement habitat restoration and enhancement measures in Alder, Benewah, Evans, and Lake Creeks; 2) Purchase critical watershed areas for protection of fisheries habitat; 3) Conduct an educational/outreach program for the general public within the Coeur d'Alene Reservation to facilitate a "holistic" watershed protection process; 4) Develop an interim fishery for tribal and non-tribal members of the reservation through construction, operation and maintenance of five trout ponds; 5) Design, construct, operate and maintain a trout production facility; and 6) Implement a five-year monitoring program to evaluate the effectiveness of the hatchery and habitat improvement projects.

Since that time, much of the mitigation activities occurring within the Coeur d'Alene sub-basin have had a connection to the project entitled "Implement of Fisheries Enhancement Opportunities on the Coeur d'Alene Reservation", which is sponsored and implemented by the Coeur d'Alene Tribe Fisheries Program and is the subject of this report. These activities provide partial mitigation for the extirpation of anadromous fish resources from usual and accustomed harvest areas and Reservation lands.

STUDY AREA

The study area addressed by this report consists of the southern portion of Coeur d'Alene Lake and four watersheds, which feed the lake (see *Figure 1*). These areas are part of the larger Coeur d'Alene sub-basin, which lies in three northern Idaho counties Shoshone, Kootenai and Benewah. The basin is approximately 9,946 square kilometers and extends from the Coeur d'Alene Lake upstream to the Bitterroot Divide along the Idaho-Montana border. Elevations range from 646 meters at the lake to over 2,130 meters along the divide. This area formed the heart of the Coeur d'Alene Tribe's aboriginal territory, and a portion of the sub-basin lies within the current boundaries of the Coeur d'Alene Indian Reservation.

Coeur d'Alene Lake is the principle water body in the sub-basin. The lake is the second largest in Idaho and is located in the northern panhandle section of the state. The lake lies in a naturally dammed river valley with the outflow currently controlled by Post Falls Dam. The lake covers 129 square kilometers at full pool with a mean depth of 22 meters and a maximum depth of 63.7 meters.

The four watersheds currently targeted by the Tribe for restoration are located mostly on the Reservation (*Figure 1*), but cross boundaries of ownership and jurisdiction, and have a combined basin area of 34,853 hectares and include 529 kilometers of intermittent and perennial stream channels. The climate and hydrology of the target watersheds are similar in that they are influenced by the maritime air masses from the pacific coast, which are modified by continental air masses from Canada. Summers are mild and relatively dry, while fall, winter, and spring brings abundant moisture in the form of both rain and snow. A seasonal snowpack generally covers the landscape at elevations above 1,372 meters from late November to May. Snowpack between elevations of 915 and 1,372 meters falls within the "rain-on-snow zone" and may accumulate and deplete several times during a given winter due to mild storms (US Forest Service 1998). The precipitation that often accompanies these mild storms is added directly to the runoff, since the soils are either saturated or frozen, causing significant flooding.

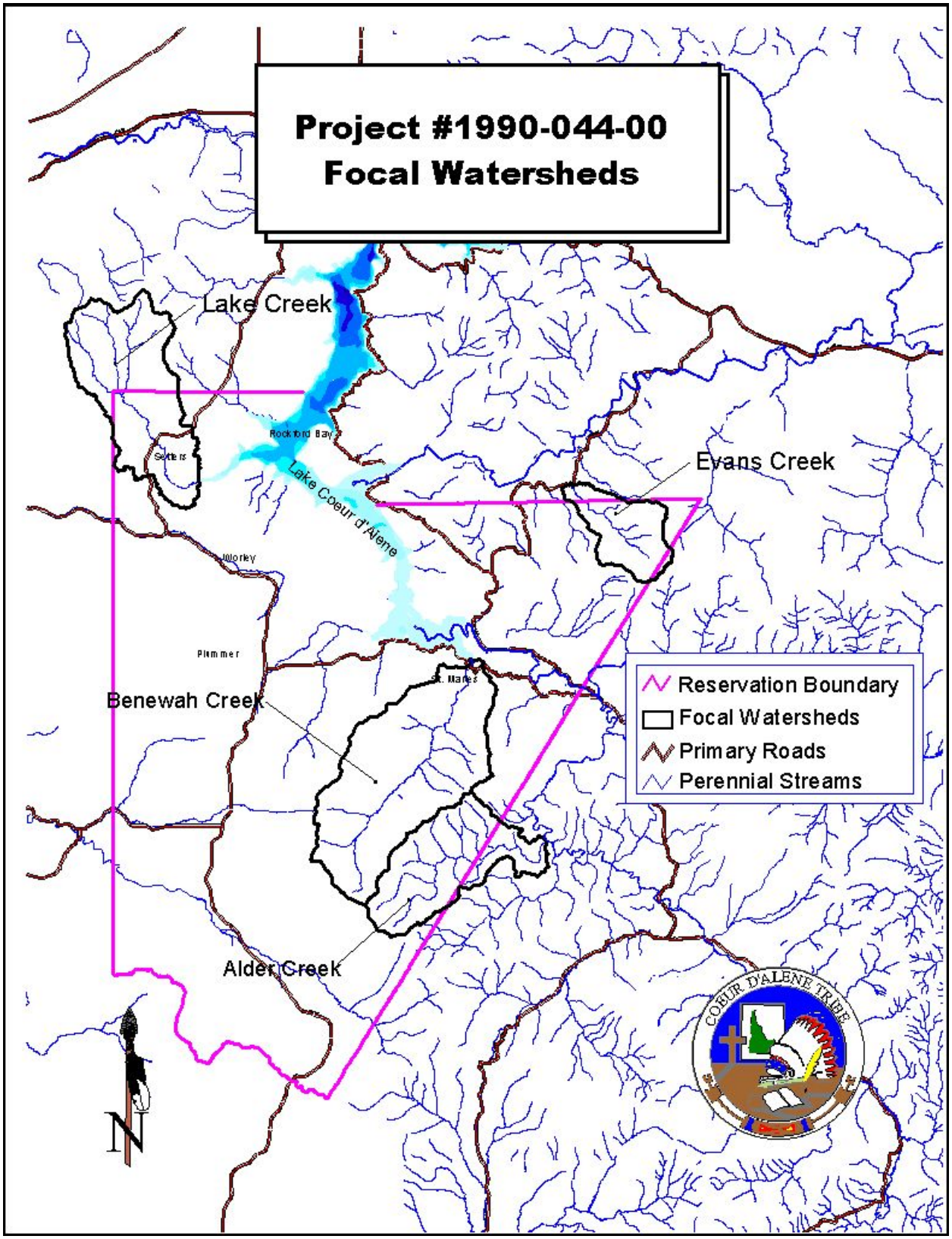

Figure 1. Locations of BPA Project 90-044-00 Focal Watersheds on the Coeur d'Alene Indian Reservation.

STUDY OBJECTIVES

This annual report summarizes previously unreported data collected to fulfill the contractual obligations for BPA project #1990-044-00, *Coeur d'Alene Subbasin Fisheries Habitat Enhancement*, during the 2006 calendar year. Even though the contract performance period for this project crosses fiscal and calendar years, the timing of data collection and analysis, as well as implementation of restoration projects, lends itself to this reporting schedule.

The 2006 performance period marked the first year that BPA implemented its Process Improvement Initiative with the Pisces system serving as the vehicle for developing statements of work and tracking project performance. This document attempts to provide some consistency between the project objectives, around which past reports have been structured, and the new work element format adopted for use in Pisces. The report is formatted into three primary sections that respectively provide results and discussion of: 1) monitoring and evaluation of biological and physical habitat indicators; 2) implementation of restoration and enhancement projects; and 3) education and outreach work performed during 2006. The relevant work elements and/or milestones found in the statement of work are listed under these section headings and described in the body of the report.

Section 1: Monitoring and Evaluation

Objective: *Reduce the abundance and distribution of non-native brook trout in Benewah Creek.*

WE K: Remove brook trout from Benewah Creek.

WE L: Test the effectiveness of brook trout removal by comparing changes in density between treatment and control watersheds.

Objective: *Assess changes in salmonid distribution and production.*

WE M/N/O/P: Install and maintain migration traps and PIT tag systems in Lake and Benewah creeks to measure the productivity of the adfluvial life history of cutthroat trout.

WE Q: Conduct surveys at index sites to assess changes in the distribution and density of salmonid populations in mainstem and tributary reaches within the four target watersheds.

Objective: *Evaluate habitat restoration effectiveness at treatment sites.*

WE U: Measure physical habitat indicators at treatment and control sites that are representative of specific restoration/enhancement strategies.

WE V: Measure water and air temperature along the longitudinal profile of target streams.

Section 2: Restoration and Enhancement

Objective: Improve stream channel stability, habitat complexity and stream/ groundwater interaction through habitat restoration and enhancement that addresses identified deficiencies in watershed processes.

WE E: Install culvert on North Fork Alder Creek to restore connectivity in the upper watershed.

WE F: Implement stream channel construction on the Benewah Creek Wildlife Management Unit (WMU) to restore stable channel configuration consistent with historic conditions.

WE G: Plant all disturbed areas associated with channel construction on the Benewah Creek WMU.

WE H: Restore native riparian forest plant communities consistent with management plan documents for the Benewah Creek WMU.

WE I: Inspect and maintain LWD and ELWD structures as needed at treated sites in Evans Creek.

Section 3: Education and Outreach

Objective: Coordinate and participate in a variety of forums with managers and stakeholders to profile management issues and allow for participation by interested parties.

WE B: Conduct meetings with interested parties to coordinate restoration efforts and develop cooperative opportunities.

WE B: Participate in Tribal inter-disciplinary processes to review and comment on issues related to the management of fisheries and other natural resources on the Reservation and in the ceded lands.

Objective: Provide cultural and educational opportunities to improve the involvement in and understanding of Program activities.

WE Z: Provide summer internships for high school students to assist with implementation of project activities and to expose students to natural resource management issues.

WE Z: Provide educational programs for the local community to increase the understanding of project related activities within a scientific and cultural context.

WE Z: Work with university extension programs to extend outreach activities related to the project to the Reservation community.

WE Z: Publish a quarterly newsletter that highlights Program activities, recognizes cooperative efforts and serves as a forum for discussing land management issues.

SECTION 1: MONITORING AND EVALUATION

METHODS

Biological Monitoring

Trout Population Estimation

The channel types delineated during previous surveys (Lillengreen et al. 1996) served as the basic geomorphic units for selecting sample sites for conducting fish population surveys. In these early channel type surveys, stream reaches were stratified into relatively homogeneous types according to broad geomorphologic characteristics of stream morphology, such as channel slope and shape, channel patterns and channel materials, as defined by Rosgen (1994). Stream reaches were further stratified by basin area to ensure that both mainstem and tributary habitats were represented in the stratification scheme. Sample locations within each stratum were randomly selected in proportion to the total reach length. The length of each sample unit was standardized to 61 meters to encompass at least 20 channel lengths for most sites.

Sites were electrofished in the summer to quantify the abundance and distribution of fishes during base flow conditions occurring between July and September (*Figures 2-5*). Trout populations were estimated using the removal-depletion method (Seber and LeCren 1967, Zippen 1958). Block nets were placed at the upstream and downstream boundaries to prevent immigration and emigration during sampling. Each sample site was electrofished using the standard guidelines and procedures described by Reynolds (1983). Fish were collected using a Smith-Root Type VII pulsed-DC backpack electrofisher. Two electrofishing passes were made for each sample site as the standard procedure. If the capture probability during the initial passes was less than or equal to 50 percent, then a third and/or fourth pass were generally made to increase the precision of the population estimate. Salmonid species, including westslope cutthroat trout (*Oncorhynchus clarki lewisi*), brook trout *(Salvelinus fontinalis)* and bull trout *(Salvelinus confluentus)* were the target species for this study. Captured fish were identified, enumerated, measured (TL to nearest mm), and weighed (nearest 0.1g). Other species such as longnose dace, redside shiner, longnose sucker, and sculpin (spp.) were considered incidental catch and were only counted.

Population estimates were calculated using the following equation for two pass removals (Armour et al. 1983):

$$N = \frac{U_1}{1-(U_2/U_1)}$$

where:

N = estimated population size;

U_1= number of fish collected in the first pass; and

U_2= number of fish collected in the second pass.

The standard error of the estimate was calculated as:

$$se(N) = \sqrt{\frac{M(1-M/N)}{A-\left[(2p)^2(U_2/U_1)\right]}}$$

where:

se(N) = standard error of the population estimate;

M= $U_1 + U_2$;

A= $(M/N)^2$; and

p= $1-\frac{U_2}{U_1}$.

Population estimates when more than two passes were necessary were calculated using the following equation (Armour et al. 1983):

$$N = \frac{M}{1-(1-p)^t}$$

where: N = estimated population size

M = sum of all removals ($U_1 + U_2 + \ldots U_t$)

t = the number of removal occasions

U_i = the number of fish in the ith removal pass

$C = (1)U_1 + (2)U_2 + (3)U_3 + \ldots (t)U_t$

R = (C-M)/M

$p = (a_0)1 + (a_1)R + (a_2)R^2 + (a_3)R^3 + (a_4)R^4$

a_i = Polynomial coefficient from Table 8 (Armour et al. 1983).

The standard error was calculated as:

$$se(N) = \sqrt{\frac{N(N-M)M}{M^2 - \frac{N(N-M)(tp)^2}{(1-p)}}}$$

where: se(N) = standard error of population estimate. The approximate 95% confidence interval on the unknown population size was calculated as follows (Armour et al. 1983):

$$95\%CI = N \pm 2 * \sqrt{\mathrm{var}(N)}$$

The population estimates were converted into density values (# fish/100 m^2) for each sample site then extrapolated to the reach in which the samples were collected to estimate the total number of fish in the reach. The confidence intervals were converted in the same manner (Johnson and Bhattacharyya 2001). Total reach areas were obtained from the digital data layer maintained by the Tribal GIS Program.

Trout Age and Size

Age composition was estimated by applying length-at-age proportion keys (Gulland and Rosenberg 1992) developed from scale analyses of fishes of known length from 1996-2004. The length-at-age proportion keys are stream and species-specific. Raw scales were used for age determination. Salmonid scales were taken from the side of the body just behind the dorsal fin and above the lateral line (Jearld 1983). Scale samples were sorted by watershed to allow for independent determination of age and growth rate. In the laboratory, several dried scales were mounted between two glass microscope slides and viewed using a Realist, Inc., Vantage 5 microfiche reader. Age was determined by counting the number of annuli (Lux 1971, Jearld 1983).

Power Analysis

The program MONITOR (Gibbs 1995) was used to estimate the power to detect a positive or negative change of Westslope cutthroat and brook trout densities from annual population estimates in Alder, Benewah, Evans and Lake Creeks over a nine-year period from 1996-2004. The MONITOR program uses Monte Carlo simulations to model variation in count surveys over time. The program then generates detection rates produced from route-regression analysis. The density (mean ± 1 sd, n = 10 years) of westslope cutthroat and brook trout from each population estimate site was used as input for the power analysis. The results of the power analysis apply to detecting percentage of change at the stream scale. An alpha level of 0.10 and 1000 iterations were used for all Monte Carlo simulations. For results interpretation and discussion, detection ranges were broken into fine-scale (-4% to 4%) and coarse-scale (-10% to -4%, and 4% to 10%). Results were interpreted relative to past power analyses reported in (Vitale et al. 2002A).

Adfluvial Westslope Cutthroat Trout Run Size and Migration

Migration traps were installed in Lake and Benewah creeks in 2006 to estimate adult spawner and juvenile outmigrant run size and timing. A resistance board weir (RBW) trap (Tobin 1994, Stewart 2002) was used in Lake Creek in 2006 for the second year. The adult trap used for Benewah Creek was not changed from previous years, but will be replaced with a RBW in 2007. A new juvenile outmigrant trap design was used in Lake Creek to more effectively capture juveniles and post-spawn adults. Traps were checked and cleaned at least once daily during peak spawning periods from March through the early-June. Fish captured in the traps were identified, counted, measured for length (nearest mm), and weighed (0.1 gram). A scale sample was taken from all adults to assess the age of each fish.

Westslope Cutthroat Trout Survival (PIT tagging)

Outmigrating, juvenile westslope cutthroat trout from Lake Creek were PIT tagged and released to estimate within-lake survival in subsequent years. PIT tagging followed the Pacific States Marine Fish Commission, PTAGIS guidelines. Subsamples of tagged fish were held in a PVC-framed net pen to determine 24-hour post-PIT tag survival and tag retention.

Brook Trout Removal from Benewah Creek

In August 2006, non-native brook trout were removed from the 4th order upper mainstem and 3rd and 2nd order tributaries of Benewah Creek. In the mainstem, removal started at the confluence of Windfall Creek and proceeded upstream to the confluence of West and South Forks. The removal effort then focused on the 2nd and 3rd order West and South Forks of Benewah Creek. All index sites associated with the population estimate sampling were sampled prior to brook trout removal. A sample of approximately 150-200 brook trout were euthanized and dissected to ascertain gender, reproductive maturity, and number of eggs, egg skein weight and testes weight. Scale samples were taken from each sacrificed fish. The brook trout population in Alder Creek is the control to compare watershed-scale population, density, spatial patterns and the above-mentioned reproductive life history variables. A similar number of Alder Creek fish were sacrificed and analyzed as described above.

Physical Habitat Monitoring

Sites and Variables Monitored

An important aspect of the proposed monitoring and evaluation program is the study of physical, chemical and biological characteristics of select treatment (i.e. restored or enhanced) sites and similar but untreated "control" sites. The comparison of treatment and control site characteristics can provide an important measure of change, improvements or lack thereof, brought about by the treatments. The initial treatment and control site pairings completed in 2002 followed a hierarchical stratification of the target watersheds incorporating both ultimate and proximate control, consistent with the guidelines provided by Paulsen et al. (2002) and Hillman and Giorgi (2002). The channel type classification used in these pairings was initially developed using USGS Quads prior to the first year of habitat surveying. These channel type classifications were reevaluated in this report by examining channel morphology as determined by measured data, hydraulic geometries determined from regional regressions, and future monitoring needs. For each reach, a representative riffle cross-section was chosen to aid in the updated classification. Cross-section data from a single year were used in calculating the entrenchment ratio and width/depth ratio. Sinuosity was determined from survey maps and using GIS. The channel materials were calculated from averaging riffle d50 for every surveyed year. Water surface slope was also an average of each surveyed year. The entrenchment ratio and the width/depth ratio were found using cross-sections where the bankfull area had been set to those predicted by regional curves. In some instances, these bankfull areas need to be field verified in future sampling efforts.

Table 1 provides a listing of the restoration / enhancement projects completed through 2006 that were selected for long term monitoring, along with the respective project category (treatment type) and the associated response variables. Fourteen habitat sites were surveyed and sampled in 2006 from June through November (*Table 2*). The locations of monitored sites are shown in *Figures 2 - 5*.

Table 1. BPA-funded project sites listed by watershed, treatment type and response variables.

Watershed	Treatment Site	Treatment Type	Response Variables[1]
Benewah			
	12	Channel reconstruction	M, S, C, W, P
	14 L	Streambank stabilization & Riparian Planting	M, S, C, W, P
	14U	Streambank stabilization & Riparian Planting	M, S, C, W, P
	15 L	Channel reconstruction	M, S, C, W, P
	16	Passage Improvement and channel reconstruction	M, S, W, P
Lake			
	8 L	Riparian Planting	C
	9 U	Riparian Planting	C
	11	Instream structures & Riparian Planting	M, S, C, W, P
	12	Riparian Planting	C
	WF 2	Riparian Planting	C
Evans			
	1	Riparian Planting	C
	3	Instream structures and streambank stablization	M, S, C, W, P

[1] M – Channel Morphology; S – Substrate; C – Cover; W – Large Woody Debris; P – Residual Pools

Longitudinal "Thalweg" Profile

The first effort to be undertaken upon arrival at a monitoring site was to determine the location of the downstream end of the previously surveyed reach. Once this was found, the location was flagged with surveyors' ribbon. Bank pins were established on the banks of the channel above the high water mark at major changes in the channel planform. When the 500-foot mark was reached this marked the end of the reach. For some sites, the starting or ending locations were different than the previous survey - this is further discussed later in this report. Profile surveys involved the determination of water depth, and water surface and channel bottom elevations along the thalweg of each 500-foot study reach using methods modified from Peck et al. (2001). Elevation measurements were made relative to a fixed benchmark, assigned an arbitrary elevation of 100.00 ft. All measurements were recorded as distances along the longitudinal profile. A sufficient number of measurements were taken to capture all changes in bed and water surface slope and habitat types along the reach. A SET 530R Sokkia Total Station was used to collect longitudinal profile data at most sites, in place of an autolevel, which had been used in previous surveys. Survey data was recorded on a Recon Pocket PC. After the survey was complete, data was downloaded into a text file and imported into Microsoft excel for analysis.

Table 2. Parameters collected for sites surveyed in 2006.

Site	Parameter				
	Longitudinal profile	Cross-sections	Large Woody Debris	Cover	Substrate
Benewah 15 L	X	X	X	X	X
Benewah 16	X	X	X	X	X
Benewah 17		X	X	X	X
Bozard 1	X	X	X	X	X
Bozard 2	X	X	X	X	X
Bozard 3		X	X	X	X
Evans 3	X	X	X	X	X
Lake 7	X	X			X
Lake 8 L	X	X	X	X	X
Lake 9U	X	X	X	X	X
Lake 10	X	X	X	X	X
Lake 11	X	X	X	X	X
Lake 12	X	X	X	X	X
West Fork 2	X	X	X	X	X

Bed Form Differencing

Identifying pool and riffle habitats is important in monitoring changes in bedform and fish habitat. Residual pool depth (RPD) is a particularly important habitat indicator because it can be accurately measured independent of discharge (Kershner et al 2004) and increasing RPD is generally associated with increased salmonid biomass (Hogel 1993; Binns 1994). A macrohabitat identification technique called the Bed Form Differencing was applied to each of the longitudinal profiles collected to minimize the error in identifying pools and riffles due to acknowledged inconsistencies associated with field identification (Kershner et al 2004) and to

facilitate comparisons across datasets (Arend 1999). This method was developed by O'Neill and Abrahams (1984) as a way to objectively identify bedforms in a survey reach.

Four types of bedforms are identified using this method: absolute maximums (riffles), absolute minimums (pools), local maximums, and local minimums. The tolerance value is determined by taking the standard deviation of all of the "differences" and multiplying it times a coefficient. If habitat units exceed this value they are classified as either a minimum or a maximum. If they do not exceed this value they are identified as not being a bedform. If a maximum is followed by a minimum then it is a absolute maximum (riffle). If a maximum is followed by another maximum, it is identified as a local maximum. If a minimum is followed by a maximum, it is defined as an absolute minimum (pool). A bed differencing program was developed in Microsoft Excel using Visual Basic. Residual pool depths were calculated by running a program that sorts the bedforms that are either absolute maximums or absolute minimums, then identifies the first "riffle" and starts calculating residual pools by subtracting the elevation of the absolute minimum from the adjacent downstream absolute maximum. The sample spacing is assumed to be equal to channel width though shorter spacing can be used. The resolution of our data is at a much tighter interval. As a result, we have modified our data in order to achieve spacing closer to bankfull width by running the program twice. After the first run is complete, the sign designation of each point is examined. If there is a series of more than two increasing or decreasing points, the intermediate points are deleted, then the program is ran again.

Cross Section Profiles

Cross section profiles were measured using a surveyor's level and rod at six locations along each studied reach. All but one of the sites had cross-sections that had been previously established in 2002 or 2003. All cross sections were monumented with permanent pins (rebar), stakes, lathe and flagging to allow for repeat surveying of the profiles in the future. In some cases, survey pins had to be reset because they had been moved or "lost". The benchmark established for the longitudinal profile was also used as the reference point for each of the six cross sections.

The cross section profiles were used to verify the bankfull depth and to calculate the bankfull cross sectional area, wetted perimeter, average and maximum depth and width-to-depth ratio. The flood-prone width, which is defined as the valley width at twice the maximum depth at bankfull, and entrenchment ratio, defined as the flood-prone width divided by the bankfull width, were determined by using floodplain cross-section information collected with the total station if it was collected. Survey data was input into the Reference Reach Spreadsheet.

Channel Substrate

Wolman pebble counts (Wolman 1954) were completed at riffles and pool tailouts along the survey reach. At each of these points a measuring stick or finger was placed on the substrate and the one particle the tip touched was picked up and the size measured. Particle size was determined as the length of the "intermediate axis" of the particle; that is the middle dimension of its length, width and height. Pebble count data was input into the Reference Reach Spreadsheets, which automatically graphed the distribution of particle sizes and calculated pertinent descriptive criteria such as percent by substrate class (size) and a particle size index (D value) for each habitat type for which data was collected.

Canopy Density

Vegetative canopy density (or shade) was determined using a conical spherical densiometer, as described by Platts et al. (1987). The densiometer determines relative canopy "closure" or canopy density, which is the amount of the sky that is blocked within the closure by vegetation, and this is measured in percent. Canopy density can change drastically through the year if the canopy vegetation is deciduous. Canopy cover over the stream was determined at randomly selected locations throughout the survey reach. At each selected location, densiometer readings were taken one foot above the water surface at the following locations: once facing the left bank, once facing upstream at the middle of the channel, once facing downstream at the middle of the channel and once facing the right bank. Percent density was calculated by multiplying the sum of the four readings by 1.5. If the result was between 30 and 65%, 1.0 % was subtracted; if the result is greater than 65, 2% was subtracted. The adjusted density readings were then averaged for the entire reach. While these data were collected at all monitored sites, the results are not summarized as the data is not relevant to the channel type evaluation that is the principle objective of this report. These data will be summarized in future annual reports.

Instream Organic Materials

The organic materials survey transect was walked along the thalweg starting at the downstream end of the reach. All woody debris that was greater than 4 inches in diameter at the small end was tallied and measured whether or not it crossed the line of the transect. This included material that was suspended above the water surface and extended outside of the wetted stream width; it is not intended to include living trees or shrubs that hung over the water. For all observed LWD, orientation was noted by taking a compass heading (degrees) looking from the large end of the piece towards the small end. Stream orientation was also recorded. Other measurements taken of all LWD were the diameter at the large end, diameter at the small end and the length between these two ends. The large end diameter was measured immediately above the roots, if there are roots attached. Data handling included the calculation of the total volume and density of LWD found within the bankfull width of each studied reach. These calculations were performed in a spreadsheet worksheet added to the Reference Reach Spreadsheet. While these data were collected at all monitored sites, the results are not summarized as the data is not relevant to the channel type evaluation that is the principle objective of this report. These data will be summarized in future annual reports.

Sinuosity

The sinuosity of a stream reach is estimated as the ratio of the stream channel length to the direct basin (valley) length. For the stream segments, the "total stream length" in the study reach is that measured for the longitudinal thalweg profile (ie. 500 feet) and the valley length was measured (estimated) by pulling a hip chain as straight as possible between the upstream and downstream ends of the 500-foot (152.4 meters) reach. Sinuosity was calculated by dividing the stream length by the valley length.

Stream Typing

The classification of stream channel types followed guidelines presented by Rosgen (1996) and used data collected during the thalweg profile, cross section profile and sinuosity surveying efforts. The objective of classifying streams on the basis of channel morphology was to use discrete categories of stream types to develop consistent, reproducible descriptions of the stream

reaches. These descriptions must provide a consistent frame of reference to document changes in the stream channels over time and to allow comparison between different streams. The dominant substrate type (ie. slit/clay, sand, gravel, cobble) was included as a modifier to the channel type. The numbering for this (from Rosgen 1996) is 1 for bedrock, 2 for boulder, 3 for cobble, 4 for gravel, 5 for sand and 6 for silt and clay. The delineative criteria included entrenchment ratio, width-to-depth (W/D) ratio, sinuosity and slope.

Regional Regression Equations

Regional regression equations were used to estimate bankfull discharge and regional hydraulic geometry relationships at each of the habitat survey sites. USGS Regional Regression analysis developed by Berenbrock (2002) and Hortness and Berenbrock (2004) were used to calculate the following return intervals: Q1.5, Q2, Q2.33, Q5, Q10, Q25, Q50, Q100, Q200, and Q500. Region 2 equations were used for these calculations. Regional hydraulic geometry relationships were determined using equations developed by Castro and Jackson (2001). Watershed characteristics previously collected and outlined in Appendix E of the Tribe's RM & E Plan (2002) were used as the data inputs. Mean basin elevation was derived from averaging the site elevation with the highest elevation in the watershed. Precipitation was estimated for each watershed from precipitation data for the period of 1961-1990 (UI climate lab). Lake Creek, Benewah Creek, Alder Creek, and Evans Creek sites were assumed mean annual precipitation values of 25 inches, 27 inches, 30 inches, and 30 inches respectively. The sites were also grouped by ecoregion: Western Interior Basin and Range (wibr) or Western Cordillera (wc). Evans Creek, Benewah Creek, and Alder Creek are located within the Western Cordillera Ecoregion. For Lake Creek, equations for both ecoregions were examined (initially Lake Creek was classified as Western Interior Basin and Range). Each ecoregion has a different set of equations. These equations are either based on drainage area or a known bankfull discharge. The Q1.5 from the USGS methods was used as the known bankfull discharge. User-defined functions were created in Excel to evaluate these parameters. Parameters based on drainage area include bankfull area, bankfull width, bankfull mean depth, and bankfull discharge. Parameters based on a chosen bankfull discharge include bankfull area, bankfull width, bankfull mean depth, and bankfull velocity.

Temperature Monitoring

Stream water temperature was measured along the longitudinal profile of the mainstems and in major tributaries in 23 fixed locations of Benewah, Lake and Evans Creeks. Hobo Temp Pro (Onset Computer Corp.) digital temperature dataloggers, accurate to (±0.2 °C) were deployed and quality controlled following procedures outlined by Dunham et al. (2005). A fifteen-minute sampling interval was used for all data loggers. In addition to water temperature, air temperature was measured at two sites in relation to the ambient stream temperature and thermal heterogeneity study in Benewah Creek watershed and the Lake Creek watershed.

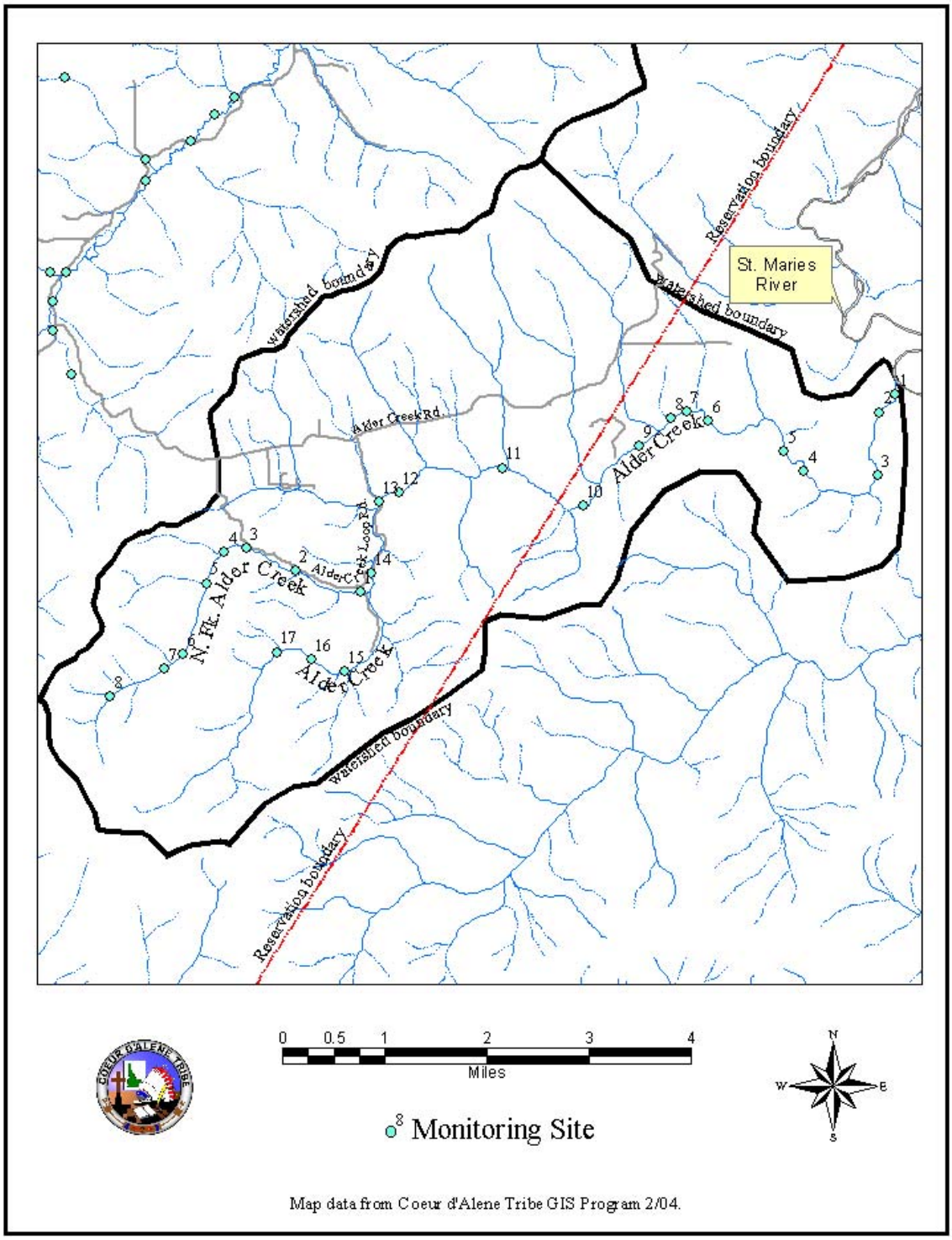

Figure 2. Map of Alder Creek watershed showing fish population and stream habitat monitoring sites.

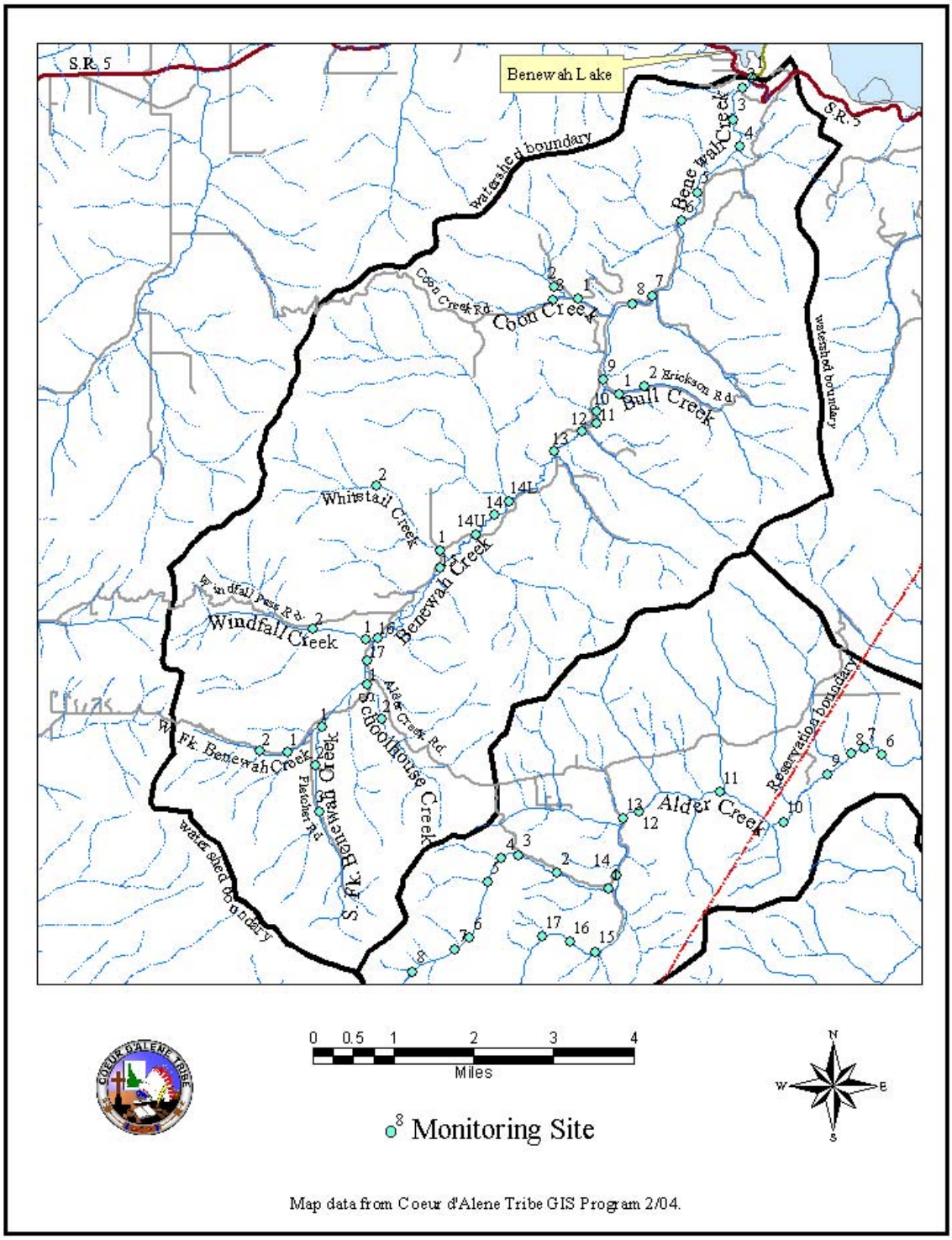

Figure 3. Map of Benewah Creek watershed showing fish population and stream habitat monitoring sites.

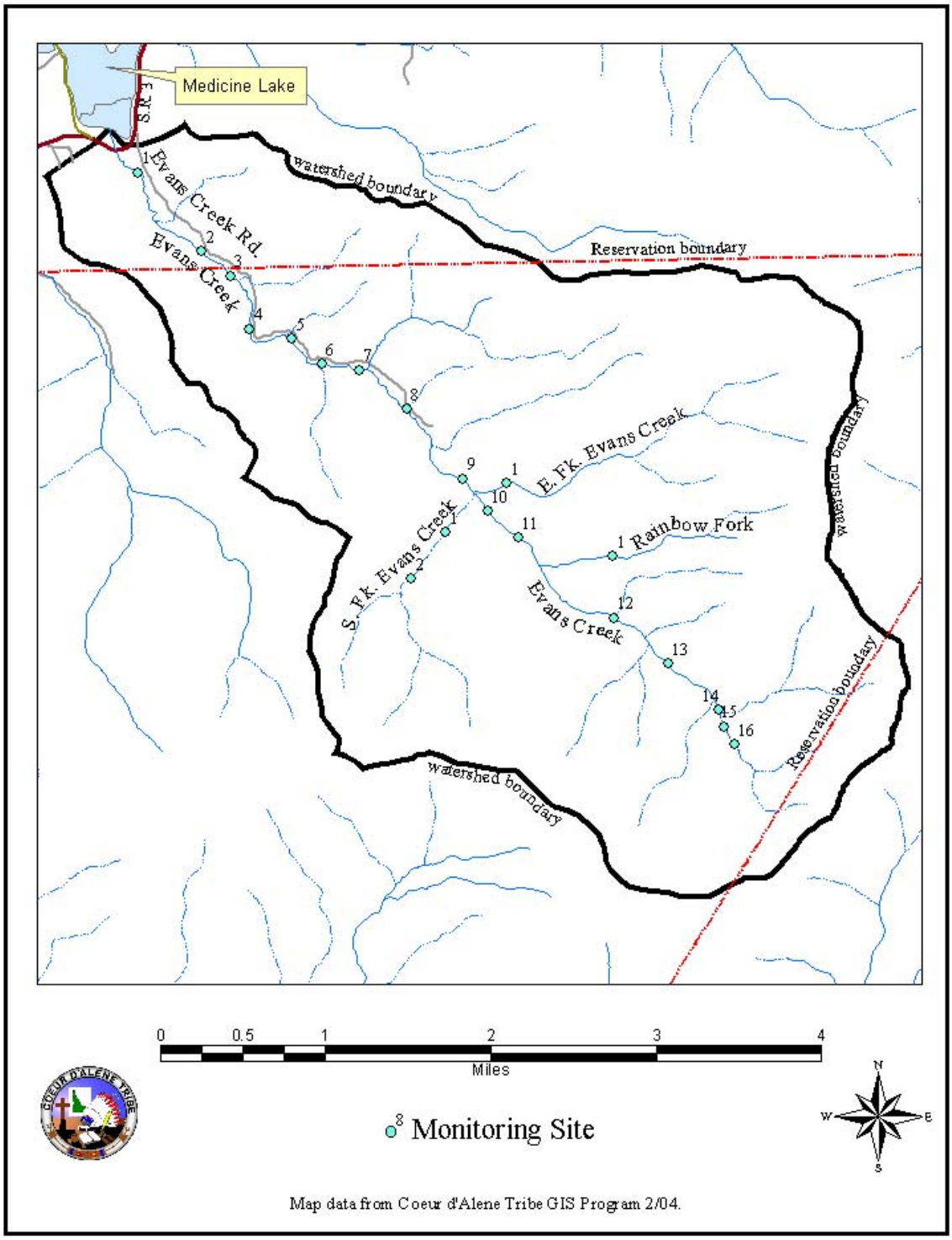

Figure 4. Map of Evans Creek watershed showing fish population and stream habitat monitoring sites.

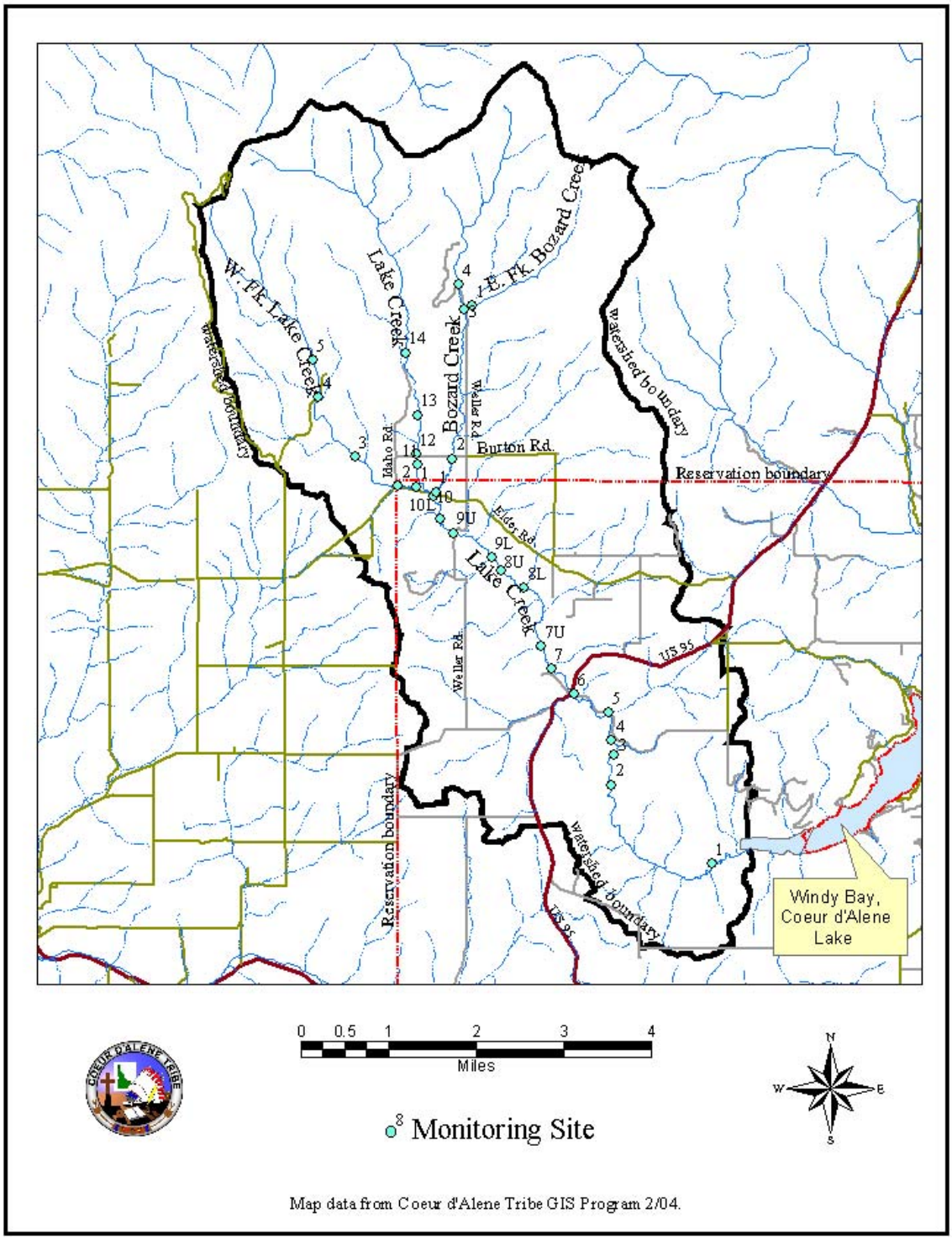

Figure 5. Map of Lake creek watershed showing fish population and stream habitat monitoring sites.

RESULTS

Biological Monitoring

Trout Population Estimation

Similar to past years, westslope cutthroat trout were widely distributed in the Benewah, Evans, and Lake Creek watersheds during base flow conditions in the summer, with maximum densities in 2nd and 3rd order tributaries. In contrast, westslope cutthroat trout distribution in Alder Creek was limited to the lower mainstem. In Alder Creek, only 20% of the sampled area was occupied by cutthroat trout and much of the upper mainstem and North Fork Alder Creek contained no cutthroat in the sample. The highest mean densities of westslope cutthroat trout at the watershed scale were 14.8/100m^2 and 14.5/100m^2 from Lake and Evans creeks (*Table 3*). Maximum densities at the reach scale in each watershed were; 58.4/100m^2 in Bull Creek a tributary of Benewah Creek, 41.7/ 100m^2 in West Fork Lake Creek, 48.8/100m^2 in East Fork Evans Creek and 4.2/100m^2 in mainstem Alder Creek. The westslope cutthroat trout populations in Lake, Benewah and Evans creeks were as strong as they have been at anytime during the past 11 years (*Figure 6*). Lake Creek had the highest total estimate of the four target watersheds at 9,318±879 and the trend of increasing numbers at the watersheds scale was significant (p=0.01). Benewah Creek had a total estimate of 7,037±1,065 with a significant trend (p=0.025) of increasing numbers. The total estimate for Evans Creek was 5,161±546, but the apparently increasing trend was not significant. The total population estimate in Alder Creek was 456±3 and was lower than the previous 5 years.

Non-native brook trout were found only in the Alder and Benewah creek watersheds, but they were the dominant salmonid in Alder Creek. The mean density of brook trout at the watershed scale in Alder Creek was 16.9/100m^2 (*Table 3*). The highest density of brook trout at the reach scale was 59.6/100m^2 in the upper mainstem Alder Creek. In Alder Creek brook trout were distributed throughout the watershed, occupying more than 90% of the sampled habitat, and found in higher densities than cutthroat trout in 47% of the habitats where they were found in sympatry. In Benewah Creek, brook trout were distributed in the upper mainstem and associated tributaries with highest densities of 14.5/100m^2 in the upper mainstem and 13.8/100m^2 in the West Fork Benewah Creek. There were significant increasing trends for total brook trout numbers in both Alder (p=0.002) and Benewah (p=0.003) creeks (*Figure 7*). The total estimate in Benewah Creek, however, was 7% lower than in 2004 when removal efforts were initiated.

Table 3. Density of westslope cutthroat trout and non-native brook trout (mean ± SE) at the watershed scale from the four target watersheds in 2006. Values in parentheses are the number of reaches comprised of multiple sample sites used for the estimate.

	Stream			
Species	Alder Creek	Benewah Creek	Evans Creek	Lake Creek
westslope cutthroat trout	0.5±0.3 (13)	11.3±4.6 (16)	14.5±4.5 (10)	14.8±5.3 (8)
brook trout	16.9±5.2 (13)	3.2±1.2 (16)		

A power analysis was done to evaluate the power to detect annual changes of cutthroat and brook trout populations at the watershed scale. The 11-year (1996-2006) population estimate data set was used for the power analysis. The power to detect changes in cutthroat trout populations is highest in Evans and Benewah creeks (*Figure 8*). However, the higher power is associated with only a coarse-scale detection range of ± 4% to 10% and does not meet the criteria of detecting

fine-scale changes (± 3%) with 0.80 power at α 0.10 (Vitale et al. 2002A). The power of detection in for brook trout in Alder Creek is twice that of Benewah Creek (*Figure 9*).

Trout Age and Size

Summary statistics were generated for lengths, weights, and condition factors of estimated age groups for cutthroat trout from the four creeks (*Table 4*) and brook trout from Alder and Benewah creeks (*Table 5*). Mean weights and condition factors were compared across Benewah, Evans, and Lake creeks for each of the estimated age classes of cutthroat trout from 0+ to 3+. Numbers of cutthroat trout in Alder Creek and numbers of fish in age classes greater than 3+ were disproportionately lower and thus were excluded from the comparative analyses. In addition, statistical comparisons were not conducted for estimated age classes of brook trout because there was a disproportionately low number of fish caught in Benewah Creek compared to Alder Creek.

Statistical comparisons of weights and condition factors for age-0 cutthroat trout were conducted using the non-parametric Kruskal-Wallis test because of unequal variances in the data. If a statistically significant difference was detected, then a non-parametric multiple comparison test was used to determine significant pairwise differences (Neter et al. 1990). For all other age classes, assumptions of equal variances and normality were satisfied, and ANOVA was used to determine if significant differences existed across the study streams. Multiple comparisons were tested using the Tukey method.

Age-0 cutthroat trout from Benewah Creek weighed less than fish from both Evans and Lake creeks ($\chi^2 = 17.9$, $p<0.001$), but had higher condition factors than fish from those two creeks ($\chi^2 = 18.4$, $p<0.001$). This indicates that age-0 fish from Benewah were generally smaller in length, and consequently heavier at a given length, than similar aged fish from the other two creeks (*Table 4*). The significant results, however, could also be attributed to sampling error, as it may be difficult to obtain an accurate field weight estimate for small age-0 fish. Age-1 cutthroat trout from Benewah Creek were both heavier ($F = 33.1$, $p<0.001$) and had higher condition factors ($F = 29.4$, $p<0.001$) than fish from the other two creeks. In addition, age-2 cutthroat trout from Benewah Creek were heavier than fish from the other two creeks ($F = 30.0$, $p<0.001$). All other tests were not significant.

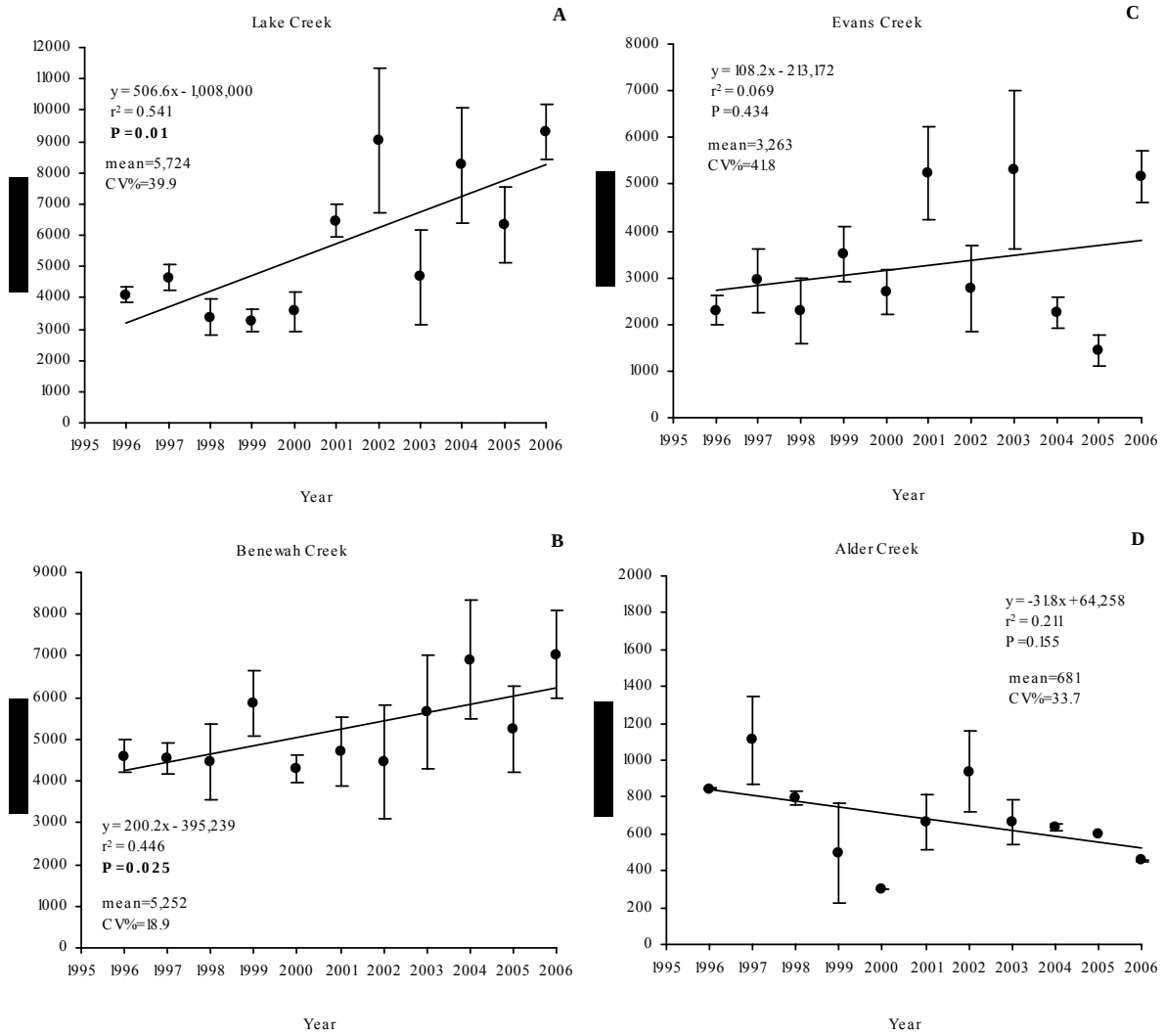

Figure 6. Population trends of westslope cutthroat trout estimated at the watershed scale in; A) Lake Creek, B) Benewah Creek, C) Evans Creek and D) Alder Creek.

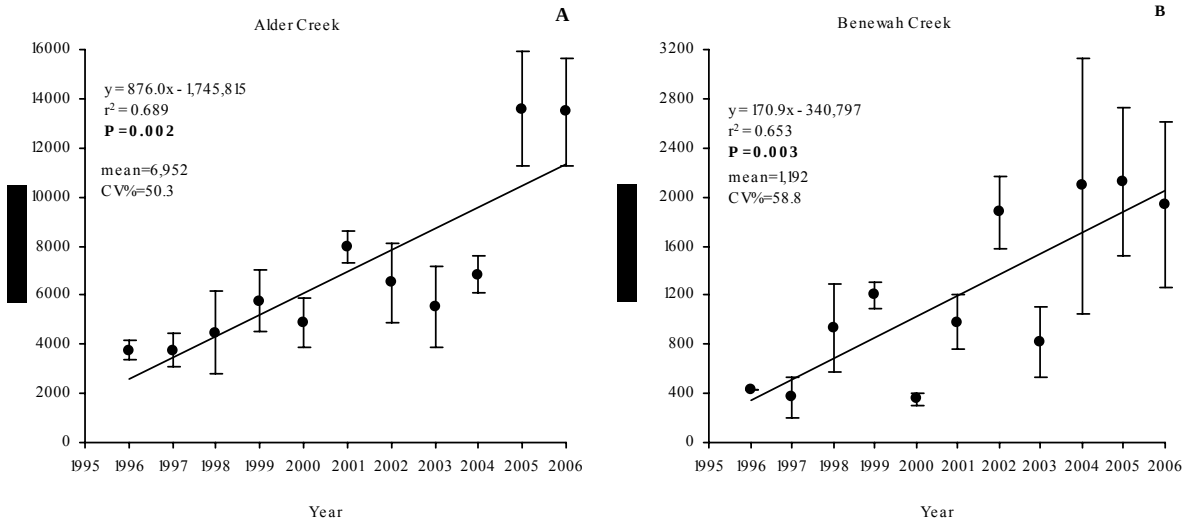

Figure 7. Population trends of nonnative brook trout estimated at the watershed scale in A) Alder Creek and B) Benewah Creek.

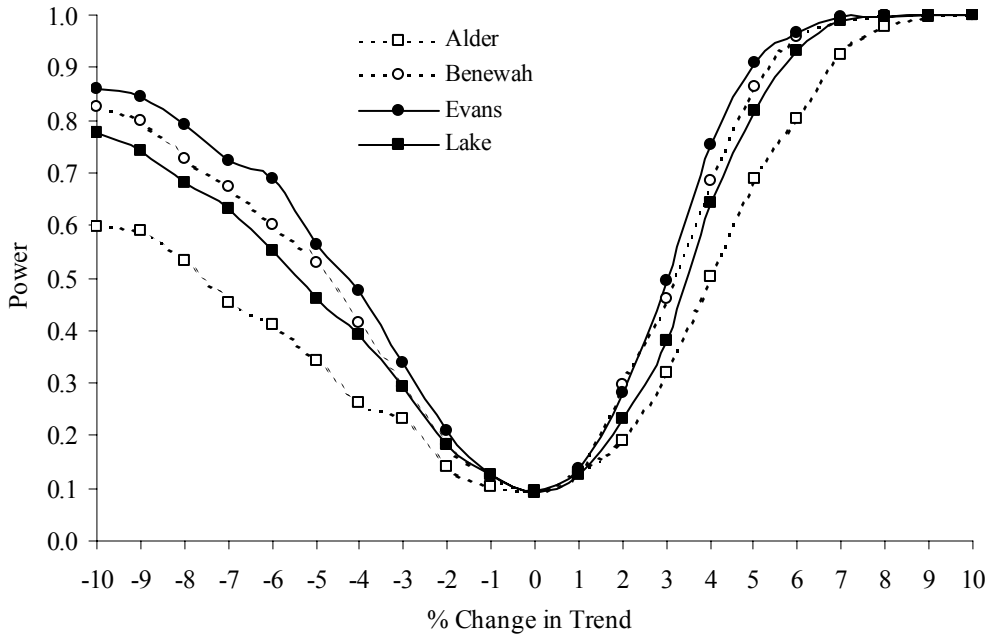

Figure 8. Power to detect annual changes in westslope cutthroat trout populations in four streams on the Coeurd' Alene Tribe Reservation (n=11 yrs, α level = 0.10).

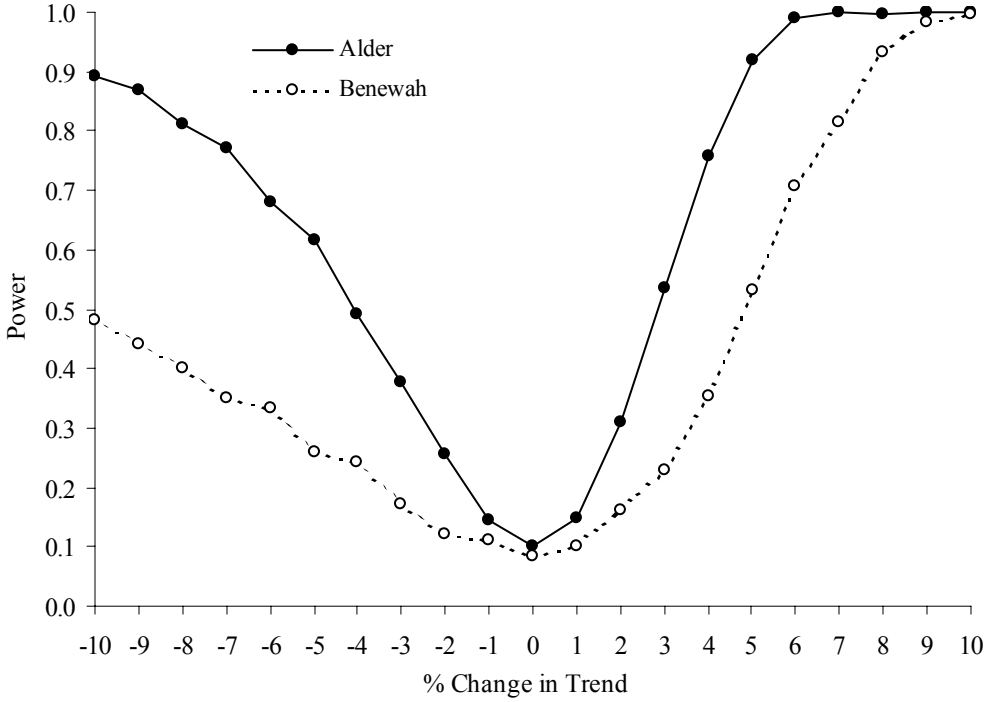

Figure 9. Power to detect annual changes in brook trout populations in two streams on the Coeurd' Alene Tribe Reservation (n=11 yrs, α level = 0.10).

Table 4. Summary statistics (mean, standard deviation (SD), and range) for total lengths, weights, and condition factors for estimated age classes of westslope cutthroat trout captured by electrofishing in Alder, Benewah, Evans, and Lake creeks in the summer and fall of 2006.

		Total Length		Weight		Condition Factor	
Age	N	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
				Alder Creek			
1	3	115 (7)	108 - 122	13.8 (2.1)	11.4 - 15.1	0.9 (0.089)	0.82 - 0.99
2	14	130.8 (11.5)	115 - 159	20.2 (6.6)	12.7 - 36.6	0.88 (0.118)	0.75 - 1.18
3	8	150.4 (10.8)	136 - 164	28.5 (6.9)	20.5 - 37.1	0.82 (0.04)	0.77 - 0.89
4	1	197	197 - 197	69.4	69.4 - 69.4	0.91	0.91 - 0.91
5	1	245	245 - 245	131.5	131.5 - 131.5	0.89	0.89 - 0.89
				Benewah Creek			
0	114	57 (7.9)	37 - 84	1.9 (0.9)	0.6 - 6.4	1.02 (0.212)	0.51 - 1.64
1	41	102.7 (9.7)	81 - 120	11 (3)	4.9 - 17.3	0.99 (0.114)	0.8 - 1.23
2	151	126.7 (13.7)	95 - 157	19.6 (6.2)	8.8 - 36	0.94 (0.108)	0.64 - 1.28
3	24	161.5 (13.8)	136 - 193	38.9 (10.8)	19.5 - 63.1	0.9 (0.065)	0.78 - 1.04
4	7	212.7 (16.1)	194 - 245	91.6 (29)	68.5 - 153	0.93 (0.077)	0.79 - 1.04
				Evans Creek			
0	109	61.4 (12)	35 - 80	2.4 (1.2)	0.4 - 4.9	0.94 (0.158)	0.69 - 1.65
1	161	96.5 (11)	77 - 119	8.1 (3.2)	4.1 - 16.7	0.87 (0.114)	0.61 - 1.21
2	78	128.8 (11.4)	97 - 153	19 (5.8)	7.7 - 33.9	0.87 (0.103)	0.69 - 1.18
3	44	168.1 (15.5)	142 - 195	44.6 (13.6)	24.1 - 73.3	0.91 (0.082)	0.77 - 1.15
4	14	214.5 (11.2)	200 - 235	91.4 (18)	74.9 - 129	0.92 (0.082)	0.8 - 1.08
5	3	262.3 (13.8)	252 - 278	156 (18.7)	145 - 177.6	0.86 (0.04)	0.83 - 0.91
				Lake Creek			
0	254	62.7 (8.8)	36 - 85	2.4 (1)	0.3 - 5.3	0.92 (0.15)	0.58 - 1.69
1	127	90.4 (12.5)	68 - 122	6.6 (3)	3.1 - 18.6	0.84 (0.109)	0.54 - 1.19
2	116	130.9 (14.2)	94 - 156	19.8 (6.2)	7.6 - 34.1	0.85 (0.07)	0.68 - 1.07
3	50	168.8 (12.8)	144 - 195	43.4 (11.2)	26.3 - 70.1	0.88 (0.071)	0.76 - 1.07
4	7	212.9 (8.8)	198 - 224	90.2 (12.6)	66.3 - 103.7	0.93 (0.075)	0.83 - 1.05
5	1	253	253 - 253	158.9	158.9 - 158.9	0.98	0.98 - 0.98

Table 5. Summary statistics (mean, standard deviation (SD), and range) for total lengths, weights, and condition factors for estimated age classes of brook trout captured by electrofishing in Alder and Benewah creeks in the summer and fall of 2006.

		Total Length		Weight		Condition Factor	
Age	N	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
				Alder			
0	152	64.3 (7.4)	44 - 80	3 (1)	1 - 6.2	1.1 (0.192)	0.58 - 1.71
1	126	98.9 (12.8)	76 - 130	9.7 (3.7)	3.7 - 21.7	0.97 (0.118)	0.68 - 1.28
2	177	126.9 (13.8)	86 - 155	19.8 (6.6)	3.7 - 39.6	0.93 (0.111)	0.54 - 1.35
3	150	161.9 (19.3)	121 - 203	43.5 (16.6)	15.1 - 86.3	0.97 (0.105)	0.73 - 1.29
4	52	206.5 (14)	176 - 240	91.1 (21.5)	51 - 154.7	1.02 (0.115)	0.76 - 1.27
5	8	243.3 (15.4)	225 - 270	147.3 (26.1)	104.6 - 179	1.02 (0.111)	0.91 - 1.22
6	2	267.5 (10.6)	260 - 275	203.9 (21.1)	189 - 218.8	1.06 (0.016)	1.05 - 1.08
				Benewah			
0	10	68.3 (9.1)	50 - 81	3.3 (1.3)	1.1 - 5.4	1 (0.176)	0.7 - 1.32
1	10	89.1 (10.5)	76 - 110	7 (2.5)	4.4 - 13.1	0.97 (0.109)	0.8 - 1.17
2	30	126.2 (12.8)	103 - 145	20.4 (6.2)	10.9 - 31.1	0.98 (0.083)	0.85 - 1.21
3	44	165.1 (17.9)	138 - 204	46.2 (15.8)	26.2 - 83.9	1 (0.105)	0.81 - 1.24
4	11	188 (22.5)	161 - 232	64.1 (22.6)	35.7 - 110.2	0.94 (0.1)	0.79 - 1.18
5	5	248.8 (18.7)	232 - 280	159.1 (37.9)	138 - 226.2	1.02 (0.095)	0.87 - 1.13

Trout Migration

A resistance board weir (RBW) trap, which was first tested in Lake Creek in 2005, was again deployed in Lake Creek in 2006. The RBW trap was installed on March 2 and was fished 69 days to May 10. The RBW captured 24 adult westslope cutthroat trout (*Table 6*). Although the number of captured adults was too small to provide a robust estimate of the temporal distribution of upriver migrants, no adults were captured by the RBW in Lake Creek after April (*Figure 10*). The number of adults captured in 2006 was lower than the total of 124 adults captured by the RBW in 2005. This discrepancy may have been due to sustained high flows from April 5 to April 18 in 2006 that pushed the top of the RBW panels several inches under the water surface, compromising the efficiency of the trap and possibly permitting fish to escape upriver. Only 7 adults were captured during this time, comprising 29% of the adults captured throughout the season. However, the RBW design appears to be more effective at trapping adults than the old-style vertical weir as more adults have been captured in 2005 and 2006 than in previous years. The "pop-out panel" outmigrant trap design (similar to that used in 2005) was deployed in Lake Creek from March 30 to June 14 and fished approximately 93% of the time. During this time period, 233 post-spawn adults were captured in the outmigrant trap, nearly ten times as many captured in the upstream trap (*Table 6*). Sixty percent of the post-spawn adults were captured during an abbreviated time period during the last two weeks in April (*Figure 10*). Although post-spawn adults were generally captured later than upstream migrating adults, there was considerable overlap in timing between the two groups. Mean condition factors were lower for post-spawn adults than for pre-spawn adults, most notably for females *(Table 6)*.

From March 31 to June 14, 2407 juvenile cutthroat were captured by the Lake Creek outmigrant trap. Although there was considerable variability among daily capture estimates, juvenile outmigrants were not disproportionately distributed over coarser time periods (*Figure 11*). More than half of the outmigrating juveniles were estimated to be 2+ fish, with 42% of the run collectively estimated as 1+ and 3+ fish , and only 2% estimated as 4+ fish (*Table 7*).

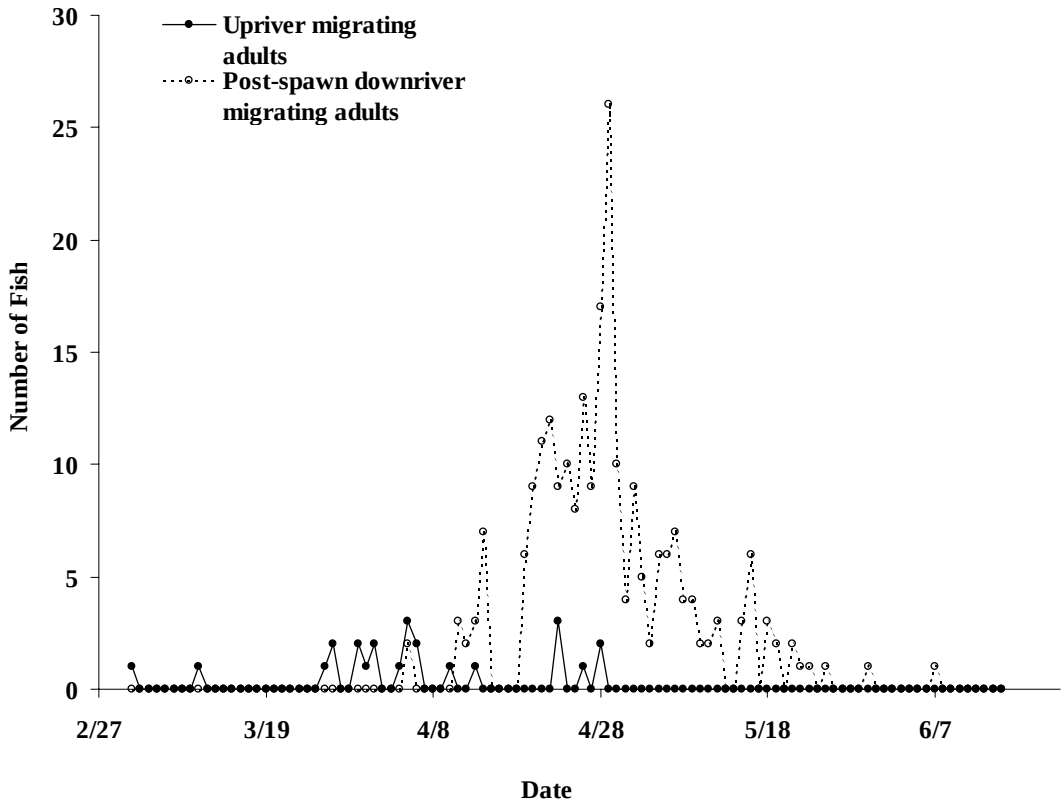

Figure 10. Timing of adult adfluvial westslope cutthroat trout captured during their upriver and post-spawn downriver migration in Lake Creek, 2006.

Table 6. Length, weight and condition factor means and standard deviations (SD) for adult adfluvial westslope cutthroat trout captured by a resistance board weir trap and outmigrant trap in Lake Creek in 2006.

		Total Length (mm)		Weight (g)		Condition Factor	
Gender	N	Mean	SD	Mean	SD	Mean	SD
		Pre-spawn fish caught moving upriver through weir					
Female	14	359.5	31.0	444.5	93.3	0.95	0.068
Male	8	411.3	44.0	629.3	180.7	0.88	0.066
Unknown	2	282.5	43.1	217.4	95.7	0.93	0.004
		Post-spawn fish caught moving downriver through trap					
Female	152	369.4	20.6	413.5	65.9	0.82	0.068
Male	80	394.7	37.5	534.5	118.2	0.86	0.072
Unknown[1]	1	--	--	--	--	--	--

[1] Data not collected from the fish

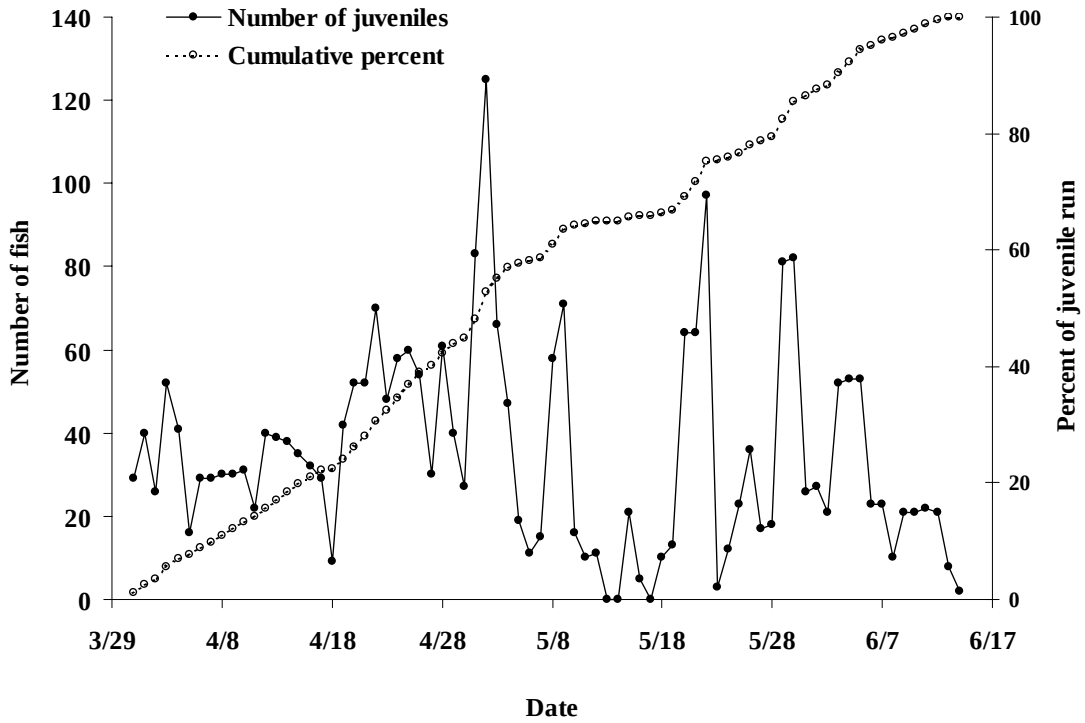

Figure 11. Timing of outmigrating juvenile adfluvial westslope cutthroat trout captured in the outmigrant trap in Lake Creek, 2006.

Westslope Cutthroat Trout PIT Tagging

A total of 803 juvenile adfluvial westslope cutthroat trout were PIT tagged between April 1 and June 5 in Lake Creek in 2006, accounting for approximately a third of the fish trapped. Fish were tagged throughout the outmigration period, though juveniles captured during the early portion of the run were typically tagged at a higher rate than fish migrating later (*Figure 12*). The estimated age composition of the tagged fish, however, was similar to that estimated for the total run with the majority of the tagged fish estimated as 2+ fish (*Table 7*). In addition, of those fish that were tagged, younger fish comprised a higher percentage of the early portion of the run than the later portion (*Figure 13*).

Ten release trials of variable time periods were conducted to estimate tag retention, mortality, and capture efficiencies for estimates of juvenile outmigration abundances (*Table 8*). All of the PIT tagged fish that were used in the trials survived the 24 h holding period and retained their PIT tags before they were released. Although capture efficiencies varied across the outmigration period, most of the calculated efficiencies exceeded 65 percent. The total number of outmigrating juveniles estimated from the calculated efficiencies was 4912 ± 811.

In Benewah Creek, the old-style vertical weir adult trap was used to capture upriver migrating adults and was fished 75% of the time from April 15 to May 23. Cutthroat trout were not captured by the weir; 16 brook trout, however, were captured during this time. The "pop-out panel" downriver trap design was installed on May 1 and fished until June 2. Only four adult and four juvenile cutthroat trout were caught in the trap with their capture occurring between May 1-12 and May 11-23, respectively.

Table 7. Comparison of estimated age composition between PIT tagged juveniles and all juveniles for adfluvial westslope cutthroat trout captured in the outmigrant trap in Lake Creek 2006.

	Trapped		PIT Tagged	
Age	Number	% Composition	Number	% Composition
1+	291	12	116	14
2+	1350	56	443	55
3+	709	30	235	29
4+	41	2	9	1

Table 8. Abundance estimates for juvenile westslope cutthroat trout outmigrating from March 31 to June 14 in Lake Creek, 2006. Abundance estimates with associated standard errors (SE) were calculated using a simple stratified mark-recapture design.

	Time period for release trial estimate						Abundance estimates	
Release trial	Start date	End date	Juveniles tagged	Juveniles captured	Tagged juveniles recaptured	Trap efficiency	Mean	SE
1	31-Mar	12-Apr	22	432	17	0.78	552	57.9
2	13-Apr	13-Apr	38	60	21	0.56	107	11.9
3	14-Apr	17-Apr	36	164	30	0.84	196	12.6
4	18-Apr	20-Apr	36	134	31	0.86	155	8.7
5	21-Apr	21-Apr	36	77	25	0.70	110	9.5
6	22-Apr	27-Apr	36	339	19	0.54	628	90.3
7	28-Apr	28-Apr	36	89	28	0.78	114	8.0
8	29-Apr	2-May	29	301	26	0.90	335	19.1
9	3-May	1-Jun	36	938	15	0.43	2170	393.4
10	2-Jun	14-Jun	36	353	23	0.65	545	62.5
Total			**341**	**2887**	**235**		**4912**	**413.6**

Brook Trout Removal

A total of 2,517 brook trout with a total biomass of 97.1 kg were removed from upper Benewah Creek and tributaries using single pass electroshocking in 2006. Increased focus was placed on mainstem habitats and an additional 3,553 m of mainstem habitats were sampled compared with 2005, for a total of 9,074 m treated in 2006 *(Table 9)*. Brook trout were removed from the upper mainstem beginning at the confluence with Whitetail Creek and upstream to the confluence of the West and South Forks. As in past years, additional attention was focused on sampling the entire West Fork and South Fork. All index sites associated with the population estimate were sampled prior to brook trout removal. Eighty-three percent of the brook trout removed came from the upper mainstem *(Table 9)*. Five age classes of fish were removed and the estimated total number of mature females and males removed was 736 and 659 respectively (*Table 10*). A higher percentage of adults were removed (55.4%) than in past years and the estimated number of eggs removed was 4.7 times greater than in 2005 (*Table 10*). Most of the adults removed were from the upper mainstem habitat.

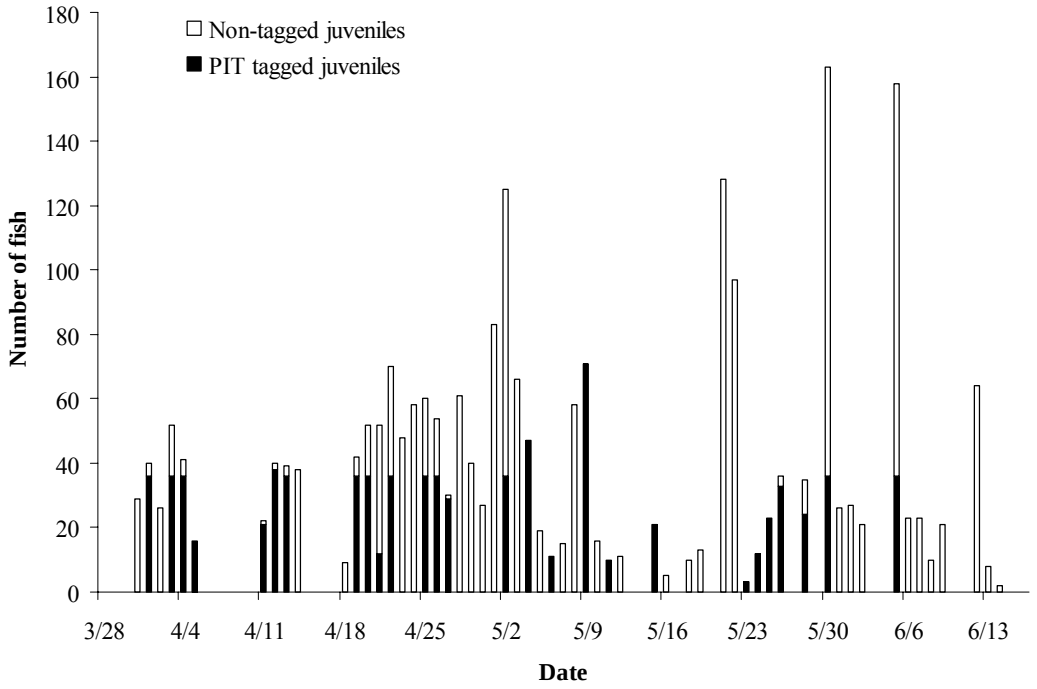

Figure 12. Relative numbers of juvenile adfluvial westslope cutthroat trout PIT tagged during their outmigration in Lake Creek in 2006.

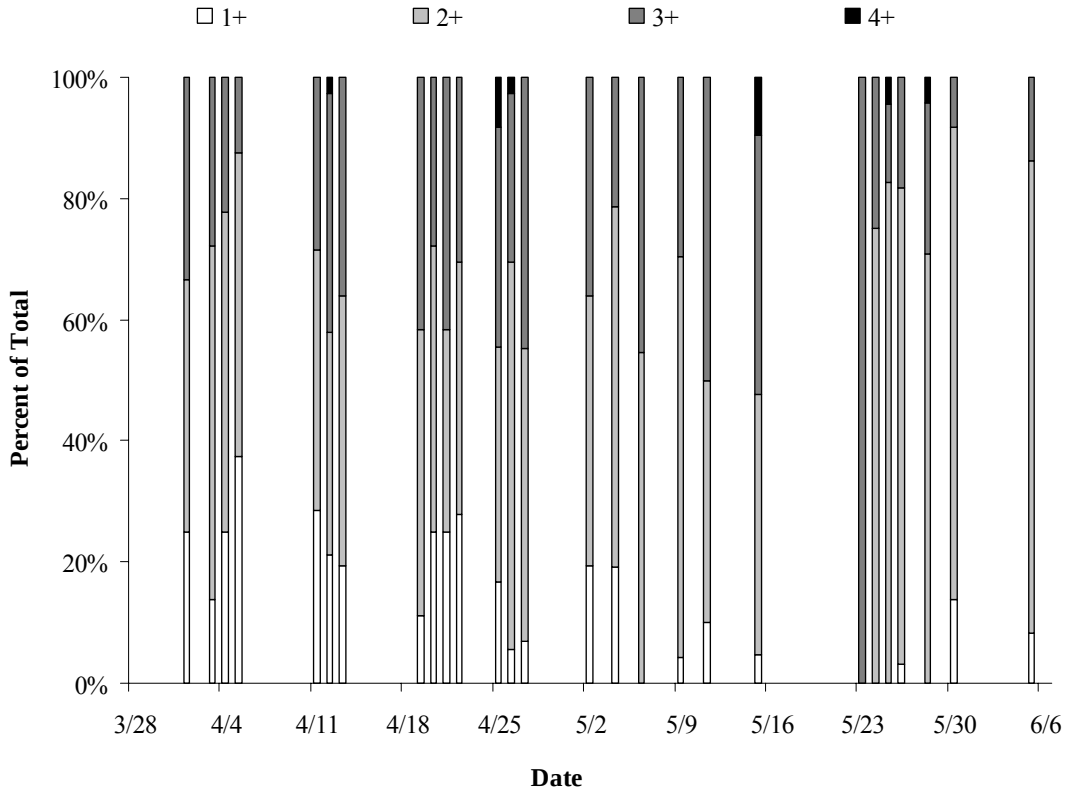

Figure 13. Estimated percent age composition of adfluvial westslope cutthroat trout PIT-tagged over the outmigration period in Lake Creek, 2006.

Table 9. Length of streams sampled, number and age composition of brook trout (Salvelinus fontinalis) removed from Benewah Creek.

	Length of stream shocked (m)			Number of brook trout removed			% Age composition[a]					
							Age					
Year	Tributaries	Mainstem	Total	Tributaries	Mainstem	Total	0	1	2	3	4	5
2004	3,687	213	3,900	563	56	619	30.9	12.4	42.8	10.2	3.4	0.3
2005	3,687	1,834	5,521	243	1,153	1,396	34.4	8.7	33.5	16.9	6.1	0.4
2006	3,687	5,387	9,074	421	2,096	2,517	14.1	7.6	36.5	28.0	10.9	2.9

[a] *Age was estimated using an age-at-length proportion key (Gulland and Rosenberg 1992) from scale analysis of 130 brook trout from Benewah Creek, from 1996-2003.*

Table 10. Gender, percentage of adults removed and estimated number of eggs removed from the population of brook trout (Salvelinus fontinalis) in Benewah Creek.

Year	Mature females removed[a]	Mature males removed[a]	Juveniles removed	Total removed	% Adults	Female to male ratio	Number of eggs removed[b]	Total biomass removed (kg)
2004	95	81	443	619	28.4	1.17	14,392	13.7
2005	319	207	870	1,396	37.7	1.54	38,367	32.9
2006	736	659	1,122	2,517	55.4	1.41	197,587	97.1

[a] *Estimated from logistic regression of maturity at length relationship from n=130 females, n=114 males and n=90 juveniles dissected in 2004 and 2005.*

[b] *Estimated from the number of eggs to total length relationship from 2004 and 2005 combined data(#of eggs= 2.95*Total Length-265.48, n=64) multiplied by the number of mature females in each 5 mm length interval.*

Physical Habitat Monitoring

Evaluation of Treatment/Control Site Pairings

Fourteen sites were surveyed and sampled in 2006 from June through November. The focus of sample effort was in the Lake Creek Watershed where 6 mainstem and 4 tributary sites were surveyed. Surveying was also completed at three sites in the Benewah Creek watershed and one site in Evans Creek. Benewah 15L was established as a new treatment site. No longitudinal data was available for Bozard 3 or for Benewah 17 because the survey files became corrupted.

The classifications for nine of 27 sites remained unchanged and 10 sites maintained the same level I classification, but substrate characteristics placed them into a new level II classification. (*Table 11*). The most common updated Rosgen channel type was C4. Three sites initially classified as "E" type channels were reclassified as "C" type channels. Two "C" type channels were reclassified as "E" type channels, WF Lake 2 and WF Lake 3. Two other "C" type channels were reclassified as "F" type channels, Evans 1 and Evans 2. Evans 1 has backwater effects from the Coeur d'Alene River while Evans 2 had severe bank erosion and was moderately entrenched. Evans 4 and 5 were found to be C4 instead of E3 channel types. Benewah 13 was found to be a C4 channel. Bozard 1 and 2 are slightly entrenched E type channels.

Stream Temperatures

Temperature results from data loggers are reported for the period of July 1 through August 31, the time period of maximum summer temperatures. The maximum daily temperature at each site was compared to 17.0°C, the upper 95% confidence interval for optimal growth, identified experimentally by Bear (2005).

Mainstem temperatures in Benewah Creek generally increased in a downstream direction, with the percent of time exceeding 17ºC ranging from 15.3% above Schoolhouse Creek to 48.7% at the 9-mile bridge *(Table 12)*. Temperatures at several monitored sites including, the mainstem 9-mile bridge, mainstem above Whitetail Creek and in lower Whitetail Creek itself, were all influenced by channel construction during much of the summer and the measured temperatures may be either higher or lower than expected (See project description B_8.9, Section 2). Upstream of these temperature-influenced sites, the high instantaneous temperature of 21.2ºC was recorded at two mainstem locations above Site 17. A slight cooling effect is apparent around the confluence with Windfall Creek and was noted in past years near the confluence of Whitetail Creek as well. Additional thermal heterogeneity was measured in several mainstem springbrooks that emerge at or near the bankfull elevation of the channel, but are isolated during baseflow conditions. These springbrooks never exceeded 17ºC. The principle tributaries to the upper mainstem, including Windfall, School House and Whitetail creeks, were also much cooler than mainstem habitats and had temperatures exceeding 17ºC ranging from 9.7% - 2.9% of the time, respectively.

The warmest temperatures in the Lake Creek watershed were recorded in the mainstem at site 6 (river mile 9.5), where the instantaneous maximum temperature was 22.5°C and temperatures exceeded the 17°C upper limit for optimal growth 39.4% of the time (*Table 13*). Mainstem site 10, located 6.3 km upstream and influenced by the West Fork and Bozard Creek, was cooler with an instantaneous maximum temperature of 21.5 °C and a 33.7% exceedance of 17ºC. Temperatures measured at the downstream end of the primary spawning tributaries, including the upper mainstem, Bozard Creek and West Fork Lake, were cooler still and had temperatures exceeding 17ºC ranging from 23.1%-29.5% of the time, respectively. The highest elevation sites, in upper Bozard Creek and EF Bozard, had mean daily maximum temperatures of 15.4ºC or less and exceeded 17ºC less than 3% of the time.

Evans Creek is cooler in summer compared to Benewah and Lake creeks. The highest instantaneous temperature of 18ºC was recorded in the lower mainstem, with a 1.9% exceedance of 17ºC (*Table 14*). All other sites measured had maximum daily temperatures below 17.0 °C.

Table 11. Updated Rosgen Classification of habitat sites surveyed 2002-2006.

Watershed	Site	Site type	Entrenchment ratio	Width/Depth ratio	Sinuosity	Water Surface Slope (%)	Channel Materials (d^{50})	Initial classification	Updated Classification[1]
Alder	12	Control	>2.2	22.6	1.20	1.27	27.0	C1	**C4**
Benewah	9	Control	>2.2	25.4	1.04	0.66	49.3	C3	**C4**
Benewah	12	Treatment	2.99	52.0	1.40	0.45	76.3	C4	**C3**
Benewah	13	Control	>2.2	22.5	1.31	0.30	25.1	C3	**C4**
Benewah	14 L	Treatment	>2.2	18.1	1.70	0.42	16.2	C4	C4
Benewah	14 U	Treatment	>2.2	39.1	1.10	0.62	26.4	C4	C4
Benewah	15 L	Treatment	>2.2	22.3	2.20	0.15	25.4	C5	**C4**
Benewah	16	Treatment	>2.98	18.0	1.12	0.60	26.6	C5	**C4**
Benewah	17	Control	>3.09	13.9	1.41	0.79	11.7	C4	C4
Evans	1	Treatment	1.3	28.2	1.42	0.02	21.1	C6	**F4**
Evans	2	Control	1.15	36.2	1.12	1.32	58.6	C3	**F4**
Evans	3	Treatment	>2.68	29.6	1.36	1.14	30.0	C3	**C4**
Evans	4	Control	>2.2	19.8	1.04	1.37	38.7	E3	**C4**
Evans	5	Treatment	>2.2	46.0	1.06	1.95	54.1	E3	**C4**
Lake	7	Control	>2.2	14.9	1.19	0.57	15.9	E4	**C4**
Lake	8	Treatment	>2.2	9.9	1.12	0.37	30.6	E4	E4
Lake	9	Treatment	>2.2	6.8	1.17	0.19	6.6	E4	**E5**
Lake	10	Control	>2.2	7.1	1.62	0.20	5.2	E4	E4
Lake	11	Treatment	1.7	31.1	1.06	0.23	0.6	C5	C5
Lake	12	Treatment	>5.8	5.6	1.11	0.59	0.4	E5	E5
Lake	13	Treatment	>3.03	32.7	1.34	0.27	0.1	D5	**C5**
Bozard	1	Control	1.95	9.4	1.40	0.25	19.1	E5	**E4**
Bozard	2	Control	2.38	9.3	1.79	0.29	1.8	E5	E5
Bozard	3	Control	>6.4	10.8	1.20	2.88	24.7	E4	E4
WF Lake	2	Treatment	2.19	7.9	1.18	0.48	3.3	C5	**E4**
WF Lake	3	Control	2.48	7.6	1.27	0.54	0.5	C5	**E5**
Windfall	1	Control	3.2	14.6	2.24	0.26	1.8	C4	C4

[1] Sites with bold and underline font have updated Level I or Level II classifications.

Table 12. Maximum and minimum stream temperatures and days exceeding the upper 95% confidence level for optimum growth of westslope cutthroat trout derived by Bear (2005) from Benewah Creek for the period of July 1-Aug 31, 2006. Refer to Figure 3 for site locations.

Site	Stream order	Instantaneous maximum Temp. (°C)	Mean (CV%) of daily max. Temp. (°C)	Mean (CV%) of daily min. Temp. (°C)	Days (% time) exceeding 17.0 (°C)[1]
Mainstem at 9 Mile Bridge[2]	4	21.4	18.6 (9.6%)	15.5 (10.4%)	50 (48.7%)
Mainstem above Whitetail Creek[2]	4	23.2	19.2 (9.8%)	14.4 (11.1%)	58 (43.7%)
Mainstem below Windfall Creek	4	20.3	16.9 (9.0%)	14.1 (10.7%)	27 (20.0%)
Mainstem above Windfall Creek	4	20.8	16.7 (10.8%)	13.1 (11.8%)	28 (16.1%)
Mainstem above Site 17	4	21.2	17.3 (9.4%)	12.1 (14.1%)	30 (17.1%)
Mainstem Above Schoolhouse	4	21.2	17.3 (9.2%)	12.0 (14.1%)	32 (15.3%)
Windfall Creek Site 1	3	19.7	15.3 (15.1%)	12.7 (12.0%)	22 (9.7%)
School House Creek Site 1	3	18.5	14.6 (11.9%)	11.5 (15.9%)	8 (2.9%)
Whitetail Creek Site 1[2]	3	20.1	13.8 (20.2%)	11.5 (13.4%)	14 (6.2%)
Springbrook 4	N/A	14.3	10.7 (9.7%)	10.1 (10.6%)	0 (0%)
Springbrook 5	N/A	16.7	13.9 (10.6%)	10.8 (16.2%)	0 (0%)

[1] *17.0 (°C) is the upper 95% confidence interval of temperature for optimum growth of westslope cutthroat trout (Bear 2005).*
[2] *Site temporarily affected during 2006 channel restoration work.*

Table 13. Maximum and minimum stream temperatures and days exceeding the upper 95% confidence level for optimum growth of westslope cutthroat trout derived by Bear (2005) from Lake Creek for the period of July 1-Aug 31, 2006. Refer to Figure 5 for site locations.

Site	Stream order	Instantaneous maximum Temp. (°C)	Mean & (CV%) of daily max. Temp. (°C)	Mean & (CV%) of daily min. Temp. (°C)	Days (% time) exceeding 17.0 (°C)[1]
Mainstem Site 6	4	22.5	20.8 (10.1%)	14.7 (13.0%)	60 (39.4%)
Mainstem Site 10	4	21.5	18.0 (9.3%)	14.5 (11.3%)	32 (33.7%)
Mainstem Site 11	3	22.5	18.1 (11.7%)	12.9 (14.2%)	40 (23.1%)
West Fork Site 1	3	21.3	16.7 (15.4%)	13.6 (19.1%)	30 (29.5%)
Bozard Creek Site 1	3	21.9	17.7 (9.4%)	13.7 (12.6%)	39 (24.6%)
Bozard Creek (Below EF Bozard)	3	18.0	14.9 (9.0%)	11.6 (12.0%)	6 (2.3%)
Bozard Creek Site 3 (Above EF Bozard)	2	18.7	15.4 (8.4%)	11.8 (11.3%)	7 (2.9%)
East Fork Bozard Creek	2	17.8	14.7 (8.7%)	11.7 (11.9%)	5 (1.4%)

[1] *17.0 (°C) is the upper 95% confidence interval of temperature for optimum growth of westslope cutthroat trout (Bear 2005).*

Table 14. Maximum and minimum stream temperatures and days exceeding the upper 95% confidence level for optimum growth of westslope cutthroat trout derived by Bear (2005) from Evans Creek for the period of July 27-Aug 31, 2005. Refer to Figure 4 for site locations.

Site	Stream order	Instantaneous maximum Temp. (°C)	Mean & (CV%) of daily max. Temp. (°C)	Mean & (CV%) of daily min. Temp. (°C)	Days (% time) exceeding 17.0 (°C)[1]
Mainstem Site 3	3	18.0	15.3 (6.7%)	12.3 (7.6%)	7 (1.9%)
Mainstem Site 9	3	15.2	12.9 (6.8%)	11.4 (8.1%)	0 (0%)
Mainstem Site 10	2	15.4	13.0 (7.0%)	11.5 (8.4%)	0 (0%)
East Fork Site 1	2	16.7	14.2 (6.7%)	12.4 (8.2%)	0 (0%)

[1] *17.0 (°C) is the upper 95% confidence interval of temperature for optimum growth of westslope cutthroat trout (Bear 2005).*

DISCUSSION

The overarching goal of the CDA Tribe Fisheries Program as it relates to native westslope cutthroat trout is to restore the native salmonid to population levels that allow for subsistence harvest, maintain genetic diversity and increase the probability of persistence in the face of anthropogenic influences and the prospect of climate change. The lacustrine-adfluvial life history results in large westslope cutthroats that migrate as mature adults from Coeur d'Alene Lake into tributaries to spawn. In 1993 the Coeur d'Alene Tribe closed Lake Creek and Benewah Creek to fishing to initiate restoring the westslope cutthroat trout to historical levels. Early in the 1990s, BPA-funded surveys and inventories identified limiting factors in Tribal watersheds that would need corrected in order to restore westslope cutthroat trout populations. The limiting factors include: low quality, low complexity mainstem stream habitat and riparian zones; high stream temperatures in mainstem habitats; negative interactions with nonnative brook trout in tributaries; and negative food web interactions in Coeur d'Alene Lake. All of the above limiting factors are either being directly addressed with restoration techniques, biological control, or with monitoring and evaluation that will provide data to refine future management decisions.

Population and Production of Westslope Cutthroat Trout

The eleven-year population data set for westslope cutthroat trout indicates statistically significant increasing trends at the watershed scale in Lake and Benewah Creeks. The westslope cutthroat trout population in Evans Creek reveals no trend and a decreasing, but not statistically significant, trend is apparent in Alder Creek. In addition to the increasing population trend, Lake and Benewah Creek also have the highest mean densities at the watershed scale. The increasing population trends of westslope cutthroat trout in Lake and Benewah Creeks are likely the result of the continued harvest moratorium in place since 1993, and that most of the habitat restoration efforts have been focused in the Lake Creek and Benewah Creek watersheds. Although there is evidence of increasing population trends, production of westslope cutthroat trout in all four target streams remains in the lower range reported in the literature and much lower than the 100-300 (kg/hectare) proposed by Waters (1992) for salmonids in more productive stream systems. Mean annual production in 2nd and 3rd order tributaries is generally 2-7 times greater than in 3rd and 4th order mainstems of Lake, Benewah and Alder creeks. Production is more evenly distributed in Evans Creek, likely due to the distribution of more suitable summer temperatures throughout Evans Creek. Our working hypothesis is that the density and population of westslope cutthroat trout will increase due to increased juvenile survival and increased habitat productive capacity as 3rd and 4th order mainstem habitat is restored. Projects B8.9 and E1.3 (described in Section 2 of this report) are examples of the types of mainstem restoration that will increase habitat productive capacity for westslope cutthroat trout.

Nonnative Brook Trout Control

The populations of non-native brook trout continue on a statistically significant, increasing trajectory in both Alder and Benewah creeks. The increasing population trends for non-native brook trout are not favorable because brook trout negatively impact westslope cutthroat trout, displacing westslope cutthroat trout when they overlap (Griffith 1988, Adams et al. 2001, Peterson and Fausch 2003, Shepard 2004). Given the large amount of evidence that nonnative brook trout compete and displace cutthroat trout, it is justifiable that a control program is an essential component of cutthroat trout recovery in the watershed. The best method for implementing this program is still uncertain and there is still insufficient post-removal density

data to make an evaluation of removal effectiveness at this time. Refinements to the scope of the removal efforts are ongoing and largely based on the data being collected. Consistent with 2004, we verified that no fish captured during the 2005 and 2006 removal periods had yet spawned. Thus, in relation to spawn timing, sampling is removing adult brook trout prior to spawning. However, the results from the 2005 and 2006 removals reveal that the density of brook trout in the upper mainstem was higher than anticipated based on annual population estimates. In 2005 and 2006, three times and eight times more adults were removed, respectively, compared to 2004 and most of the adults removed came from the mainstem habitat. This trend suggests that the mainstem is likely the largest source of adults, which drives the future production potential in the watershed. If left unchecked, the ongoing invasion of brook trout in the watershed is likely to proceed in an upstream direction from these mainstem "strongholds" (Peterson and Fausch 2003); intensifying the effects of competition in the most suitable habitats left for cutthroat trout over time. In response to this evidence, the length of mainstem targeted for removals has been increased by 5,174 m since 2004. Additional tributary reaches may also need to be treated in the future as brook trout are detected at population index sites. This appears to be occurring in Windfall Creek following removal of a passage barrier in 2004 to improve access for migratory cutthroat to spawning areas. As part of a more thorough evaluation, criteria should be established that would trigger removal efforts based on exceedance of a desired maximum density (e.g., $<0.25/100\ m^2$) over some time frame as measured at index sites. For reasons discussed in previous reports, including the need to maintain both the resident and adfluvial life histories of cutthroat trout, and the cost and uncertainty associated with complete removal of brook trout, among others (Vitale et al. 2007), removals will likely need to continue over the foreseeable future to first achieve low densities of brook trout throughout the watershed and then maintain these lower densities.

The three years of removal data suggest that reduction of the adult component is possible. The ratio of adults to juveniles removed was greatest in 2006 (55.4%), followed by 2005 (37.7%) then 2004 (28.4%). The total brook trout population estimate in Benewah Creek was 7% lower than in 2004 when removal efforts were initiated. Although this trend is not statistically significant in the context of the 11-year population dataset, it is one indicator of success. Also, the reach scale estimates from 2006 in several tributaries where removals have been consistently implemented, including upper mainstem Benewah, South Fork Benewah and West Fork Benewah, all show lower densities than the 11-year average density for the respective sites. The reach scale estimates from tributaries that have not been targeted for removals (School House, Windfall and Whitetail), on the other hand, all show higher than average densities in at least two of the last three years.

Improving mainstem habitats through restoration may have the secondary effect of increasing production potential for brook trout. As other researchers suggest, nonnative species control then becomes a necessary component of habitat restoration where sympatric populations are present (Peterson et al. 2004; Shepard et al. 2002). Migrant trapping in both spring and fall may be an efficient way to improve the overall effectiveness of control efforts. The amount of mainstem sampled has been expanded to include all of the mainstem above Whitetail Creek, while the same tributaries will be resampled as in 2004-2006. This adds an additional 2.6 km of mainstem for a total of nearly 8.0 km of continuous stream sampled to remove nonnative brook.

Measuring Population Responses to Restoration

We predict increases in westslope cutthroat trout production, productivity and distribution in watersheds with habitat restoration. Production and productivity gains for lacustrine-adfluvial westslope cutthroat trout will be realized as juvenile rearing distribution expands into more suitable mainstem habitats and density increases in tributary habitats. Productivity increases will be estimated as juveniles produced per spawner, and continued increases in juvenile density in 2nd and 3rd order tributaries, and both density and distribution increases in 4th order mainstem habitat. An important metric to evaluate adfluvial westslope cutthroat trout response is the relationship of juveniles per spawner, and total number of spawners. As habitat capacity is increased from restoration, the number of juveniles per spawner will increase. Theoretically, as habitat capacity reaches a maximum in a watershed, and all available habitat is fully seeded with juveniles, then maximum habitat capacity has been reached. When maximum habitat capacity is reached, the relationship between juveniles per spawner and total spawners becomes density-dependent. As the number of spawners increases, juveniles per spawner decreases. Adding additional spawners does not increase the total number of juveniles produced.

An important part of this relationship is the juvenile-to-adult survival, that measures the survival of westslope cutthroat trout in Coeur d'Alene Lake. Effective trapping techniques for adults and juveniles are required to measure the habitat capacity and juvenile-to-adult survival. The Fisheries Program has made substantial improvements of the trapping methods. In 2005, a resistance-board weir trap (Tobin 1994, Stewart 2002) was used to capture spawners migrating upstream in Lake Creek. The resistance-board weir trap is designed to handle high flows and debris loading much better than the conventional, vertical weir trap design the program used in the past. In addition, a new juvenile outmigrant trap design with "pop out" panels that can be removed during high flows and debris loading events was used. The "pop out" panel design reduces the potential for trap failure because the panels can be removed before they become debris-laden, clog and physically fail. In the past, after a trap failure, it would take several days to get the trap fishing again. The 2006 field season marked the first time that the Program has estimated trap efficiency using release groups of PIT tagged fish to estimate the total number of outmigrant juveniles with confidence intervals after Carlson et al. (1998). The total estimate of juvenile outmigrants in Lake Creek was 4,912 ±413.6, or about 77% of the total population estimated during the previous summer. This suggests that adfluvial fish are a significant component of the overall population in that watershed. These migratory fish may be more resilient than resident types to changes in habitat carrying capacity and to stochastic disturbances in tributaries because adults are somewhat insolated during their residence in the lake, similar to pacific salmon (Montgomery 2003). The efficiency trials used to derive these estimates are important and need to be replicated in Benewah Creek and should be conducted annually to facilitate the development of more robust relationships.

The monitoring and research program has mostly focused on in-stream westslope cutthroat trout production through multi-pass electroshocking population estimates. However, survival, growth and life history attributes of adfluvial cutthroat trout in Coeurd'Alene Lake have not been studied. Results from past studies on Coeur d'Alene Lake reveal that non-native piscivorous species, especially northern pike prey on adfluvial westslope cutthroat trout (Rich 1992, Anders 2003). The in-lake survival of adfluvial westslope cutthroat trout is a critical knowledge gap because nonnative predators in Coeur d'Alene Lake may be limiting production. In addition, competition with nonnative kokanee likely reduces the size of spawners and reduces the amount of eggs available for spawning. Thus, from a recovery standpoint, assessing the scale of the impacts the Coeur d'Alene Lake food web has upon adfluvial westslope cutthroat trout is

imperative. To fill the survival estimate knowledge gap, a within lake survival study using PIT tag technology was initiated in 2005. PIT tagging groups of outmigrating juvenile westslope cutthroat trout, then detecting the surviving adults as they return to spawn will allow for a juvenile-to-adult survival estimate and provide the data needed to measure within-lake growth rates and better understand the adfluvial life history. The first returns from the 2005 release group are expected in 2007.

Habitat Monitoring

Monitoring Methods and Issues

The physical habitat monitoring conducted during the last five years is significant in terms of developing baseline data, aiding in formulating project performance criterion and expected responses, and understanding long-term trends in habitat and population responses in the target watersheds. Many lessons have been learned through the initial years of habitat surveying, including the challenge of comparing habitat data over time. Some of the survey methodology has been modified each year in an attempt to improve the quality, repeatability and significance of data being collected. In some cases, these modifications have made it more challenging to compare data across sample periods. Some discussion is provided below to describe the consequences of changes to survey methods and recommendations for the future.

Temperature

Our temperature data again supports the presence of favorable cutthroat habitat in the cooler tributaries of both Benewah and Lake creek watersheds. However, elevated summer temperatures in the mainstem of both creeks suggest that optimal growing temperatures may still be exceeded 40-50% of the time in some reaches. The availability of cool water inputs from groundwater sources, as evidenced by the data collected from several isolated spring brooks in the broad alluvial reach of the Benewah mainstem, indicates that cold-water refugia could be provided for summer rearing salmonids if floodplain habitats can be reconnected with the main channel to increase hyporheic dynamics. Restoring these conditions at multiple reaches within a mainstem valley segment may increase westslope cutthroat trout production through increasing the availability of favorable habitats for summer rearing. Specifically, we will continue to track summer temperatures in the Benewah watershed as contiguous mainstem reaches are restored to determine if the incremental addition of pool volume (via bed elevation) and floodplain reconnection provide more optimal rearing habitats.

Canopy Density

The canopy density methodology was modified so that instead of being taken at the cross-sections, the data was collected at six randomly selected locations. This change was deemed necessary because the vegetation by the cross-sections was being clipped and trimmed back when the cross-sections were being surveyed. Total percent canopy density can be compared for all years but changes in canopy by cross-section can only be calculated for 2003-2005.

Longitudinal Profile

In 2003 and 2004 the thalwag tape for the longitudinal profile was stretched out along the thalweg of the channel by running the tape over or around existing woody debris or rocks. Starting in 2005, bank pins were established above the high water mark at each surveyed site.

The tape was then stretched along the bank and tied to these pins. The tape distance was recorded for each pin.

In 2006, the longitudinal profile was measured using a total station instead of an autolevel. Bank pins were established by field crews before the total station was used. Though using the total station provided important data on meander geometry, many of the longitudinal profiles that resulted do not match up well with the longitudinal profiles collected with an autolevel from 2002-2005. For 2006 data, longitudinal profiles were input into an excel spreadsheet as coordinate points including northing, easting, and elevation values. The northing and easting values of each surveyed point were converted into a channel station using the distance formula. The point coordinates were also used to create a plan view for each site. There are some differences between thalwag profiles surveyed using this method and using an autolevel and tape. Many sites that were measured at 500 ft in previous years were longer than 500 ft when the stationing from the total station coordinates was calculated. This was because each surveyed point was located in the thalwag of the channel that may or may not have corresponded to the center of the channel. In the future, longitudinal profiles will be collected with an autolevel and the total station will be used to survey in the location of the cross-section pins and to get channel pattern data. Also, the bank pins will be used to stretch the tape the same and aid in repeatability. The bed form differencing equation has been used to identify residual pools for each site starting in 2004. It was decided for the 2006 report that this method, though useful, was identifying pools that were not significant. This is the result of the sampling measurements of the thalwag being so close together. Therefore, identified pools less than 1 ft in residual depth were eliminated.

Cross-Sections

There are some differences in how the cross-sections are classified into habitat types. In 2003, cross-sections were classified in the field. In 2004 and 2005, stream cross-sections were classified on where they were located on the thalwag profile graph if there was no record of habitat type on the data sheets. For 2006, cross-section designations from the previous survey year were used unless the cross-section type was recorded.

In each year, bankfull estimates were made in the field at each cross-section. In many cases, bankfull elevation for a specific cross-section did not match up to the previous years. There are many hardships in identifying bankfull elevation in the field, especially at sites that have been disturbed. The cross-sectional areas derived from the equations from Castro and Jackson (2001) and Berenbrock (2002) were used to help compare riffle cross-sections between years.

Starting in 2006, cross-sections were surveyed using points from the previous surveyed year. New stations were also added to encompass any change in topography not captured by the given points. In the future, this will aid in comparing the cross-sections because change in elevation at each point can be examined. By comparing the changes at intervals along the cross-section we will be able to examine the change both within and outside of the bankfull channel. This will be especially useful in cross-sections where direct channel restoration has occurred such as Benewah site 16.

Pebble Counts

In 2002-2004, channel substrate was measured using a modified version of Wolman's (1954) pebble count method as described by Rosgen (1993). The modified method adjusts the material sampling locations so that streambed materials are sampled on a proportional basis along a given stream reach. Pebble counts were collected at each habitat type: Riffle, Pool, Run, and Glide. The percent of each habitat type was used to determine a weighted pebble count. Both cross-sections and areas outside of the cross-sections were surveyed for the pebble counts. Sometimes two cross-sections were used to complete the pebble counts for one habitat type. In 2005, pebble counts were completed at the cross-sections. Not all cross-sections were surveyed. Riffle cross-sections were surveyed the most often. It was difficult to sample in pools and collect substrate samples in an unbiased manner. For 2006, the method was modified to include 100 counts at riffle cross-sections and pool tailouts to better characterize substrate conditions relative to spawning.

Large Woody Debris

In some cases, it is hard to tell whether the data entered for the small end diameter is in inches or feet. Some entries for the small end are "1". This could be 1 inch or 1 foot. To determine which, the large end diameter is examined. If the large end is greater than 4 inches, it is assumed that the small end is 1 inch. Before this assumption was made, previous years data was examined to see if the individual log could be identified.

Sometimes the location of wood was noted but incomplete information on the length and diameter was given. In these cases, if no small end diameter was listed, it was assumed that the diameter was 4 inches. If no large end diameter was given, it was assumed that the large and small end diameters were the same. Again, before the assumptions were made, the previous years data was examined to see if the individual log could be identified.

Some distinct logs can be traced through each year by comparing longitudinal stationing. Many of these logs have different lengths and different diameters then the previous year. Also, in some cases logs lying above the bankfull channel may or may not have been counted. In 2006, the location of the log within and outside of the bankfull channel was recorded. How this wood impacts the channel is not recorded. It is suggested that some more of the methods outlined in the Schuett-Hames et al. (1999) be incorporated into the large wood methodology.

Treatment/Control Site pairings

Control site conditions were evaluated during the past year based on measured data that yielded updated channel type designations and recommendations were made for new control/treatment pairings (*Table 15*). Several treatment sites that warranted further scrutiny were also evaluated in the context of balancing monitoring needs and staff commitments. Sites were categorized as either stable or unstable. Unstable sites are sites that have evidence of active lateral or horizontal adjustments and represent a transitional phase between channel types.

Four control sites were found to not be compatible with existing treatment sites. These sites included Alder 12, Benewah 9, Benewah 13, and Bozard 3. These sites were unpaired but should be kept in the survey rotation to serve as possible control sites for future treatments. Two sites, Lake 13 and Evans 2, were recommended for removal from the survey rotation. Lake 13

was recommended for removal because it is a braided channel (D5) that does not match any current or envisioned treatment sites at this time. Evans 2 was eliminated because of access issues. Windfall 1 was initially unpaired but has been now paired with Whitetail 1, a new treatment site. Evans 3, a treatment site, is now unpaired. In addition, it was recommended that a future habitat site should be established between Bozard 2 and Bozard 3. Bozard 3 has a different valley type (Type VII versus Type VIII) and a higher gradient (0.0288 versus 0.0048) than West Fork Lake 2, its initial paired site. This new site would serve as a logical control site for treatments at West Fork Lake 2 and West Fork Lake 3, in the event that proposed treatments are implemented at that site.

Two sites that have been previously monitored, including Lake 12 and Benewah 17, were found to exhibit stable conditions that fall within the range of reference conditions for their respective channel types and could serve as control sites for a range of channel treatments as well as serve as reference reaches for stable natural channel design. It was determined that Lake 12 could serve as a control site, despite having received vegetative treatments in the past. This site is a stable, low width/depth ratio E5 channel due, in part, to the presence of reed canary grass, but was identified for riparian treatments because of a limited amount of cover from woody plants. The primary response variable at the site is thought to be canopy density because bank erosion is negligible and width/depth ratios are within the range of reference values for stable sites. Benewah 17 is a stable C4 channel located on property owned by the Tribe, which has remained undisturbed for at least 8 years. The surrounding riparian vegetation is mixed conifer forest that is representative of potential natural vegetation communities in the valley. Similar to Lake 12, Benewah 17 has received riparian treatments in the last 4 years, but the only potential response variable is canopy density. Both of the sites have good applications as control sites for a variety of channel treatments.

Increasingly, there is a need to identify future reference sites that are representative of the different valley/channel type combinations present in the target watersheds. Having reference sites that represent the full range of landscapes present in the target watersheds would facilitate the development of restoration strategies and performance criteria for treatment sites that are proposed in the future. The Fisheries Program is increasingly focusing on completing restoration projects that treat instream habitat and restore normative ecological processes for larger stream reaches. Part of this approach acknowledges the use of natural channel design methods developed by Dave Rosgen (2006) and others (FISRWG 1998). In natural channel design, a reference reach is selected that provides the template for designing the new stream channel at the restoration site. A reference reach is defined as "a reach that is undisturbed or is minimally disturbed by management activities, or may have recovered from historic management disturbances" (Frazier et al. 2005). Reference sites should be the same valley and stream type as the desired condition at the restoration site. In some cases, finding a suitable reference reach in the same watershed as the treatment reach is not possible. In this case, reference reaches from nearby watersheds can be used. Sometimes it is not possible to restore a site to its historic condition due to changes in hydrology or land use adjacent to the stream reach (NRCS 1998). In this case, managers have to identify possible options for the site and chose the one that they feel has the best potential to satisfy restoration objectives.

Table 15. Evaluation summary for monitored control and treatment sites.

Control sites	Treatment sites	Stability	Further review needed?	Site descriptions	Recommendation	New pairing
Alder 12	Evans 3	Unstable	√ Field	This site has bedrock influence and is unlike any exiting treatment sites	Maintain as a possible control	Unpaired
Benewah 9	Benewah 14 L	Stable	√ Office	This site is a B channel type and unlike any existing treatment sites	Maintain as a possible control	Unpaired
Benewah 13	Benewah 12	Unstable	√ Office	Acitve bank erosion and heavily grazed; high width/depth ratio C4	Maintain as possible control	Unpaired
Benewah 17	Benewah 14 U Benewah 15 L Benewah 16	Stable		Unmanaged, mainstem site on Tribal property	Maintain as control; appropriate reference site for design work	Same as initial with the addition of Benewah 14 L and Benewah 12
Windfall 1	Unpaired	Unstable		Site has some eroding banks and is slightly entrenched	Maintain as control site	Whitetail 1 (new treatment site)
Evans 2	Evans 1	Unstable		Site has only one year of survey data; access issues limit usefulness	Eliminate as a control site	Not applicable
Evans 4	Evans 5	Stable	√ Field	This is a forested site; an old road "ford" exists on site	Keep as control site; Review Evans 5 for possible control site status	Same as initial
Lake 7	Lake 8	Stable	√ Office	Lake 7 - Located upstream of a bridge Lake 8 - Bedrock influence; multiple channel types present (E4/C4)	Maintain Lake 7 as possible control; eliminate Lake 8 as monitored treatment site	Unpaired
Lake 10	Lake 9U	Stable		Site located near an inactive stream gage	Keep as control site	Same as initial
Bozard 1	Lake 11 Lake 13	Unstable		Beaver dams present; slightly entrenched.	Keep as control site	Unpaired
Bozard 2	Lake 12	Unstable		Beaver dams present; slightly entrenched	Keep as control site	Unpaired
Bozard 3	WF Lake 2	Stable		Bozard 3 - Valley type and gradient mismatched WF Lake 2 - Riparian plantings have been the treatment for this site	Maintain Bozard 3 as possible control; maintain WF Lake 2 as monitored treatment site and establish new control site pairing	Unpaired
WF Lake 3	Unpaired	Unstable		Reach is straightened and incised; potential restoration site	Keep as a monitoring site for pre/post comparisons	Lake 12; new site
	Lake 12	Stable	√ Field	Riparian plantings have been the only treatment; canopy cover is the only response variable	Use as a control site for design work and other E-type channels.	Lake 11
	Lake 13	Unstable		Braided channel; only has one year of data	Eliminate site from survey rotation	

SECTION 2: RESTORATION AND ENHANCEMENT ACTIVITIES

OVERVIEW

Restoration and enhancement activities were implemented primarily in the Benewah and Alder creek watersheds during 2006. All restoration activities completed during the contract period are summarized in *Table 16* followed by a more detailed site characterization and summary of activities for individual treatments. In several locations, multiple treatments have been implemented to meet the objectives for larger sites. These treatments are grouped under the same project ID heading so that the interrelationship of activities is more apparent.

A brief explanation of the project ID that is used in the summary table and in the detailed descriptions is warranted here. The project ID is an alphanumeric code that corresponds to the location of individual treatments in relation to the river-mile of the drainage network for the watersheds of interest. The first digit of the code signifies the watershed that the treatment is located in, using the first letter in the watershed name (e.g., B=Benewah Creek, E=Evans Creek, etc.). The series of numbers that follow correspond to the river-mile location (in miles and 10^{ths}) at the downstream end of treatment sites. River mile is tabulated in an upstream direction from mouth to headwaters and treatments that are located in tributary systems have river mile designations separated by a forward slash (/). For example, the downstream end of project L_5.2/0.2 is located in the Lake Creek watershed 0.2 miles up on a tributary that has its confluence with the mainstem 5.2 miles from the mouth. This nomenclature is intended to indicate the spatial relationship of treatments to the mainstem and tributary aquatic habitats having significance to the target species. Furthermore, it readily conveys information about the relationship of multiple treatments by indicating the distance to common points in the drainage network.

Table 16. Summary of restoration/enhancement activities completed in 2006 for BPA Project #199004400.

Project Description			Project Chronology				
Project ID	**Activity**	**Treatments (Metrics)**	**2002**	**2003**	**2004**	**2005**	**2006**
B_8.9	Plant Vegetation	Riparian enhancement (46.3 ha; 3,689 m of streambank)	Panted 8,957 trees (12 ha, 610 m of streambank)	Planted 13,611 conifers and 2,013 deciduous trees (23 ha, 1,200 m of streambank)	Planted 8,500 conifers, 3,650 deciduous trees, and 4,800 herbaceous plugs (6.4 ha)	Planted 8,000 conifers (4.9 ha of floodplain, 1,879 meters of stream bank)	Planted 10,000 conifers (restocked 10.6 ha)
B_8.9	Stream Channel Construction	Constructed 1,112 m of channel (Increased channel length by 236 m)	Completed baseline HEP; channel assessment and development of restoration prescriptions			Channel design finalized; NEPA completed; Constructed lower 518 m of channel on the property	Constructed 594 m of channel.
B_8.9	Plant Vegetation	Streambank stabilization (4.14 ha, 2,376 m of streambank)				Planted 15,850 herbaceous plugs, 4,100 deciduous trees (1.82 ha of floodplain, 1,036 meters of stream bank)	Planted 26,387 herbaceous plugs and 7,450 deciduous trees (2.32 hectares of floodplain, 1,340 meters of streambank)
E_1.3	Increase Habitat Complexity	Instream wood addition (152 m)				Placed 4 MBF of natural wood and 16 ELWD™ (Type 20 N) structures along 152 m of channel	Physical and biological monitoring completed
A_7.4/1.9	Fish Passage Improvement	Culvert replacement (restores access to 2,468 m of habitat)				Completed design; NEPA compliance; Signed landowner contract	Installed culvert; planted 470 herbaceous plugs and 60 deciduous trees on restored site

Project B_8.9: Instream/Channel Construction

Project Location:

Watershed: Benewah	Legal: T45N, R3W, S18 NE ¼ NE ¼
Sub Basin (River Mile): RM 8.9	Lat: 47.249851 Long: -116.762181

Site Characteristics:

Slope/Valley gradient: <1%	Aspect: N	Elevations: 2,650
Valley/Channel type: B2/C4	Proximity to water: In channel	

Other: Project restores channel planform, grade and profile to what is believed to be within the range of historic conditions for 594 meters of stream.

Problem Description: The Benewah valley between river miles 8.9 and 11.9 can be broken into three general reaches that relate to the level of sinuosity and the degree of channel incision that has taken place. The lower 2.3 km and upper 0.8 km have experienced more avulsions and channel straightening than the middle 2.1 km. The valley slope is 0.007 throughout, however sinuosity in the lower and upper reaches is 1.38 and 1.3, respectively, compared to 1.8 in the middle reach. Downstream avulsions and head cutting have moved upstream through the lower reach where this project is located, causing it to be become incised and substantially reducing the access to its old floodplain. Hydraulic analysis of representative channel cross-sections show the overall level of incision is approximately equivalent to the capacity of a 5-year return interval peak flow event with some areas exhibiting incision that approaches the 10-year peak flow.

The incised channel is characterized by unstable stream banks with accelerated erosion rates and increased sediment yield to the channel. The most recent estimates of stream bank erosion were made using the BANCS model (Rosgen 2001), which combines quantitative measures of stream bank characteristics with derived values of near-bank sheer stress to generate estimates of average annual erosion rates. In measured reaches erosion rates were estimated at 0.16±0.07 tons/yr/ft with an estimated sediment yield of 156.1 tons/yr. When these results are extrapolated to the larger reach located between river miles 8.9 and 11.9, total annual sediment yield from streambanks is estimated at 1,689.6±739.2 tons/yr.

Several avulsion channels and to a lesser extent, remnant historical channels have left portions of the valley bottom with some wetland habitat. However, it appears that groundwater tables have been lowered along with the streambed, as many of the wetland areas are only marginal in size and a band of xeric vegetation of variable width is located along the channel margin throughout the incised reach. Based on analysis of observational data, including current vegetation patterning, wetland delineations, and historic soils data from 1904, it is estimated that lowering of the water table related to channel incision has reduced wetlands habitats by up to 40% compared with historic conditions.

This stream reach is located in a portion of the watershed that historically provided important summer and winter rearing habitats for westslope cutthroat trout. Existing conditions currently support low densities of cutthroat trout (<2 fish/100 m^2). Lack of habitat diversity, reduced infiltration of water from adjacent wetlands, and elevated water temperatures are all factors that limit the productivity of these reaches.

Description of Treatment: The initial work to develop a restoration design began with development of the relationship between the runoff characteristics of the watershed and stable hydraulic geometry for the stream channel. Subsequently, the HEC-RAS hydraulic model was used to estimate hydraulic conditions and simulate water surface elevations, flow regimes, velocities and shear stress for the design channel. A substrate specification was developed to withstand some vertical movement during the 10-year return interval discharge but not over sized to the point of complete immobility. Implementation of the restoration design involves filling the stream channel to historical elevations and utilizing historical alignments where possible. The designed planform creates channel grade and profiles within the range of historical channel conditions, based on topographic and field analysis. Historical conditions will be met by lifting the incised channel by filling the channel with imported rock at intervals along its length that correspond to areas that would naturally be riffles. Pools between these riffles will remain unnaturally deep until existing basin sediment loads slowly fill them. In areas that have laterally expanded following entrenchment, new banks and floodplain will be created. Large wood material will be used throughout the project to increase lateral roughness where needed, create banks, and maintain planform until hydric plant communities become fully established.

A total of 594 m of channel were constructed in 2006, increasing the total length of restoration at the site to 1,112 m. Ten riffles were constructed using a total of 2,905 cubic meters of imported gravel and an additional 974 cubic meters of gravel were placed on stream banks in pool sections. Several sections of the existing incised channel were "plugged" with approximately 4,066 cubic meters of imported fill to create new floodplain habitat. A total of 90 MBF of large wood, the equivalent of 23 truckloads, was placed in the channel and on the floodplain to provide cover, increase habitat complexity, and increase roughness and stability.

Restoration activities over the last two years have increased channel length by 236 m, resulting in an overall 31% increase in sinuosity from 1.28 to 1.68. Slope deceased by 58% from 0.0048 pre-construction to 0.002 in 2006. Mean residual pool depth increased significantly ($p < 0.0167$) from 0.57 m pre-construction to 1.18 m in 2006 (*Figure 14*). Mean low-flow thalweg depth also increased significantly from 0.38 m pre-construction to 0.52 m in 2006 (*Figure 14*). Instream large wood volume increased 395% from 0.565 m^3/100 sq. m pre-construction to 2.801 m^3/100 sq. m in 2006. Together these changes reflect a significant increase in the quantity of instream habitats available to native fishes as well as an improvement in the diversity and complexity of these habitats.

Project Timeline: A 30% stream channel design, appropriate for fit in the field construction, was completed for the lower 2,621 m of channel in January 2005 (Inter-Fluve, Inc. 2005). A wetland delineation and function assessment were completed for the same area in May 2005. All NEPA analysis and permitting requirements, including CWA certification, 404 and 401 authorizations, NPDES permits and the supplemental analysis for the BPA Watershed Management Program EIS, were completed for the project in 2005. Construction of the remaining 1,410 m of channel in the completed design will occur over the next two field seasons, depending on funding, staffing and other logistical considerations.

Project Goals & Objectives: Implement 2,621 m of stream channel construction as part of a larger project to restore historic wetland habitats and hydraulic connections with the valley bottom for 5.1 km of stream over a 10-year timeframe. Restore stable channel configurations to treatment areas and increase the frequency and duration of over bank flooding equal to the 1.5-

year return interval. Increase coldwater refuge by improving dynamic and long-term surface and ground water storage. Provide for a measurable increase in abundance and distribution of westslope cutthroat trout in treatment areas.

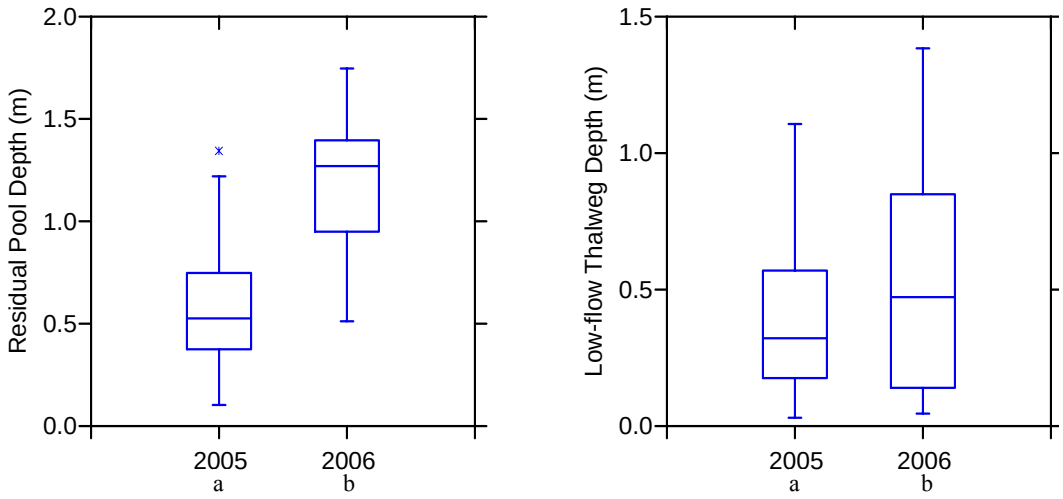

Figure 14. Box plots comparing residual pool depth and low-flow thalweg depth in 2005, pre-construction, and 1-year post-construction in 2006. The horizontal lines within the boxes are median values, the upper and lower edges of boxes the central 50% of the distribution, and the whiskers the highest and lowest values, including "outliers" (asterisks). Median values indicated by different lowercase letters below year on the x-axis are significantly different ($p < 0.0167$).

Relationship to Scope of Work: This project fulfills the Program commitments for WE F in the 2007 Scope of Work and Budget Request (Contract #27934) for the contract period June 1, 2006 - May 31, 2007.

Project B_8.9: Riparian/Planting

Project Location:

Watershed: Benewah	Legal: T45N, R3W, S18 NE ¼ NE ¼
Sub Basin (River Mile): RM 8.9	Lat: 47.249851 Long: -116.762181

Site Characteristics:

Slope/gradient: <1%	Aspect: N	Elevations: 2,650
Valley/Channel type: B2/C4	Proximity to water: Floodplain	

Other: Project specifically treats the 1,340 meters of streambanks and 2.32 hectares of associated floodplain disturbed during stream channel construction (see project description above).

Problem Description: Restoration of Benewah Creek is underway to restore a stable channel at the previous elevation of the channel in the floodplain. Approximately 2,621 m of channel may be constructed over the next 3-4 years. Implementation of the completed design will result in 7.2 ha of direct disturbance from construction, development of temporary access, and site dewatering during construction. These areas will require rapid establishment of woody and herbaceous species to support the short- and long-term stability of the site.

Current wetland function is degraded as a result of the processes of channel incision that have occurred over a period of approximately 80 years. Based on site conditions and conditions in other nearby watersheds, it is clear that both groundwater and periodic flooding once provided much of the hydrology to maintain wetlands in the project area. Although the geomorphic location of these wetlands is clearly riverine floodplain, the dominant water source in some areas has probably transitioned over time to seasonally perched groundwater and/or direct precipitation owing to the disconnection between the creek and its current floodplain. A band of xeric vegetation of variable width is located along the channel margin throughout the incised reach. Based on analysis of observational data, including current vegetation patterning, wetland delineations, and historic soils data from 1904, it is estimated that lowering of the water table related to channel incision has reduced wetlands habitats by up to 40% compared with historic conditions.

Description of Treatment: A vegetation plan was developed for the site based on inventories of native wetland plant species conducted during wetland delineations and functional assessments on the project site at and at a control site in the watershed. The plan is documented in the Benewah Creek Restoration Design (InterFluve, Inc. 2005) and in the Stormwater Pollution Prevention Plan (SWPPP) for construction activities. The plan identifies a mix of 27 native species to be planted on the site, delineates planting areas based on key environmental gradients, and provides material specifications and planting densities. Plant species include seven species of woody trees and shrubs, 10 species of herbaceous sedges (*Carex sp. and Scirpus sp.*) and rushes (*Juncus sp.*), and 10 species of herbaceous grasses.

A total of 26,387 herbaceous plugs and 7,450 woody trees and shrubs were planted in fall 2006 along 1,340 meters of streambanks and 2.32 hectares of associated floodplain that was disturbed or created during construction. In addition, all floodplain surfaces and 0.52 hectares of access roads and the bypass trench, used in dewatering the construction site, were hand seeded and

mulched with herbaceous grasses applied at a rate of 48 kg/ha. In the spring of 2007, 4000 live willow poles were planted to complete the second full season of revegetation work. Early indications of vegetation response appear very favorable.

Project Timeline: Annual plantings will be completed in the fall and the spring immediately following stream channel construction. Annual and periodic inspections will be completed to evaluate survival and growth and determine if restocking of planting sites is warranted.

Project Goals & Objectives: Goals for this project include 1) increase stream shading; 2) provide a long-term source of large woody debris for natural recruitment; 3) promote streambank and floodplain stabilization; 4) increase riparian species diversity and cover; and 5) enhance stream buffer capacity. Success criteria include: establish at least 80% herbaceous cover by native species at the end of 2 years following site disturbance.

Relationship to Scope of Work: This project fulfills the Program commitments for WE G in the 2007 Scope of Work and Budget Request (Contract #27934) for the contract period June 1, 2006 - May 31, 2007.

Project B_8.9: Riparian/Planting

Project Location:

Watershed: Benewah Sub Basin (River Mile): RM 8.9 – 11.9	Legal: T45N, R3W, S18 NE ¼ NE ¼

Site Characteristics:

Slope/gradient: <1%	Aspect: N	Elevations: 2,650
Valley/Channel type: B2/C4	Proximity to water: Floodplain	

Other: Project has treated 3,689 linear meters of stream channel and 46.3 hectares of associated floodplain from 2002 to 2006.

Problem Description: The Benewah valley has a history of anthropogenic disturbance by logging and agricultural activities that date to the early twentieth century. Logging removed many of the coniferous trees in the valley bottom between 1915-1930. Splash dams and flumes were developed in the creek to facilitate the movement of harvested logs to down valley mill sites. The combination of direct land clearing adjacent to the creek and the construction and operation of splash dams had a direct affect on channel form and function with negative implications for the productivity of habitats for juvenile rearing. In the most recent past, dating from approximately the 1940's through 2000, the property was managed for grazing and/or hay production, which has precluded the regeneration and establishment of a diverse native riparian plant community along much of the 3.2 miles of streams associated with this property.

Current riparian function is degraded as evidenced by low stream canopy closure, little overhanging vegetation, and low volumes of LWD. The wood that is present in the channel is mostly comprised of small pieces that generally do not function to shape channel morphology or maintain habitat diversity. Also, the existing riparian community offers little potential for providing recruitment of large wood in the future. Currently, discharges greater than the 5-year return interval flood begin to exit the existing channel in a non-uniform manner. As a result several avulsion channels have developed in portions of the floodplain as a direct result of low roughness and lack of root mass in floodplain soils. Active avulsions have the potential to cut-off remaining channel length and lead to abandonment of relatively high quality habitat.

This stream reach is located in a portion of the watershed that historically provided important summer rearing habitat for westslope cutthroat. Mainstem reaches of the property were likely utilized as over-winter habitat as well.

Description of Treatment: Riparian plantings have been undertaken to re-establish forest plant communities adjacent to the stream channel and provide long-term roughness across the valley bottom. Restoring a forested valley bottom will improve structural habitat conditions in the coming decades and is fundamental to the long-term restoration and enhancement of this site.

Approximately 46.3 hectares have been planted over the five-year period from 2002-2006 with room for approximately 76 hectares of additional plantings (*Figure 15*). Plantings in these areas have consisted of primarily coniferous species, including western white pine, ponderosa pine, lodgepole pine, Douglas fir, western larch, western red cedar, and Engelmann spruce, to ensure

future inputs of large wood to the stream channel, however, deciduous species have been utilized where site conditions are favorable for survival.

A total of 8,957 deciduous and coniferous plants were installed in 2002, treating an area of approximately 12 hectares and a little more than 610 linear meters of stream channel. An additional 13,611 conifers and 2,013 deciduous trees and shrubs were planted in 2003 treating approximately 23 hectares and a little more than 1,200 linear meters of stream channel. Approximately 8,500 conifers, 3,650 deciduous trees, and 4,800 herbaceous plugs were planted in spring and fall 2004. Portions of the 2004 plantings were associated with side channel construction and the culvert replacement at Windfall Creek. An additional 8,000 conifers were planted in April 2005. The combined plantings in 2004-05 treated 11.3 ha and 1,879 linear meters of stream channel. An additional 10,000 conifers were planted in spring 2006, with much of the trees used to restock approximately 10.6 ha of floodplain and valley bottom planted in 2004 and 2005 (*Figure 15*). These areas had poor survival apparently resulting from competition with established herbaceous grasses. The sites were prepared using a tractor-pulled disk to breakup the sod layer prior to planting.

Project Timeline: Preliminary restoration prescriptions were developed for this project site following completion of a detailed stream channel assessment in October 2002. The prescriptions were outlined in a report entitled, Benewah Creek Assessment and Restoration Prescriptions (Inter-Fluve, Inc. 2002).

Plantings were completed in both spring and fall seasons between 2002 and 2005. Periodic inspections have been completed at several of the planting sites on the property. Conifer survival was estimated on October 6, 2003 in the Windfall Creek unit, at which time the overall survival was determined to be only 45 – 55%. Delays in planting and prolonged drought throughout the summer are thought to have been the primary cause for mortality. Survival estimates were also conducted in spring 2005 at the three units planted in 2003 and spring 2004 (*Figure 15*). Survival at these sites ranged from 75.9 - 86.5%. Detailed physical habitat surveys were also completed at three index sites on the property in 2002, 2003 and 2004 to look at instream LWD volumes and canopy density among other indicators. Ongoing annual monitoring is planned to identify areas to retreat in the event that project objectives cannot be met as a result of cumulative mortality and/or other factors.

Project Goals & Objectives: Goals for this project include 1) increase stream shading; 2) provide a long-term source of large woody debris for natural recruitment; 3) promote streambank and floodplain stabilization; 4) increase riparian species diversity and cover; and 5) enhance stream buffer capacity. Provide for significant increases in canopy density and overhanging vegetation over the next 20 years. Target canopy closure is 92%.

Relationship to Scope of Work: This project fulfills the Program commitments for WE H in the 2007 Scope of Work and Budget Request (Contract #27934) for the contract period June 1, 2006 - May 31, 2007.

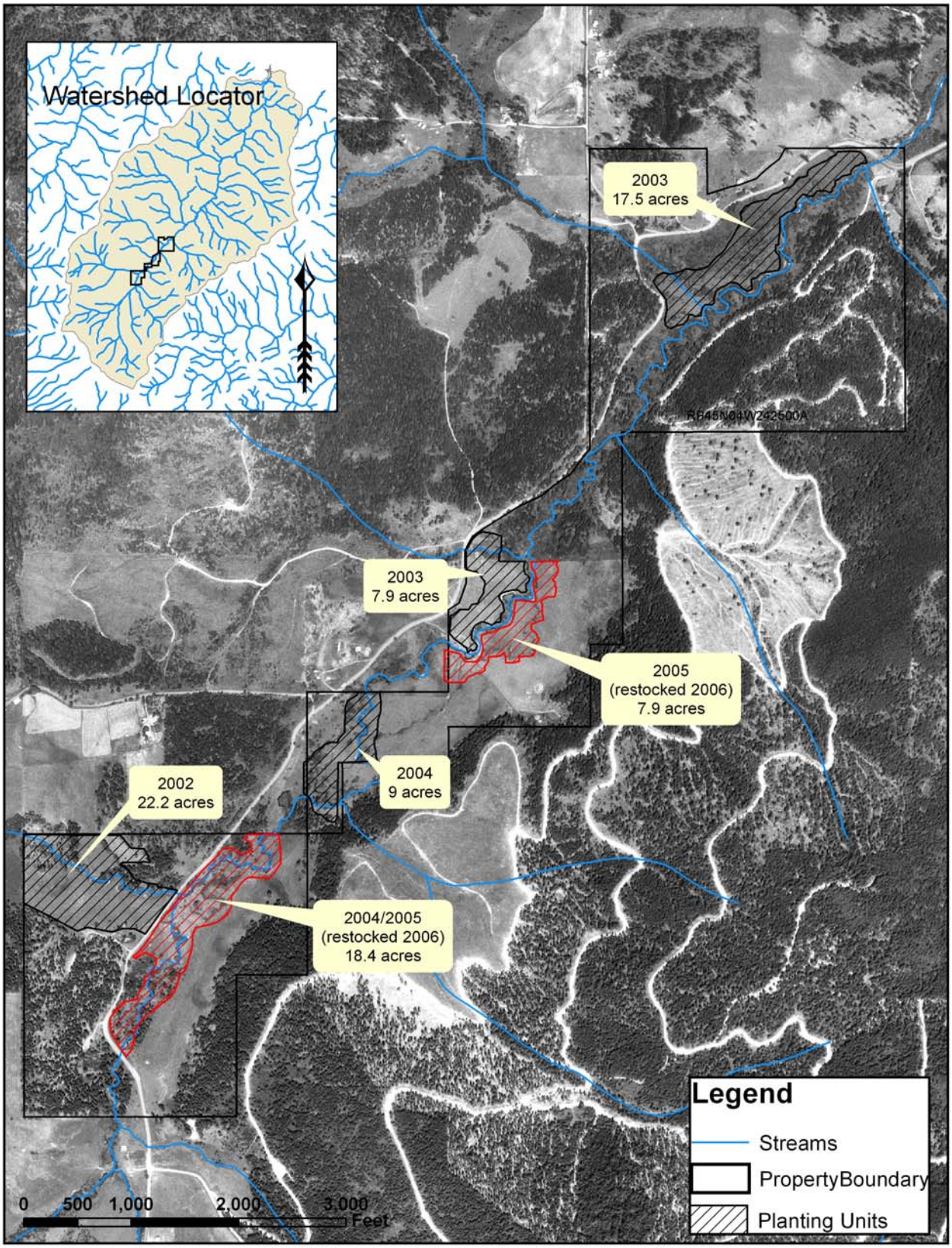

Figure 15. Locations of riparian planting units on the Benewah Creek WMU, 2002-2006

Project E_1.3: Instream/Large Wood Additions

Project Location:

Watershed: Evans Creek	Legal: 47 N, R2W, S3, SE 1/4
Sub Basin (River Mile): RM 1.3	Lat: 47.272331 Long: -116.728551

Site Characteristics:

Slope/gradient: 3%	Aspect: N	Elevations: 2200
Valley/Channel type: E3/C3	Proximity to water: Instream and adjacent floodplain	

Other: A combination of natural large woody and ELWD™ systems was placed along 152 meters of channel in 2005 to simulate natural debris loading.

Problem Description: Portions of the floodplain on this site were cleared and developed as pastures in the past. Major flood events in the late 1990's widened the channel downstream of a bridge crossing the creek. Past bank stabilizations efforts were implemented in order to narrow the channel. The riparian area consists of willow regrowth and established Cottonwoods. The large wood present in the channel was placed there during a previous restoration project and is not effective at impacting channel form due to decomposition of the wood itself and changes in the channel. There is also limited large woody debris recruitment to the stream. A result of this lack of wood is an absence of defined pools. In previous years, the landowner has constructed temporary rock dams by hand using small cobble available in the reach. These "dams" created shallow residual pools that helped to hold fish during periods of low flow, but provided little cover and would wash away during higher flows in the winter and spring.

Placing wood in the channel will create deeper pools, provide areas for spawning gravels to accumulate, and provide cover for fish to hide from predators. Wood additions placed on the floodplain will help reduce the velocity of flood flows and minimize channel avulsions. This project will help increase the quality of habitat along 152 m of stream channel.

Description of Treatment: A habitat project was completed in Evans Creek in October 2005. This project involved placing 4 MBF of natural wood and 16 ELWD™ (Type 20 N) structures along 152 m of Evans Creek. Approximately 44 pieces of natural wood were placed on the site, these consisted of pulp logs that came in a variety of sizes as large as 10 m long and 0.6 m in diameter. The ELWd™ structures were formed from eight smaller diameter logs to form structures that were approximately 63-68 cm in diameter and 6 m long. The ELWd™ structures were delivered to the site banded together, taken apart, and then rebuilt near the locations for final placement. Rock was added to the center of nine of the structures, which were hollow, to help ballast the structures. The remaining seven structures were placed with an excavator and left banded together with no rock inside.

High flows in January 2005 redistributed much of the wood placed at the site, eliciting a need to conduct an evaluation of O&M needs at the site as well as look at habitat and biological responses. Four of the hollow ELWd™ structures were transported downstream of the project reach. Two of these structures moved approximately 128 meters below the end of the project reach and two more moved 160 meters from the end of the project reach. Additional natural wood that was placed also moved. The landowner recovered one of the ELWd™ structures that

had moved off the site. The ELWd™ structures that were constructed by hand had been cabled to nearby Cottonwood trees after construction. The force of the high flows caused many of these structures to change orientation even though they remained cabled. *Figures 16 and 17* show the site immediately after construction and one year after construction. A series of 5 ELWd™ structures are now grouped together forming a larger jam (*Figure 18*).

Figure 16. Evan Creek project site following construction in October 2005.

Figure 18. Log jam of 5 ELWdTM Structures. Two of the structures had been oriented facing upstream with their ends cabled together.

Figure 17. Evans Creek project site in September 2006.

Project Timeline: All NEPA analysis and permitting requirements, including CWA certification, 404 and 401 authorizations, and the supplemental analysis for the BPA Watershed Management Program EIS, were completed for the project in 2005. The project was completed in October 2005. Subsequent evaluations for measuring habitat and population responses were conducted in September 2006.

Project Goals & Objectives: Implement a pilot project to examine the use of engineered large woody debris structures (ELWD™ Systems) and natural wood to improve instream habitat conditions for cutthroat trout as well as improve bank stability. Placement of structures and

debris volumes will simulate natural woody debris loading under relatively undisturbed conditions.

Relationship to Scope of Work: This work was conducted to fulfill the Program commitments for WE I in the 2007 Scope of Work and Budget Request (Contract #27934) for the contract period June 1, 2006 - May 31, 2007.

Monitoring Results: Habitat data has been collected for the site from 2003-2006. Figure 19 shows a comparison of the longitudinal profile immediately before and one year after restoration. The locations of the *ELWd*^{TM} structures along the proile are shown. Localized scour of the bed surface is evident in conjunction with the *ELWd*^{TM} structures. The density of large wood in 2005 and 2006 was 4.11 m^3/100 m and 14.63 m^3/100 m, respectively, which equates to a 256% increase. Approximately 96% of the 2005 wood density was due to a large rootwad that had a volume of 3.97 m^3. This rootwad was greatly decayed and was broken and moved off the site by high flows prior to the 2006 survey. Pool frequency increased from 0.6/100 m in 2005 to 2.6/100 m in 2006, a change of 333%. In this comparison, bed features were characterized as pools when residual depth was >0.3 m. The mean residual pool depth was 0.42 m in 2005 and 0.39 m in 2006, but this difference was not significant.

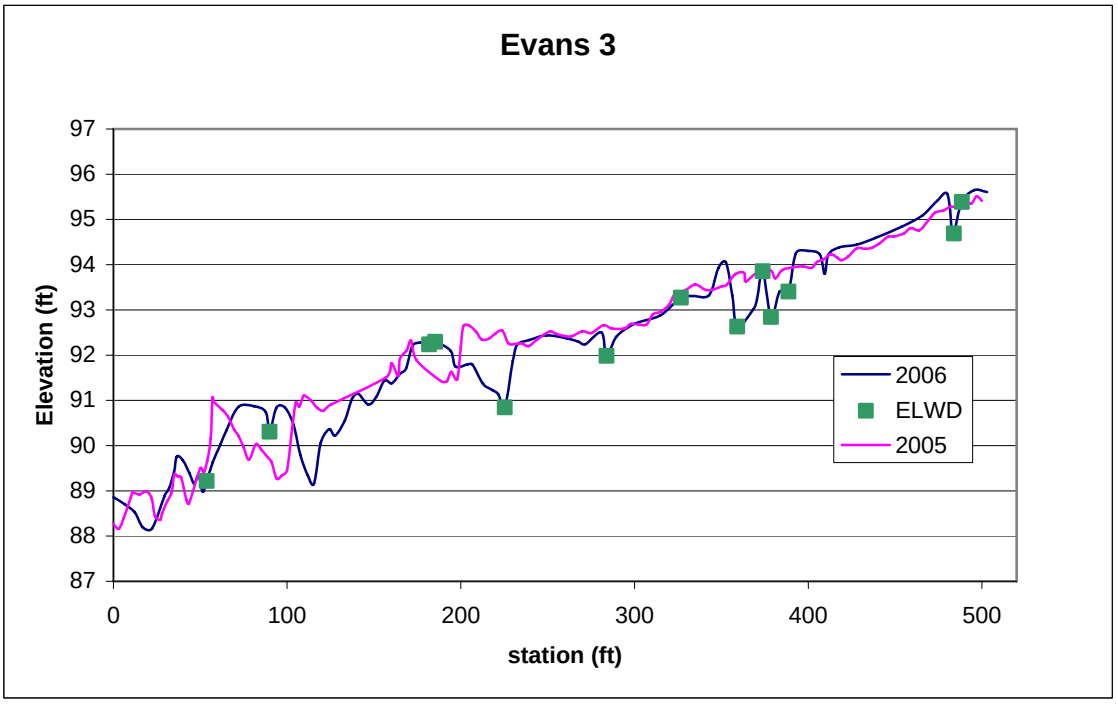

Figure 19. Comparison of Evans Creek site 3 before and one year after restoration. ELWd^{TM} *locations in summer 2006 are also shown.*

Summer fish population data has been collected for the site since 1996 (*Figure 20*). In 2006, one year after construction, the measured density of westslope cutthroat trout was 13.86/100 m^2 compared with a mean density of 2.38 (±0.78)/100 m^2 during the 10 previous years. Prior to 2005, the landowner constructed temporary rock weirs by hand using small cobble available in the reach. These "dams" created shallow residual pools that helped to hold fish during periods of low flow, but provided little cover and would wash away during higher winter flows. No dams were built in the shock site in 2005, reducing the available pool habitat. This may explain, in

part, the observed fish densities, which were among the lowest recorded. The additions of the ELWdTM structures effectively increased pool frequency, pool volume and cover and improved overall habitat diversity. The increase in westslope cutthroat trout density from 2005 to 2006 was likely due to the change in these physical characteristics. It is expected that the pools created by the *ELWd*^{TM} structures will continue to deepen as localized bed scour occurs and habitat complexity will continue to improve as additional wood is entrained on the structures.

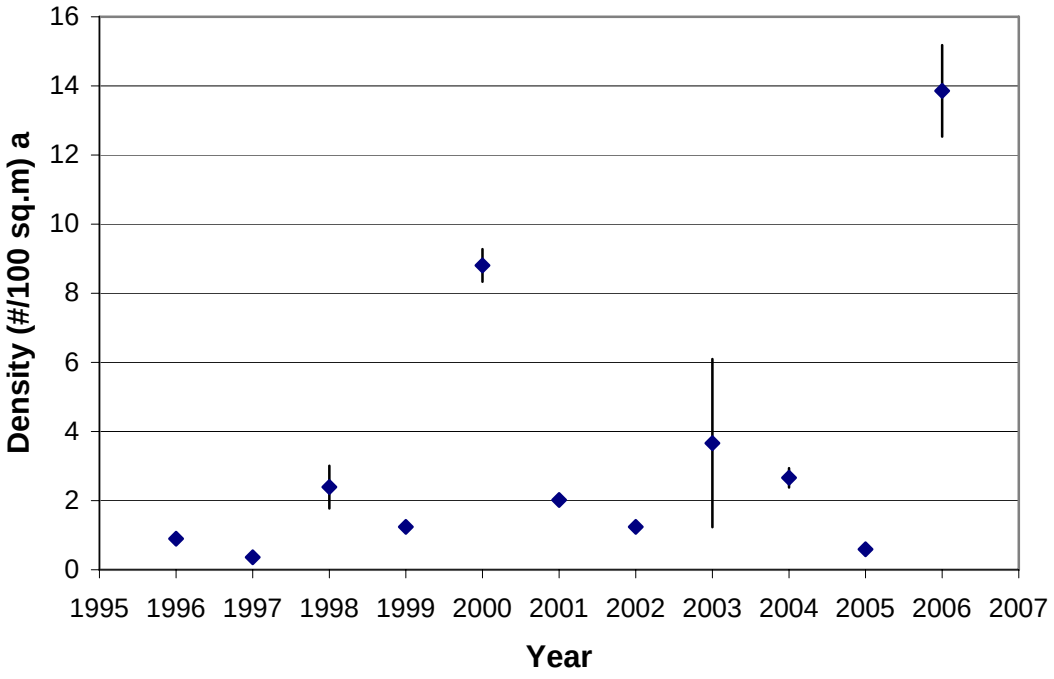

Figure 20. Density estimates at Evans Creek site 3 for 1996-2006. Error bars indicate ±95% CI. Years with capture probabilities of 1 have no sample error.

Project A 7.4/1.9: Instream/Fish Passage

Project Location:

Watershed: NF Alder Creek	Legal: 44 N, R3W, S6, NE SE
Sub Basin (River Mile): RM 1.9	Lat: 47.185997 Long: -116.755530

Site Characteristics:

Slope/gradient: 3%	Aspect: NE	Elevations: 3120
Valley/Channel type: G1/B6	Proximity to water: Instream and adjacent floodplain	

Other: A Horizontal Ellipse CMP culvert was installed to replace an old stream crossing that consisted of logs and fill. Project restores fish passage to 2,468 m of habitat.

Problem Description: The North Fork of Alder Creek is an important class I tributary to Alder Creek. The tributary is used by beavers and contains important spawning and rearing habitat for native trout. Tribal staff identified a stream crossing on the North Fork of Alder Creek as a fish barrier. The old crossing consisted of a series of logs lying over the stream with road fill on top. An estimated 2,468 m of stream channel containing important spawning and rearing habitat is located upstream of the site. Besides being a fish barrier, the old stream crossing was eroding in places. Previous studies (Vitale et al. 1999) indicated that 2.8% of the available habitat upstream of the planned culvert consists of suitable spawning gravels. Survival to emergence in the blocked area was estimated at 48.5% and the production potential was estimated at 1,256 fry/100m^2. In the same 1999 study, it was found that trout densities were nearly two-fold higher (3.1-18.8 trout/100m^2 versus 1.9-8.5 trout/100m^2) above the passage barrier compared with downstream reaches. Fisheries personnel prioritized this project due to its unique location and willing landowners.

Description of Treatment: The treatment for the site involved the design and installation of a 38-ft. long 14'33"X 9'9 Horizontal Ellipse CMP culvert to replace the old stream crossing that consisted of logs and fill (*Figure 21*). USGS regional regression analysis (Berenbrock 2002) and drainage area scaling were used to estimate the 100-year return interval discharge in N. Fork Alder Creek. The estimated discharges were 168 cfs and 206 cfs respectively. The higher value of 206 cfs was used for analysis of conveyance of the 100-year return interval storm discharge through the design culvert. The final design will pass a flood flow of approximately 380 cfs.

Sixty-six cubic yards of the existing roadway and the stream channel were dredged in order to remove the existing logs and put in the culvert. Usable dredged material and new fill material were used to reconstruct the road. The stream channel below the existing roadway was further excavated to a width and depth necessary to place clean, compacted fill around the new pipe.

The culvert arrived from the manufacturer unassembled and was assembled at the tribal rock pit in Plummer and then delivered to the site. Thirty-four individual plates had to be bolted together to form the culvert. Approximately 1300 nuts and bolts were used during this process. An excavator was used to hold the plates together while the bolts and nuts were placed in by hand. An air compressor was used to tighten the bolts. The completed culvert weighed over 10,000 lbs and was 38 ft long. This is the largest culvert that the fisheries program has installed to date. The size of the culvert proved to be the biggest challenge in installation. Its weight and length made it very hard to move. The access to the site was very limited so materials had to be

delivered in stages. Water was diverted around the site by installing a bypass pipe through the existing road fill. After diverting the water, a 10' x 18' x 38' hole was excavated. The culvert was lifted and placed into this hole by an excavator. Once the culvert was set, fill material was compacted around it. Rock riprap was placed within the culvert to simulate a natural channel and bring it to the historic grade (*Figure 22*). Following installation of the culvert, disturbed areas on site were revegetated with a mix of native sedges/rushes and deciduous trees and shrubs. A total of 470 herbaceous plugs and 60 deciduous trees were planted.

Project Timeline: NEPA compliance documentation and landowner agreement were completed in 2005. A contractor was hired and completed the culvert design also in 2005. Construction for the project was completed in June-July 2006 and planting occurred in October 2006.

Project Goals & Objectives: This project will restore connectivity with the upper North Fork Alder Creek watershed by removing a barrier to fish passage. Native trout will have access to 2,468 lineal meters of prime rearing and spawning habitats upstream of the new culvert. The new culvert allows for passage of all size classes of westslope cutthroat trout. The crossing is more stable and less susceptible to erosion. Flood flows can pass through the culvert instead of being blocked and forced over the road.

Relationship to Scope of Work: This project fulfills the Program commitments for WE E in the 2007 Scope of Work and Budget Request (Contract #27934) for the contract period June 1, 2006 - May 31, 2007.

Figure 21. Old stream crossing at NF Alder Creek site consisting of logs and fill across the channel and floodplain. The foreground illustrates ongoing road failure caused by flooding in 2005.

Figure 22. Stream crossing at NF Alder Creek with new culvert installed.

SECTION 3: OUTREACH AND EDUCATION

OVERVIEW

The Tribe uses outreach to the general public along with development of educational opportunities related to the natural resources as a means to facilitate a "holistic" watershed protection process on the Reservation. The Tribe holds a belief that responsible management must address the needs of the community that collectively affects the fishery resources and habitats. The Northwest Power Planning Council (NPPC) adopted the Tribes concept through the funding of several education and outreach objectives and tasks in the Council's annual workplans (NWPPC 1995 through 2006).

The objectives and tasks in 2006 are similar to those in past workplans of BPA project #1990-044-00, *Implement Fisheries Enhancement Opportunities on the Coeur d'Alene Reservation*. The first objective is to coordinate project activities with affected and interested parties to improve awareness of and support for restoration within the Reservation community. This objective is accomplished through several strategies, including publishing a quarterly newsletter and through coordination and participation in watershed and inter-agency work groups. The second objective is to provide cultural and educational opportunities to increase student/teacher participation in restoration activities. This objective is accomplished through continual participation and development of an educational forum to share project related information, encouraging community participation in and garnering landowner support for stream restoration opportunities on Reservation lands, and providing opportunity for summer internships to local high school students. Results are presented that detail the accomplishments for the year, along with a discussion summarizing the effectiveness of each strategy in meeting the overarching goals and objectives for the outreach and education component of the project.

DESCRIPTION OF RESULTS

The following presents details of the outreach and education work performed by the Fisheries Program and other cooperators during the period June 2006 – May 2007. The methods and results are presented in a manner consistent with the outline found in the *Scope of Work and Budget Request* for this project. *Tables (1 and 2)* present summaries of the outreach efforts and associated completion dates by objective and task.

Objective 1 Coordinate Restoration and Management Activities

WE B: Conduct meetings with interested parties to coordinate restoration efforts and develop cooperative opportunities.

Program staff met multiple times with different watershed working groups during this contract period (*Table 17*). Staff participated in two public meetings with Benewah Creek residents, who have a well-established and organized landowner association with active participants. Staff provided project updates, described additional planned efforts and introduced new information to the group. The Tribe held one meeting with the Lake Creek Watershed during 2006 and provided additional information on projects through publication and distribution of the program newsletter. Two meetings were held with the Hangman Creek Watershed Working Group to discuss the results of watershed assessments and ongoing projects. Attendance for these meetings typically ranged from 12 to 25 residents with a total of 65 participants. Records were kept and minutes were taken for each meeting along with a list of participants.

Direct mailing provided an additional opportunity to inform the public about ongoing activities in the project watersheds. This past year, the Outreach Specialist solicited participation from local landowners through local advertising and publication of the *Watershed Wrap*. This included a direct mailing of questionnaires to inquire about how to better serve the needs of all who live in the target watersheds and to help better inform the public about our projects. This effort is intended, in part, to facilitate new partnerships for restoration efforts on the Reservation.

WE B: Participate in Tribal inter-disciplinary processes to review and comment on issues related to the management of fisheries and other natural resources on the Reservation and in the ceded lands.

Fisheries staff participated in a series of meetings in support of the development of an Integrated Resource Management Plan (IRMP) for the Reservation. The initial involvement of Program staff was warranted to continue the development of a draft Programmatic Environmental Impact Statement (PEIS) beginning in 2000. Project staff attended four meetings during this contract period.

Objective 2 Provide Cultural and Educational Opportunities

WE Z: Provide summer internships for high school students to assist with implementation of project activities and to expose students to natural resource management issues.

During the summer of 2006 the Fisheries Program employed three summer youth. The youth worked with biologists and technician staff from June 12 through August 25. The youth helped with Threatened and Endangered species surveys, built fences, assisted with fish population census and stream habitat monitoring, collected water quality data, assisted with data input into computer spreadsheets, assisted the Lake Management Department with an inventory of docks on the lake, and helped with maintenance activities related to the Rails-to-Trails project.

In addition to working with Tribal staff, the summer interns attended one natural resource camp to increase their exposure to other programs and opportunities. The Nez Perce Tribe and the Clearwater Ranger District hosted the camp, June 18 - 23. The Outreach Specialist played a big part in setting up the agenda for the weeklong camp and taught seminars on environmental ethics and the intrinsic value of fish and wildlife habitats. The youth learned different types of skills used in natural resource management and gained a better understanding of employment opportunities in natural resource related fields. Also, the interns learned about the job opportunities awaiting them in fisheries, wildlife and forestry programs after they finish college.

WE Z: Provide educational programs for the local community to increase the understanding of project related activities within a scientific and cultural context.

The Fisheries Outreach Specialist worked closely with local schools and community organizations over the last year to provide a wide variety of educational opportunities that helped increase the exposure for program activities and provided information to improve the understanding of natural resource management issues on the Reservation. The venues for information exchange included field camps, classroom programs, miscellaneous lectures, and other activities related to natural resource management and environmental stewardship.

Table 17. Summary of outreach and education efforts of the Coeur d'Alene Tribe Fisheries Program.

Task	Description	Completion Dates (Thru 05/07)	Status	
			Completed	Not Completed
Objective 1:	***Coordinate restoration and management activities.***			
WE B	Coordinate and facilitate meetings with interested parties.	3/19, 3/23 (Benewah Cr) 11/14, 4/10 (Hangman Cr)	X	
Objective 2:	***Provide cultural and educational opportunities***			
WE Z:	Provide summer internships for high school students to assist with implementation of restoration projects. Natural Resource Camp hosted by Clearwater National Forest and Nez Perce Tribe	3 students sponsored from 6/12 to 8/25 Planning meetings: 2/7, 4/24; camp held 6/18 to 7/23	X	
Task 2b:	Provide education programs for the local community regarding stream restoration opportunities on the Reservation.	On-going throughout the school year.	X	
Task 2c:	Work with the University of Idaho Extension Agent to develop and implement education programs.	Ongoing; numerous dates between 6/30/06 to 5/30/07	X	
Task 2a:	Publish a Quarterly Newsletter to coincide with the spring and fall equinoxes and the summer and winter solstices. Approximately 2000 newsletter sent out.	6/19, 9/18, 12/19, 3/17	X	

Several large multi-day field camps were organized and attended by well over 2,131 students, teachers and members of the general public during this contract period. Each of these events have become annual occurrences and include Water Awareness Week, the Rock n' the Rez Youth Camp, and Water Potato Day. Water Awareness Week was a big success and reached over 280 students and teachers during the weeklong workshop, which was held May 5-9. Participating schools represented 8 municipalities and 3 counties including: Sandpoint (Sagle), Post Falls Middle School, Lakes Middle School (Coeur d'Alene), Southside (Coeur d'Alene), St. Maries Middle School, Harrison Elementary, Plummer Middle School, and Coeur d'Alene Tribal school (DeSmet). Participants rotated through a series of stations, each presenting a different aspect of stream and wetland ecology, natural science disciplines, and resource management. The Rock n' the Rez Youth Program helped exposed a large number (205 participants) of local youth to Tribal natural resource programs and activities and provided leadership training over a two week period in July and August. Attendance at Water Potato Day was approximately 425 people. In order to accommodate the large number of students who wanted to attend, the celebration was held on three successive days, October 25-27. Participants experienced traditional subsistence practices first-hand, were exposed to native songs and stories (including "Simon Says" in the Coeur d'Alene language), tree/shrub identification, and educational walks highlighting wetland functions and values. Several additional one-day field outings were also organized to benefit students interested in natural resource issues.

Several classroom programs were arranged to help inject important fisheries and other natural resource issues into the curriculum of several local schools. The Outreach Specialist participated in an eleven week after school program for the Plummer/ Worley school District, beginning in November. Participating students, largely 3rd, 4th, 5th, and 6th graders were taught traditional crafts and the relationship of traditional cultural practices to functioning natural ecosystems. The Fisheries Program also worked closely with Kootenai High School (Harrison) to present a lecture series on natural resource management and environmental stewardship. Lectures and demonstrations were presented to the Science and Forestry classes on five different days. Topics included plant and tree identification, timber cruising/scaling, safety in the woods, fire fighting, reforestation/restoration techniques and environmental education on land and the water.

The Outreach Specialist was invited to participate in several lecture series that provided opportunities to introduce Program activities and Tribal cultural practices to a wider audience of university students, teachers and the general public. Native American perspectives were provided in separate lectures given at the University of Idaho and Spokane Community College. These lectures gave students insight into traditional natural resource based economies and their relevance to living on the land and the past, present and future management of natural resources by Tribal Peoples.

Several additional activities were undertaken to address people and organizations not directly targeted by other education and outreach activities. An environmental education booth was setup and attended at the Kootenai County Fair in Coeur d'Alene. Posters depicting ongoing restoration work as well program newsletters were on display and made available at the event. The Coeur d'Alene Tribe Natural Resources Department was asked to help participate in maintenance activities (e.g., clean up trails, pick up garbage, restore steps and clear brush) at Drumheller Spring Park in Spokane, WA as a joint venture with other local tribes organized through the Upper Columbia United Tribes (UCUT). The Outreach Specialist also helped facilitate the Coeur d'Alene Tribal Schools' Antelope run, which is a special part of Tribal history commemorating Morris Antelope's run from Steptoe Butte, WA to DeSmet, ID in 1872. Tribal representation was also prominent at the Native American Fish and Wildlife Society, Pacific Region Annual Meeting held in Shelton, WA October 16-19. The Outreach Specialist moderated a panel on Northwest Indian Youth at this meeting.

WE Z: Work with university extension programs to extend outreach activities related to the project to the Reservation community.

The Outreach Specialist worked closely with the local University of Idaho Extension Offices to present a variety of educational programs to the local schools and communities. The Outreach Specialist assisted Extension Educators in presenting a 4-H curriculum for secondary students. Classes at several local schools (Kootenai, St. Maries, Worley, Plummer, Coeur d'Alene Tribal) were introduced to curriculum from the book titled *Project Wild*. Some of the topics included in this book are: 'Hooks and Ladders', 'How to catch a fish' and 'How do we plant trees'. The Outreach Specialist talked to students about the local lake and stream fisheries and discussed the difference between native and non-native fish species. Presentations were given thought out the school year, September 2006 through May 2007.

The Outreach Specialist also worked with Extension staff to prepare for presenting the *Choices* curriculum to 8th grade students for the third year at the invitation of the Plummer/Worley

Middle School. This curriculum was developed by an independent non-profit group to "empower students with vital tools that will increase their career and life opportunities."

Presented a demonstration and talk on the past and present use of fish and wildlife by the Coeur d'Alene Tribe. This camp featured several fisheries related activities (Fish Ladder game, Fish Habitat game, Fish printing). The team also went to the Plummer preschool (Head Start) to talk to the youth about fish and wildlife habitat and tribal culture. Topics were presented from both the *Project Wild* and *Choices* curriculums. The team was also instrumental in planning the Natural Resources portion of the Tribe's "Rockin' the Rez" youth camp. The team was the primary organizers for that camp, held during the summer of 2006. They also worked together to recruit students for the Intertribal Natural Resources Camp to be held in early June of 2007.

A curriculum was created to teach children about fish and wildlife and their importance to our cultural well being past and present. The curriculum is designed to educate native people about land tenure issues so that they are better prepared to make proactive land decisions. The curriculum has potential to positively affect young people by giving them a greater understanding of the importance of tribal lands to native peoples. Participants made many positive comments related to the program.

The Outreach Specialist and the Extension program also collaborated with TANF and the Plummer Worley School District to hold a career fair in October 2006 for approximately 150 middle and high school students at the Coeur d'Alene Casino. Presenters included representatives from the local community colleges, Goodwill Industries, University of Idaho, and Coeur d'Alene Tribal Departments of Education, IT, and Lake Management.

WE Z: Publish a quarterly newsletter that highlights Program activities, recognizes cooperative efforts and serves as a forum for discussing land management issues.

The *Watershed Wrap* newsletter was published every quarter of this past year. Publication dates correspond to the spring and fall equinox and the summer and winter solstice. The Fisheries Program printed between 1,700 and 2,100 copies of each issue. Approximately 1,000 to 1,200 copies were distributed by mail to local landowners, other area Tribes, and natural resources agencies, including IDFG, USFWS and USFS. The remaining newsletters were hand distributed for pick up at various local area businesses in Northern Idaho and at workshops and meetings attended by the public.

Newsletter articles are targeted for the general public and help describe: 1) on-the-ground projects to further fish and wildlife restoration and enhancement efforts; 2) various methods being used to help restore and protect target watersheds; and 3) natural resource education and outreach efforts. The Fisheries Program has especially made a concerted effort to describe the various activities conducted with local schools. Other features introduce new employees, provide profiles of fish and wildlife species, and describe special research studies conducted on the Reservation. Some examples of the titles of published articles include: "Lake Creek TMDL Update", "Announcement: Opening of Trout Ponds and Newly Constructed Tribal Pond Near DeSmet, ID", "Water Awareness Week: Reaching Out to Area 6th Graders", "Tribal Wildlife Grant Awarded for Forest Carnivore Study", "Historic Channel in Benewah Valley Sees Water Again After Nearly a Century", "Habitat Restoration Work in Evans Creek", and "Eurasian Milfoil Problems and Solutions".

EVALUATION OF EFFECTIVENESS

There are several ways in which the effectiveness of outreach and education programs is traditionally evaluated. One such measure is the number of engagements that are successfully completed based on work dates available in the calendar year. A second measure is the variety of forums made available locally for education and outreach (i.e., K-12 and college students and teachers, Reservation communities and rural landowners, professionals from local/regional agencies and other stakeholders). Also, the number of participants in organized activities provides another measure of effectiveness. One additional measure that is more difficult to assess is the individual participants awareness, understanding and interest in the processes and needs of the habitat restoration, lake and stream studies, water quality, and other natural resource management activities undertaken by a particular project.

Performance criteria for the outreach/education components of this project have been defined for each objective and task as described below. The effectiveness of this project in meeting these criteria is primarily measured through the documentation of the numbers of individuals contacted through mailings, attendance at events, and community participation in educational forums held on and around the Reservation. A summary of activities and participation is shown in *Table 18*. It is intended that the performance criteria for future activities also be based on questionnaires and/or surveys administered to the participants. The responses to these questionnaires and/or surveys will be used to develop activity-specific performance criteria so that all activities can be evaluated, modified as needed or discontinued if found to be ineffective.

Objective 1: Coordinate Restoration and Management Activities

WE B: Conduct meetings with interested parties to coordinate restoration efforts and develop cooperative opportunities.

Criteria 1: Are inter-agency work group meetings beneficial to the natural resources programs that participate?

Effectiveness: Three meetings were held with 14 to 25 participants at each meeting. Regular attendees included representatives of the following organizations: CDA Tribe Environmental, Fisheries, Wildlife, forestry, Water Quality, Lake management, Land Services, Air Quality, Pesticide Control and Land Services Programs, NRCS, Farm Services Association, UI Extension, and the Benewah - Kootenai Soil, Spokane and Water conservation District. Participants agreed that these meetings met the effectiveness criteria. The future performance criteria will be documented in meeting sign-in sheets, agendas and written notes, by written letters of support, and executed memoranda of agreement.

Criteria 2: Are watershed working group meetings effective forums to educate and outreach to the Reservation community?

Effectiveness: Three meetings were held in the Benewah and Lake Creek watersheds. The attendance logs kept with meeting minutes indicate that there were 15 or more landowners present at each of these meetings. It is difficult to determine effectiveness without future consultation with program participants. It is our intent to review the content of the meeting, at a future date, with meeting participants. Effectiveness will be

measured using personal interviews and through the use of questionnaires or survey forms that will be developed and made available at future meetings for participants to provide comments, suggestions, or questions regarding the activities of the program.

WE B: Participate in Tribal inter-disciplinary processes to review and comment on issues related to the management of fisheries and other natural resources on the Reservation and in the ceded lands.

Criteria: Is participation in IDT meetings by project staff beneficial to the overall planning process and specifically to the management of fisheries resources?

Effectiveness: The participation of the Fisheries Program staff was very effective in bringing fisheries management and fish habitat protection issues to the forefront in the IRMP process. Three Fisheries Program participants contributed important perspectives on habitat protection and other topics during preparation of the final IRMP PEIS. By responding to technical comments and inquiries related to fisheries and water resources during the 75-day public comment period, Program staff increased the awareness and understanding of resource issues and management goals for a segment of the general public.

Objective 2: Provide Cultural and Educational Opportunities

WE Z: Provide summer internships for high school students to assist with implementation of project activities and to expose students to natural resource management issues.

Criteria 1: Were summer internships an effective educational forum to increase awareness and participation in Program activities?

Effectiveness: Three students participated for the entire summer period. At least one participant has expressed an interested in pursuing a higher education degree in a natural resource related field. Having at least some of the participants involved in more directed studies can potentially increase the effectiveness of this task. Over the last two years the program has developed an advanced internship plan that provides for a more complete set of on-the-job duties related to specific tasks within the Fisheries Program.

Criteria 2: Was attendance by summer interns at the Natural Resource Camp an effective educational forum to increase awareness and generate interest in the natural resource professions?

Effectiveness: The Nez Perce Tribe sponsored the camp this year. A total of 30 students attended the weeklong camp and all attendees reportedly benefited in some way. We will be developing a formal exit review questionnaire for the campers next season. This will help to provide more details on benefits to the participants

Table 18. Summary of education and outreach activities, June 2005 - May 2006.

Category	Activity/Description	Location(s)	Attendance	Dates
Multi-day	Water Awareness Week	Lake Creek watershed	>280 students/ teachers	5/5-9

Events (i.e. field camps, cultural gatherings)	Inter-Tribal Natural Resource Field Camp	Host by Clear water and Nez Perce Tribe	35 students/ teachers	6/18-23
	Rock n' the Rez Youth Camp	Plummer, ID	>165 students; >40 general public	7/11–8/11
	Spokane TANF Natural Resource camp	Camp Larson, Worley, ID	85 youth/ teachers/parents	8/1-4
	Water Potato Day	Chatcolet Lake	~ 425 students/ teachers	10/25-27
Single Day Lectures and Presentations	Science Lecture Series	Kootenai High School, Harrison, ID	16 students	Ongoing through school year
	Culture workshop for Japan students from WSU	Washington State University Pullman, Wa	15 students	8/10
	Indian Land Tenure Foundation Curriculum	St. Maries, ID and Plummer, ID	45 students	10/05
	Indian Education Summit	Coeur d'Alene Casino, Worley, ID	125 students / teachers	10/6-7
	After School Program	Plummer/Worley Middle School	25 students	10/29-5/20
	Fish & wildlife lecture	University of Idaho, Moscow	85 students	11/7
	Cultural presentation on the environment	North Idaho college, Coeur d'Alene	45 students	11/28-29
	Cultural Day at Tribal School	Coeur d'Alene Tribal School	120 students/ teachers	1/16.17
Single Day Field Trips	Cd'A Tribe History	Q'emilin Quest Park, Post Falls, ID	500 students/ teacher/ parents	5/16
	Natural Resource Field Day	Woodland Middle School from Cd'A, at Farragut State Park	275 students/ teachers	6/2
	Youth Fishing Trips	Various groups, on the ponds or Coeur d'Alene Lake	200 students	6/22, 7/22, 8/1
	New Project WET Curriculum	Benewah Creek area	25 teachers	8/20
	Arbor Day/ Mother Earth Day	Plummer Middle School, Worley Elementary	95 students/ teacher	3/3, 4/25
	Workshop Hooks & Ladders	Q' emilin Quest Park, Post Falls, Id	450 students/ teacher/parents	4/26-27
Other Activities	Historic Society Presentations	Q'emiln Riverside Park in Post Falls	550 youth/teacher, parents	5/7
	Antelope Run	DeSmet, ID	65 students	5/26
	Environmental Cultural Education Booth	Kootenai County Fair, Coeur d'Alene, ID	>350 general public	8/25-27
	Job Fair	Spokane Community College, Spokane, WA	225 students	10/5
	Native American Fish & Wildlife Society	Shelton, WA	50 employee/ students	10/16-19
	Arbor Day	North Idaho College, Coeur d'Alene	25 general public	4/21

WE Z: Provide educational programs for the local community to increase the understanding of project related activities within a scientific and cultural context.

Criteria: Does the Outreach Specialist's sponsorship and attendance at miscellaneous meetings and activities promote the education and outreach cause?

Effectiveness: The Outreach Specialist's attendance at workshops, classes, and events provided many opportunities to make presentations about fisheries program activities. We actively engaged the Reservation community and others and demonstrated the relevance of these activities to tribal culture and themselves. The effectiveness of each of the primary activities that the Outreach Specialist was involved in is outlined below. In the future, performance of these or other educational forums will be measured by a questionnaire or survey to be made available at each workshop, class and event to measure the quality of the experience provided.

Multi-day Events

Water Awareness Week, Rock n' the Rez Youth Program and Water Potato Day

Criteria: Do these programs act as an effective educational forum to increase awareness?

Effectiveness: These are some of the more important events that the Tribal Natural Resource programs put on for the regional communities. More than 300 students, teachers and parents participated in the Water awareness Week event, with each school having approximately one half day to work through seven learning stations. Future participation can be slightly increased through better coordination and advanced scheduling with the attending schools. There were over 165 youth that attended and participated in the Rock n' the Rez program. Water Potato Day is the largest event that is sponsored by the Fisheries Program and is particularly pertinent to Tribal culture. Approximately 425 students, teachers and others attended the event this year. Success to date has been gauged by the eagerness of participating schools to signup for the next event.

Single Day Lectures and Presentations

Kootenai High School Classroom Lecture Series, Coeur d'Alene Tribal School Classroom Teaching, North Idaho College– Arbor Day-Environmental Education

Criteria: Were these lecture sessions effective educational forums to increase awareness?

Effectiveness: Eight to twelve students attended each of the five lectures. Eighteen to forty students and their teachers attended presentations at the Coeur d'Alene Tribal School. Approximately 75 students, businessmen, and teachers attended Arbor Day program at the North Idaho College. If success is determined by participation then we can conclude that these presentations were successful. In the future we will provide opportunities to the participants for formal comment.

Single Day Field Trips

Arbor Day-Natural Resource Field Trip

Criteria: Was this class an effective educational forum to increase awareness?

Effectiveness: Approximately 400 students, teachers, and parents attended.

OtherActivities

Kootenai County Fair, Post Falls Historic Society – Tribal Stories, Indian Education Summit, and Native American Fish & Wildlife Society Pacific Region Conference

Criteria: Were these an effective educational forum to increase awareness?

Effectiveness: Approximately 350 people visited our booth at the Kootenai County Fair. Approximately 550 students, teachers, and parents attended story-telling event. About125 community members participated in Indian education workshop. Approximately 75 people attended Native American Fish and Wildlife Societies regional conference. In the future it is our intent to be more diligent in seeking formal comments on the effectiveness of our efforts.

WE Z: Work with university extension programs to extend outreach activities related to the project to the Reservation community.

Criteria: Does the Outreach Specialist's work with University of Idaho extension staff promote the education and outreach cause?

Effectiveness: The UI Extension Office sponsors a number of programs designed to increase the understanding of natural resources issues on the Reservation and participation by the Outreach Specialist in these events benefits both the Extension Office and the Fisheries Program. Effectiveness of specific activities undertaken with the UI Extension is listed below. In the future, the effectiveness of these or other educational forums will be measured by a questionnaire or survey to be made available at each workshop, class or event to measure the quality of the experience provided.

WE Z: Publish a quarterly newsletter that highlights Program activities, recognizes cooperative efforts and serves as a forum for discussing land management issues.

Criteria: Did the newsletter improve awareness within the local communities and businesses regarding fisheries habitat restoration?

Effectiveness: The Newsletter was effective in getting pertinent and interesting information out to the public on and off the Reservation. This conclusion was based on the number of newsletters mailed and delivered (1,800 to 2,200 per issue) and on oral feedback from participants at the different educational forums. In the future performance criteria for the newsletter will be supported by providing recipients an opportunity to comment on the newsletter in writing, via a postcard insert, back to the program.

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APPENDIX A

HYDRAULIC GEOMETRY AND ESTIMATED DISCHARGE FOR MONITORED SITES IN TARGET WATERSHEDS

Table A1. Bankfull hydraulic parameters based on Castro and Jackson (2001). Lake Creek sites were classified as West Interior Basin and Range while all other sites were classified as Western Cordillera.

		Parameters based on Drainage Area				Parameters based on a chosen Bankfull Discharge				
Stream	Site	Bankfull Area (ft^2)	Bankfull width (ft)	Bankfull mean depth (ft)	Bankfull Discharge (cfs)	Bankfull Area (ft^2)	Bankfull width (ft)	Bankfull mean depth (ft)	Bankfull mean velocity (fps)	Known Bankfull Q (cfs)
Alder	12	25.65	27.17	1.40	151.88	43.41	30.62	1.37	3.31	138
Benewah	9	68.07	43.84	2.05	404.53	91.26	45.93	1.96	3.87	348
Benewah	12	60.38	41.34	1.95	358.68	82.49	43.47	1.87	3.78	307
Benewah	13	56.25	39.93	1.90	334.04	77.68	42.06	1.81	3.74	285
Benewah	14 U	45.18	35.86	1.75	268.07	64.51	38.01	1.66	3.59	226
Benewah	14 L	45.18	35.86	1.75	268.07	64.51	38.01	1.66	3.59	226
Benewah	15 L	38.25	33.06	1.64	226.87	56.05	35.20	1.55	3.49	190
Benewah	16	30.88	29.76	1.51	183.01	46.79	31.89	1.42	3.36	152
Benewah	17	22.82	25.66	1.34	135.09	36.21	27.73	1.25	3.18	110
Windfall	1	10.45	17.50	0.99	61.72	18.51	19.23	0.91	2.76	48
Evans	3	25.36	27.03	1.40	150.20	42.89	30.41	1.36	3.30	136
Lake	7	25.34	17.61	1.74	165.82	54.74	25.34	1.95	4.72	234
Lake	8	22.27	16.19	1.68	146.09	48.22	23.20	1.87	4.66	202
Lake	9	18.82	14.51	1.59	123.81	40.85	20.66	1.76	4.58	167
Lake	10	18.53	14.37	1.59	121.92	40.22	20.44	1.75	4.57	164
Lake	11	6.76	7.46	1.16	45.31	14.75	10.15	1.22	4.12	51
Lake	12	6.54	7.30	1.15	43.83	14.26	9.92	1.20	4.10	49
Bozard	1	8.97	8.96	1.27	59.80	19.56	12.36	1.35	4.24	71
Bozard	2	8.72	8.80	1.26	58.16	19.02	12.12	1.33	4.23	68
Bozard	3	6.94	7.58	1.17	46.45	15.19	10.36	1.23	4.13	53
W. Fork Lake	2	7.28	7.82	1.19	48.70	15.98	10.74	1.25	4.15	56
W. Fork Lake	3	6.01	6.90	1.12	40.33	13.22	9.40	1.17	4.07	45

Table A2. Bankfull hydraulic parameters based on Castro and Jackson (2001). All sites were classified as Western Cordillera.

		Parameters based on Drainage Area				**Parameters based on a chosen Bankfull Discharge**				
Watershed	Site	Bankfull Area (ft^2)	Bankfull width (ft)	Bankfull mean depth (ft)	Bankfull Discharge (cfs)	Bankfull Area (ft^2)	Bankfull width (ft)	Bankfull mean depth (ft)	Bankfull mean velocity (fps)	Known Bankfull Q (cfs)
Alder	12	25.65	27.17	1.40	151.88	43.41	30.62	1.37	3.31	138
Benewah	9	68.07	43.84	2.05	404.53	91.26	45.93	1.96	3.87	348
Benewah	12	60.38	41.34	1.95	358.68	82.49	43.47	1.87	3.78	307
Benewah	13	56.25	39.93	1.90	334.04	77.68	42.06	1.81	3.74	285
Benewah	14 U	45.18	35.86	1.75	268.07	64.51	38.01	1.66	3.59	226
Benewah	14 L	45.18	35.86	1.75	268.07	64.51	38.01	1.66	3.59	226
Benewah	16	30.88	29.76	1.51	183.01	46.79	31.89	1.42	3.36	152
Benewah	17	22.82	25.66	1.34	135.09	36.21	27.73	1.25	3.18	110
Windfall	1	10.45	17.50	0.99	61.72	18.51	19.23	0.91	2.76	48
Evans	3	25.36	27.03	1.40	150.20	42.89	30.41	1.36	3.30	136
Lake	7	49.79	37.61	1.81	295.54	66.36	38.60	1.68	3.62	234
Lake	8	43.24	35.10	1.72	256.55	58.92	36.17	1.59	3.53	202
Lake	9	35.97	32.07	1.60	213.26	50.44	33.23	1.47	3.41	167
Lake	10	35.36	31.80	1.59	209.62	49.71	32.97	1.46	3.40	164
Lake	11	11.75	18.53	1.04	69.39	19.41	19.73	0.93	2.79	51
Lake	12	11.32	18.20	1.03	66.87	18.81	19.40	0.91	2.77	49
Bozard	1	16.00	21.56	1.17	94.60	25.29	22.80	1.05	2.95	71
Bozard	2	15.51	21.24	1.16	91.71	24.63	22.47	1.04	2.93	68
Bozard	3	12.08	18.79	1.05	71.35	19.95	20.03	0.94	2.81	53
W. Fork Lake	2	12.73	19.28	1.07	75.21	20.93	20.56	0.96	2.83	56
W. Fork Lake	3	10.32	17.39	0.99	60.93	17.52	18.66	0.88	2.73	45
Benewah	15 L	38.25	33.06	1.64	226.87	56.05	35.20	1.55	3.49	190

Table A3. Bankfull hydraulic parameters based on Castro and Jackson (2001). Comparison of Lake Creek sites for both West Interior Basin and Range (wibr) and Western Cordillera (wc) equations.

			Parameters based on Drainage Area				**Parameters based on a chosen Bankfull Discharge**				
Watershed	Site	Ecoregion	Bankfull Area (ft^2)	Bankfull width (ft)	Bankfull mean depth (ft)	Bankfull Discharge (cfs)	Bankfull Area (ft^2)	Bankfull width (ft)	Bankfull mean depth (ft)	Bankfull mean velocity (fps)	Known Bankfull Q (cfs)
Lake	7	wibr	25.34	17.61	1.74	165.82	54.74	25.34	1.95	4.72	234
Lake	8	wibr	22.27	16.19	1.68	146.09	48.22	23.20	1.87	4.66	202
Lake	9	wibr	18.82	14.51	1.59	123.81	40.85	20.66	1.76	4.58	167
Lake	10	wibr	18.53	14.37	1.59	121.92	40.22	20.44	1.75	4.57	164
Lake	11	wibr	6.76	7.46	1.16	45.31	14.75	10.15	1.22	4.12	51
Lake	12	wibr	6.54	7.30	1.15	43.83	14.26	9.92	1.20	4.10	49
Bozard	1	wibr	8.97	8.96	1.27	59.80	19.56	12.36	1.35	4.24	71
Bozard	2	wibr	8.72	8.80	1.26	58.16	19.02	12.12	1.33	4.23	68
Bozard	3	wibr	6.94	7.58	1.17	46.45	15.19	10.36	1.23	4.13	53
W. Fork Lake	2	wibr	7.28	7.82	1.19	48.70	15.98	10.74	1.25	4.15	56
W. Fork Lake	3	wibr	6.01	6.90	1.12	40.33	13.22	9.40	1.17	4.07	45
Lake	7	wc	49.79	37.61	1.81	295.54	66.36	38.60	1.68	3.62	234
Lake	8	wc	43.24	35.10	1.72	256.55	58.92	36.17	1.59	3.53	202
Lake	9	wc	35.97	32.07	1.60	213.26	50.44	33.23	1.47	3.41	167
Lake	10	wc	35.36	31.80	1.59	209.62	49.71	32.97	1.46	3.40	164
Lake	11	wc	11.75	18.53	1.04	69.39	19.41	19.73	0.93	2.79	51
Lake	12	wc	11.32	18.20	1.03	66.87	18.81	19.40	0.91	2.77	49
Bozard	1	wc	16.00	21.56	1.17	94.60	25.29	22.80	1.05	2.95	71
Bozard	2	wc	15.51	21.24	1.16	91.71	24.63	22.47	1.04	2.93	68
Bozard	3	wc	12.08	18.79	1.05	71.35	19.95	20.03	0.94	2.81	53
W. Fork Lake	2	wc	12.73	19.28	1.07	75.21	20.93	20.56	0.96	2.83	56
W. Fork Lake	3	wc	10.32	17.39	0.99	60.93	17.52	18.66	0.88	2.73	45

Table A4. Discharge at select return intervals derived from USGS Regional Regression Equations (Berenbrock 2002; Hortness and Berenbrock 2004).

Stream	Site	Q1.5	Q2	Q2.33	Q5	Q10	Q25	Q50	Q100	Q200	Q500
Alder	12	138	172	187	264	335	431	504	583	648	765
Benewah	9	348	434	471	664	845	1089	1274	1480	1647	1950
Benewah	12	307	382	416	586	745	959	1122	1302	1448	1713
Benewah	13	285	355	386	544	692	892	1043	1211	1347	1594
Benewah	14 U	226	282	307	434	552	712	834	968	1078	1276
Benewah	14 L	226	282	307	434	552	712	834	968	1078	1276
Benewah	15 L	190	237	258	365	464	599	702	815	907	1074
Benewah	16	152	190	206	291	371	478	559	649	722	854
Benewah	17	110	138	151	213	271	350	411	477	531	629
Windfall	1	48	61	67	98	127	169	201	238	269	325
Evans	3	136	170	185	263	336	435	511	594	662	786
Lake	7	234	291	315	440	554	705	818	942	1041	1219
Lake	8	202	251	272	379	478	608	705	811	896	1049
Lake	9	167	207	225	313	394	501	581	668	738	863
Lake	10	164	203	221	307	387	492	571	657	725	849
Lake	11	51	64	70	100	129	167	197	229	257	305
Lake	12	49	62	68	96	124	161	190	221	247	294
Bozard	1	71	89	97	137	174	225	263	305	339	401
Bozard	2	68	86	94	133	169	218	255	295	329	389
Bozard	3	53	66	72	102	130	167	195	226	251	297
W. Fork Lake	2	56	70	76	107	135	172	200	230	255	299
W. Fork Lake	3	45	56	61	86	108	139	161	186	206	242

Table A5. Standard Error and R-Squared value for regression equations used to calculate return intervals and bankfull parameters.

Standard Error (USGS methods)

Return Interval	Standard error of model (%)	Standard error of prediction (%)
Q1.5	+61.4 to -38.1	+65.5 to -39.6
Q2	+60.2 to -37.6	+64.2 to -39.1
Q5	+60.1 to -37.5	+64.3 to -39.1
Q10	+61.4 to -38.0	+65.8 to -39.7
Q25	+63.9 to -39	+68.7 to -40.7
Q50	+66.1 to -39.8	+71.4 to -41.6
Q100	+68.5 to -40.6	+74.1 to -42.6
Q200	+71.1 to -41.5	+77.1 to -43.5
Q500	+74.7 to -42.8	+81.3 to -44.8

R-squared (Castro and Jackson). Wcc is

***wcc*[1]**	**R-squared**	***wibr*[1]**	**R-squared**
Area (Q)	88	Area (Q)	71
Area (DA)	77	Area (DA)	78.5
Q (DA)	51.3	Q (DA)	79.4
w (Q)	84.4	w (Q)	86.8
w (DA)	53.6	w (DA)	82.9
d (Q)	87.4	d (Q)	72
d (DA)	44.2	d (DA)	58.4

[1] *West Interior Basin and Range (wibr) and Western Cordillera (wc).*