Coeur d'Alene Tribe Fisheries Program

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

2005 ANNUAL REPORT

Coeur d'Alene Tribe Department of Natural Resources
Fisheries Program
401 Annie Antelope Road
Plummer, ID 83851-0408

Coeur d'Alene Tribe
Fisheries Program

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

2005 ANNUAL REPORT

BPA PROJECT #1990-044-00

TRIBAL CONTRACT #90BP10544

BPA CONTRACT #10885

Prepared By

Angelo J. Vitale
Dale W. Chess
Stephanie A. Hallock
Mark H. Stanger

February 2007

Coeur d'Alene Tribe Department of Natural Resources
Fisheries Program
401 Annie Antelope Road
Plummer, ID 83851-0408
PHONE: (208) 686-5302
FAX: (208) 686-3021

Table of Contents

List of Figures

List of Tables

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 3rd – 4th order tributaries, 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 tributaries currently targeted by the Tribe for restoration are located almost exclusively on the Reservation (*Figure 1*) 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.

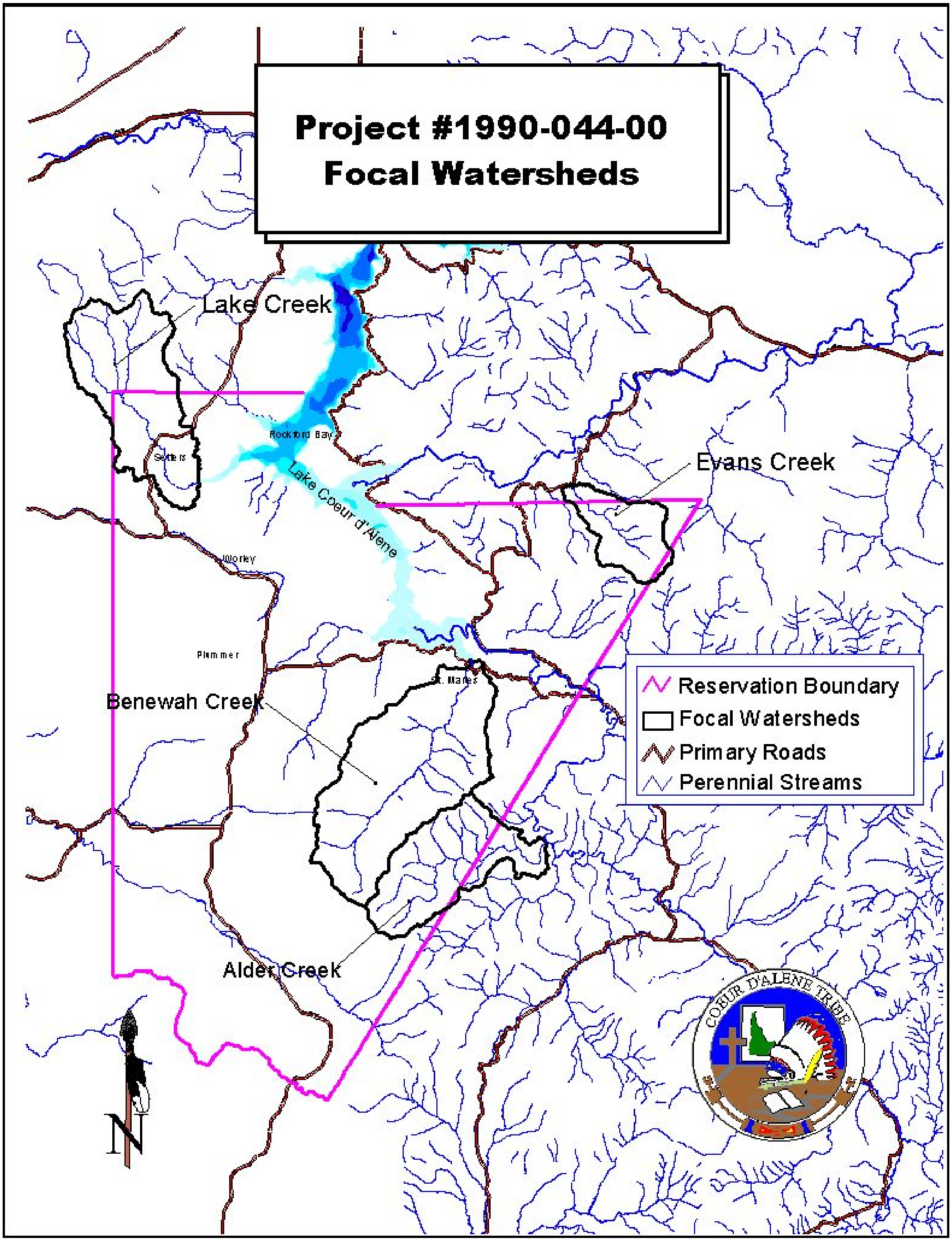

Figure 1. Locations of BPA Project 90-044-00 Focal Watersheds on the Coeur d'Alene Indian Reservation.

STUDY OBJECTIVES

This 2005 Annual Report summarizes previously unreported data collected to fulfill the contractual obligations for this project (BPA Project #1990-044-00) during the 2005 calendar year. The report is formatted into three primary sections that respectively describe results and discussion of: 1) the monitoring of biological and physical habitat indicators; 2) implementation of restoration and enhancement projects; and 3) a discussion of education and outreach work performed during 2005. The study objectives and related tasks listed below are excerpted from the document titled: *Scope of Work and Budget Request, June 2005 - May 2006. Implement Fisheries Enhancement Opportunities on the Coeur d'Alene Indian Reservation*.

Section 1: Monitoring and Evaluation

Objective 1: Conduct status and trend monitoring to detect changes in target fish populations over time.

Task 1a: Measure the abundance, distribution and other biological data related to cutthroat trout and other salmonids at index sites in mainstem and tributary reaches within the four target watersheds.

Task 1b: Install and maintain migration traps in Lake and Benewah creeks to measure the productivity of the adfluvial life history of cutthroat trout.

Task 1c: Reevaluate the power analysis using additional data on trout abundance and distribution within the four target watersheds to detect statistical changes in populations.

Objective 2: Reduce the abundance and distribution of non-native brook trout in Benewah Creek.

Task 2a: Remove brook trout from Benewah Creek.

Task 2b: Analyze data from brook trout removal.

Objective 3: Conduct monitoring to evaluate the effectiveness of habitat restoration.

Task 3a: Measure physical habitat indicators at treatment and control sites that are representative of specific restoration/enhancement strategies.

Task 3b: Measure water and air temperature along the longitudinal profile of target streams.

Task 3c: Measure summer and winter thermal heterogeneity in Benewah Creek in relation to restoration treatments.

Section 2: Restoration and Enhancement

Objective 1: Implement projects to improve instream habitat quality and quantity and restore watershed processes.

Task 1a: Implement stream channel construction in Benewah Creek to restore stable channel configuration consistent with historic conditions.

Task 1b: Revegetate all disturbed areas associated with channel construction.

Task 1c: Restore native forest plant communities within the 100-year floodplain of Benewah Creek.

Task 1d: Increase instream habitat complexity in Evans Creek through placement of LWD.

Task 1e: Conduct implementation monitoring for all new projects.

Section 3: Education and Outreach

Objective 1: Coordinate and participate in a variety of forums with managers and stakeholders to profile management issues and allow for participation by interested parties.

Task 1a: Continue meeting with watershed work groups comprised of private landowners, agency representatives and other interested parties to discuss restoration and cooperative opportunities on the Reservation.

Task 1b: 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 2: Provide cultural and educational opportunities to improve student/teacher involvement in Program activities.

Task 2a: Publish a quarterly newsletter that highlights Program activities, recognizes cooperative efforts and serves as a forum for discussing land management issues.

Task 2b: Provide educational programs for the local community to increase the understanding of project related activities and the relationship between cultural practices and tribally significant plants and animals.

Task 2c: Provide summer internships for interested high school students to assist with implementation of project activities and to expose students to natural resource management issues.

Task 2d: Work with the University of Idaho Extension Agent to develop and implement educational programs focusing on fish, water and wildlife resources and protection of the Reservation environment.

SECTION 1: MONITORING AND EVALUATION

METHODS

Biological Monitoring

<u>Trout Population Estimation</u>

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 defined as 60 meters.

Sites were electrofished in the summer to quantify the abundance and distribution of fishes during base flow conditions occurring between July and September. 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):

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=   .

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

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 i^{th} 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):

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

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).

Trout Production

Annual production (kg/hectare/yr) and production to biomass (P:B) ratio and variances were estimated following methods of Newman and Martin 1983. Production and P:B ratios were estimated separately for 2nd and 3rd order tributaries, and 3rd and 4th order mainstems.

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).

Trout Migration

Migration traps were installed in Lake and Benewah creeks in 2005 to assess migratory life history patterns of both juveniles and adults. The adult trapping program in past years has trapped enough adults to obtain life history information, but in past years, trap design (described by Conlin and Tuty 1979) reduced trap effectiveness during higher flows when adults were actively migrating. The inability to consistently operate the trap reduced our ability to estimate adult returns to Lake and Benewah Creeks. Beginning in 2005, a resistance board weir trap (RBW), (Tobin 1994, Stewart 2002) was used to test the trap's effectiveness to capture adfluvial, adult westslope cutthroat trout. The Benewah Creek adult trap design was not changed from previous years. A new outmigrant trap design was used in Lake Creek to more effectively capture juveniles and post-spawn adults. The Benewah Creek outmigrantt trap design was not changed from previous years. 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 2005, 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

Following the Rolling Provincial Review in 2001, the project was tasked with producing a research, monitoring and evaluation plan that described the methods and evaluations to assess the effectiveness of habitat restoration on Tribal projects. In response project staff developed an RM&E plan, volume 1 (Vitale et al. 2003), that described a hierarchical stratification process to select control reaches for statistical comparison with restored (treatment reaches. Site selection for control reaches followed a hierarchical stratification of the target watersheds that incorporates both ultimate and proximate control, consistent with the guidelines provided by Paulsen et al. (2002) and Hillman and Giorgi (2002). Thirteen control sites were selected using the above-mentioned process and habitat indicators were measured according to the RM&E plan beginning in 2002. Our RM&E plan was being implemented at the same time the Collaborative, Systemwide Monitoring and Evaluation Project (CSMEP) was being developed. We have followed the evolving CSMEP and Pacific Northwest Aquatic Monitoring Partnership (PNAMP) and the habitat indicators and methods we use to collect them are consistent with those discussed in both forums.

<u>Sites and Variables Monitored</u>

An important aspect of the proposed monitoring and evaluation program is the study of certain physical, chemical and biological characteristics of select treated (i.e. restored or enhanced) sites and similar but untreated "control" sites. The comparison of treated and control site characteristics can provide an important measure of changes (improvements or lack thereof) brought about by the treatments. *Table 1* provides a listing of the restoration / enhancement projects completed through 2004 that were selected to be monitored, along with the respective project category (treatment type) and the associated treatment and control monitoring sites. Restoration / enhancement project monitoring site locations are shown in *Figures 2 - 5*.

There were several basic physical characteristics measured at each of the paired treatment-control sites during 2005. These included: longitudinal (thalweg) profile of the site, six cross section profiles at each site, substrate materials ("pebble counts"), canopy cover, and amount of large woody debris (LWD) present. These parameters were measured and the data from each site was input into a single Reference Reach Spreadsheet (River4m, Ltd. 1999).

<u>Habitat Typing</u>

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 surveyor's ribbon. . A 500-foot tape (zero end) was then attached near the water surface and spooled out along the thalweg. Care was taken to keep the tape over the thalweg, especially around bends in the channel. This was accomplished by running the tape over or around existing woody debris or rocks. If no in-stream stationary items are found where needed, the tape was tied the appropriate distance from shoreline rocks or vegetation using surveyors ribbon. When the 500-foot mark was reached this was the end of the reach. This location was marked as was the start with flagging. For some sites, the starting or ending locations were different than the previous survey. This is further discussed later in this report.

Table 1. Coeur d'Alene Tribe, BPA-funded restoration / enhancement project sites with associated preliminary treatment and control pairings.

Restoration / enhancement Project ID	Project Category / Treatment Type	Treatment Monitoring Site #	Control Monitoring Site #
B_6.5	Channel reconstruction	Benewah 12	Benewah 13
B_8.1	Streambank stabilization & riparian planting	Benewah 14L	Benewah 9
B_8.5	Streambank stabilization & riparian planting	Benewah 14U	Benewah 17
B_11.5	Passage Improvement	Benewah 16	Benewah 17
E_0.1/0.0	Riparian planting	Evans 1	Evans 2
E_1.3	Streambank stabilization	Evans 3	Alder 12
E_1.6	Streambank stabilization	Evans 5	Evans 4
L_6.0	Riparian planting	Lake 8	Lake 7
L_7.3	Riparian planting	Lake 9U	Lake 10
L_8.2	Instream structures & riparian planting	Lake 11	Bozard 1
L_8.2/0.0	Riparian planting	WF Lake 2	Bozard 3
L_8.5	Riparian planting	Lake 12	Bozard 2
L_8.8	Riparian planting	Lake 13	Bozard 1

Longitudinal "Thalweg" Profile

The slope of the water surface is a major determinant of river channel morphology, and of the related sediment, hydraulic, and biological functions (Leopold 1994). A longitudinal profile surveyed along a selected channel reach is recommended for slope and channel typing determinations (Rosgen 1996).

This effort (modified from Peck et al. 2001) involved the determination of the water surface and channel bottom elevations along the "thalweg" of each 500-foot study reach. "Thalweg" refers to the flow path of the deepest water in a stream channel. The longitudinal thalweg profile, therefore, is a survey of the lowest stream bottom elevations (and associated water depths) along the reach. Measurements require the use of a surveyor's level and rod, and the 500-foot measuring tape described above. Operating and note taking procedures for this equipment are described in the RM&E Plan. Since most reaches are longer than could be seen from a single level setup, it was necessary to use "turning points" to move the level through the reach.

Profile surveying was begun once a backsite shot to a previously established benchmark was completed. This permanent reference point (top of a section of one-inch rebar driven firmly into the ground) was given the assumed elevation of 100.00 feet. From the benchmark, the level was set up and shots taken along the thalweg. A sufficient number of shots were taken to capture all changes in channel bottom slope and habitat types along the reach, generally every 4 feet or so. Collected survey data was input into a "Reference Reach Spreadsheet" (Ohio Department of Natural Resources 1999) for each site, which automatically graphed the profiles and also calculated pertinent descriptive criteria such as water surface slope.

Bed Form Differencing

Identifying pool and riffle habitats is important in monitoring changes in bedform and fish habitat. A macrohabitat identification technique called the Bed Form Differencing was applied to each of the longitudinal profiles collected. 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: 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 following the relationships and terminology in *Figure 2*. 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.

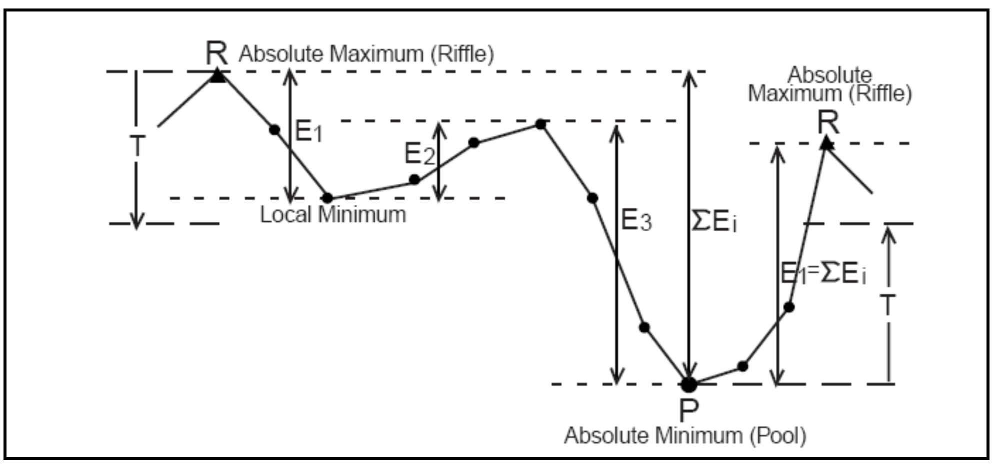

Figure 2. Hypothetical bed profile diagramming the terminology and method to calculate differences in streambed morphology (from O'Neill and Abrahams 1987).

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). This technique was chosen 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).

Cross Section Profiles

The cross section profiles were measured using a surveyor's level and rod at six locations along each studied reach. These cross-sections had been previously established and surveyed either 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 Bench Mark established for the thalweg profile surveying 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 not determined as part of this effort. The flood-prone width will be determined in the future to allow a verification of the channel type (see below). Collected cross section survey data, which included water depths where appropriate, was input into the "Reference Reach Spreadsheet" (Ohio Department of Natural Resources 1999), along with the longitudinal profile data, which automatically graphed the profiles and also calculated pertinent descriptive criteria such as bankfull elevation, cross sectional area, wetted perimeter and flood prone elevation.

Channel Substrate

Channel bed and bank materials influence the cross-sectional form, plan-view, and longitudinal profile of rivers; they also determine the extent of sediment transport and provide the means of resistance to hydraulic stress (Ritter 1967). 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. This requires that the six cross sections be located as described above. The pebble count substrate analysis was performed along each of the six cross sections within the monitored reach. Following the original method, 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. 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.

Collected pebble count data was input into the Reference Reach Spreadsheets (Ohio Department of Natural Resources 1999), 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 is indicated.

Canopy Cover

Vegetative canopy cover (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, depending on how the readings are taken. This monitoring was only for 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 each of the six cross sections established following the habitat typing survey. At each cross section, 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.

Instream Organic Materials

Organic materials play an important role in the character and productivity of stream habitats. This survey of monitored stream reaches was an inventory of the number and size of individual pieces of woody material observed along a longitudinal transect through the reach. For the Large Woody Debris (LWD) these data were converted into volumes of material so it was necessary to collect data on the lengths and diameters of the material to allow this calculation. Tree root wads were tallied separately as these typically provide additional habitat benefits because of their size and complexity. For this protocol the definition of a root wad was that it was dead, that it was detached from its original position, that it has a diameter where the tree trunk meets the roots of at least eight inches and that it was less than six feet long from the base of the root ball to the farthest extent of the trunk (Schuett-Hames, 1999).

The organic materials survey transect was walked along the thalweg starting at the downstream end of the reach. All LWD (organic material that is 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. 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 shall be measured immediately above the roots, if there are roots attached. Data handling included the tallying of all course material seen crossing the thalweg and 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.

Sinuosity

The sinuosity of a stream reach is estimated as the ratio of the stream channel length to the direct basin (valley) length. Rosgen (1996) describes the procedure for determining sinuosity of the entire stream basin but this also applies to a monitored stream reach. For a large scale determination of sinuosity, a 1:24,000 map or orthophoto and a ruler, or GIS map in measure option or GPS is used to measure the length of the basin as the straight line distance from the where the stream enters the study reach to where it leaves the reach. For the RM&E monitored 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 is 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 is calculated by dividing the stream length (500 feet) 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 described by Rosgen (1996) are entrenchment ratio, width-to-depth (W/D) ratio, sinuosity and slope. Entrenchment ratio is estimated as the typical flood-prone width divided by the bankfull channel width. Bankfull width, or the stream width and depth at bankfull stage, is determined by the elevation of the top of the "highest depositional feature"; this could be a change in size distribution of substrate or bank particles, a stain on rocks in the bank, or, most frequently, a break in the slope of the bank. When the bankfull elevation was not evident in the field, this could usually be determined by looking at the plotted cross section profiles. Flood-prone width is frequently not evident, especially where floodplain features have been obscured by agriculture or other human activities. Flood-prone width is estimated as twice the distance between the thalweg and the bankfull height.

Width-to-depth ratio is the bankfull width divided by the bankfull mean depth in a riffle section. Other dimensionless ratios include pool area ratio, pool width ratio, pool max depth ratio,pool area ratio is the ratio of the cross-sectional area of a pool divided by the bankfull cross-sectional area in a riffle section. Pool width ratio is the ratio of the width of a pool divided by the riffle bankfull mean width. Pool max depth is the ratio of the max depth of a pool divided by the riffle bankfull mean depth. These relationships are also determined for run and glide habitat types.. Sinuosity is the length of reach divided by the straight-line distance between the upstream and downstream ends of the reach. Slope is the drop in elevation of the water surface divided by the length of the reach and was determined from the upstream end of one habitat type (preferably a riffle) near the upstream end of the study reach, to the upstream end of a like habitat type near the downstream end of the study reach.

Temperature Monitoring

Stream water temperature was measured along the longitudinal profile of the mainstems and in major tributaries in 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. Stream temperature was measured at fine-scale, riffle/pool sequences in mid summer. Temperature of riffle/pool sequences was measured with a digital thermistor (Cooper Instruments model TM99A-E) and a model 2007 Cooper Instruments probe with a response time of 6 seconds at ±0.1 °C. The digital thermistor and probe is attached to a survey rod, allowing for simultaneous measurement of depth and temperature. While wading upstream, water temperature and depth (.01 meter) was recorded once in a riffle, associated pool tailout and in the deepest part of the pool. This fine-scale measurement was used to locate thermal heterogeneity in treatment and control reaches associated with the large-scale, channel/floodplain reconnection restoration in Benewah Creek. 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.

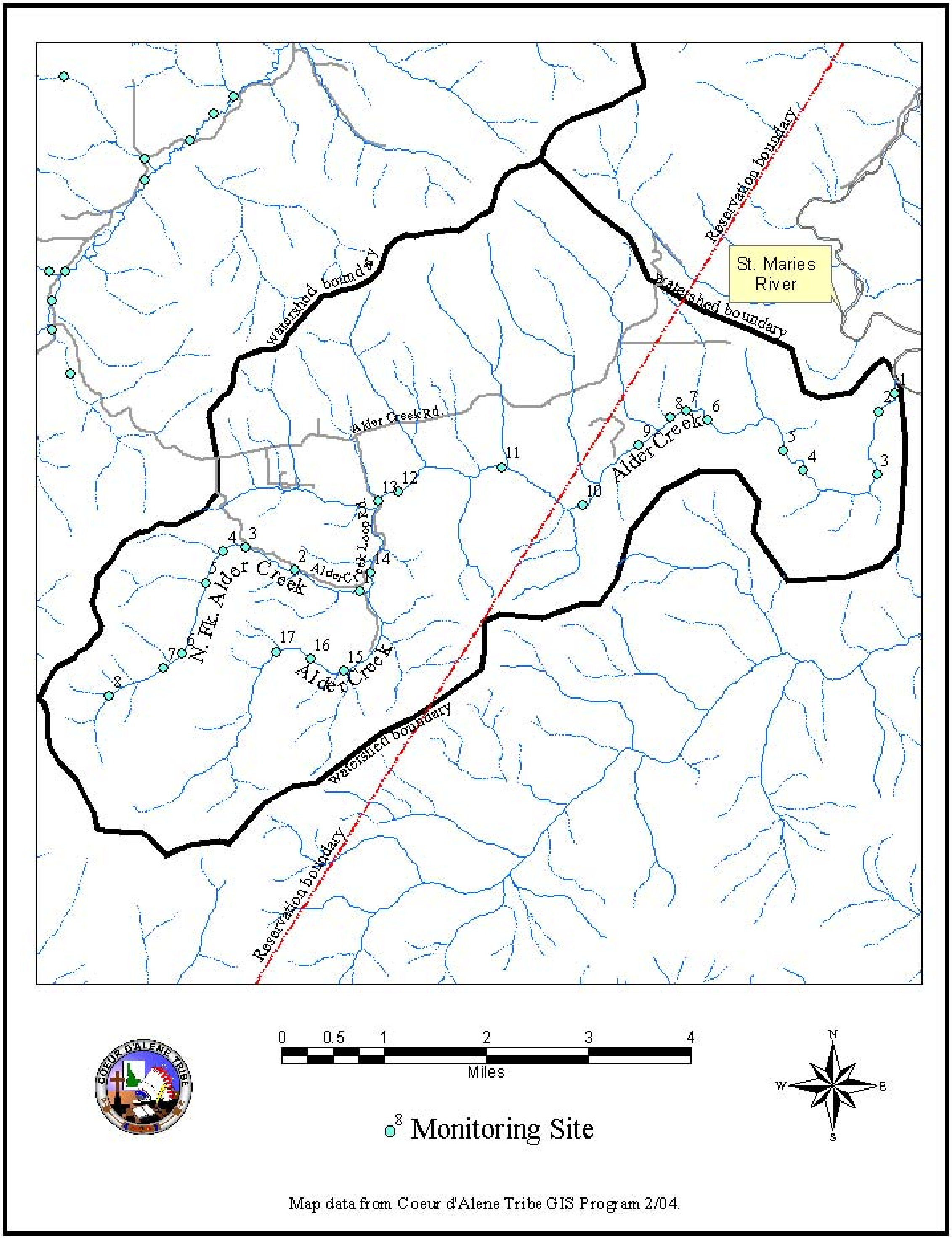

Figure 3. Map of Alder Creek watershed showing fish population and stream habitat monitoring sites.

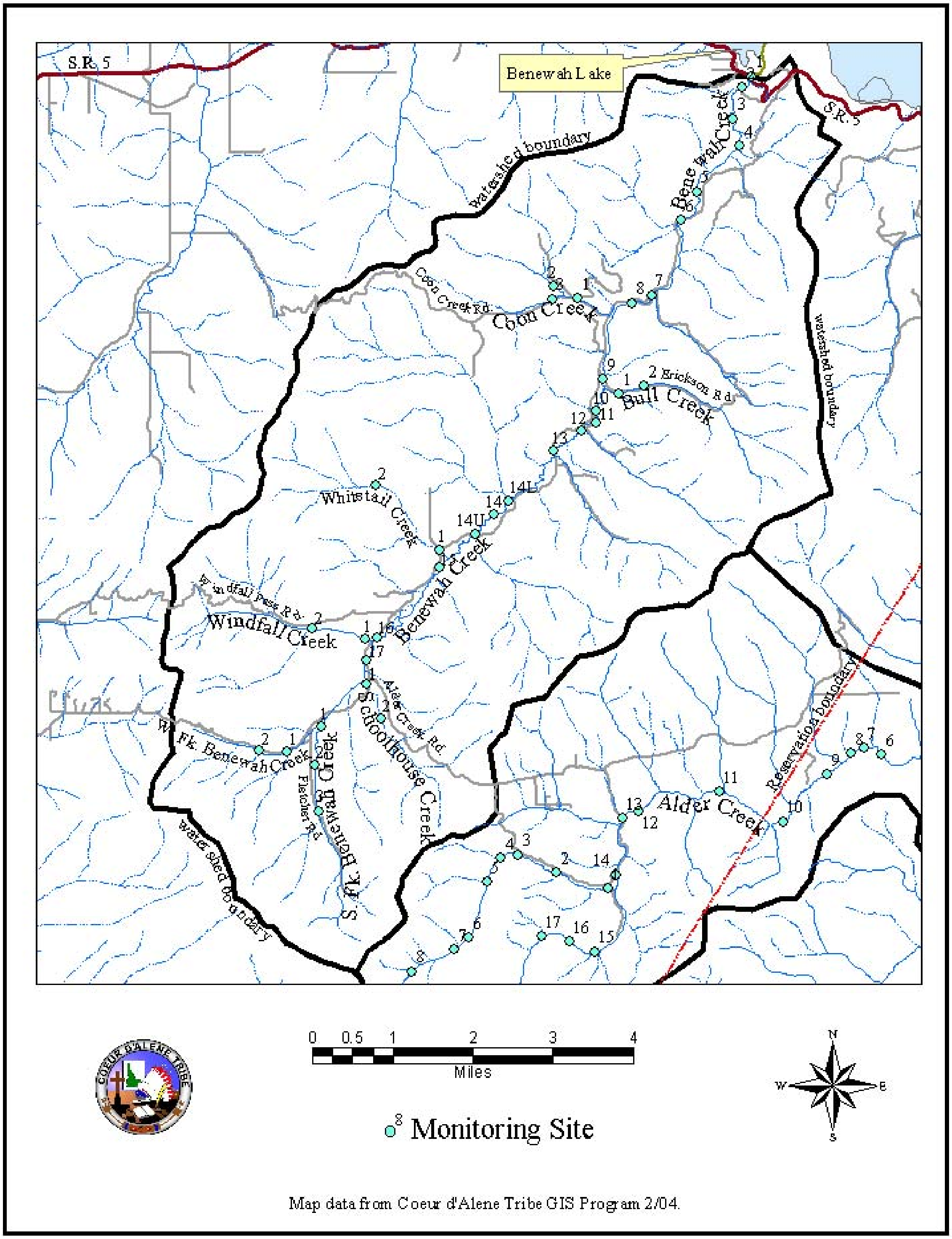

Figure 4. Map of Benewah Creek watershed showing fish population and stream habitat monitoring sites.

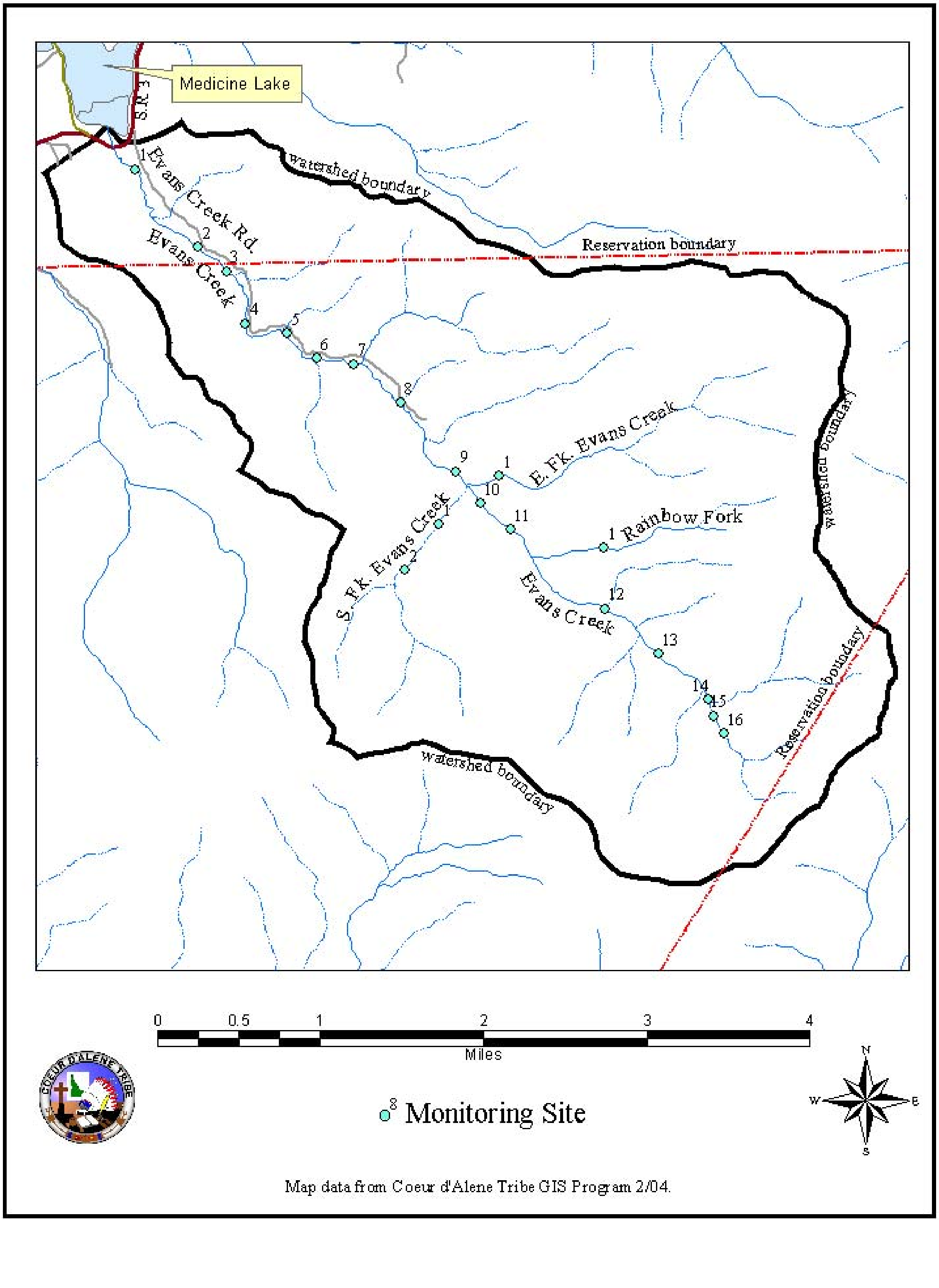

Figure 5. Map of Evans Creek watershed showing fish population and stream habitat monitoring sites.

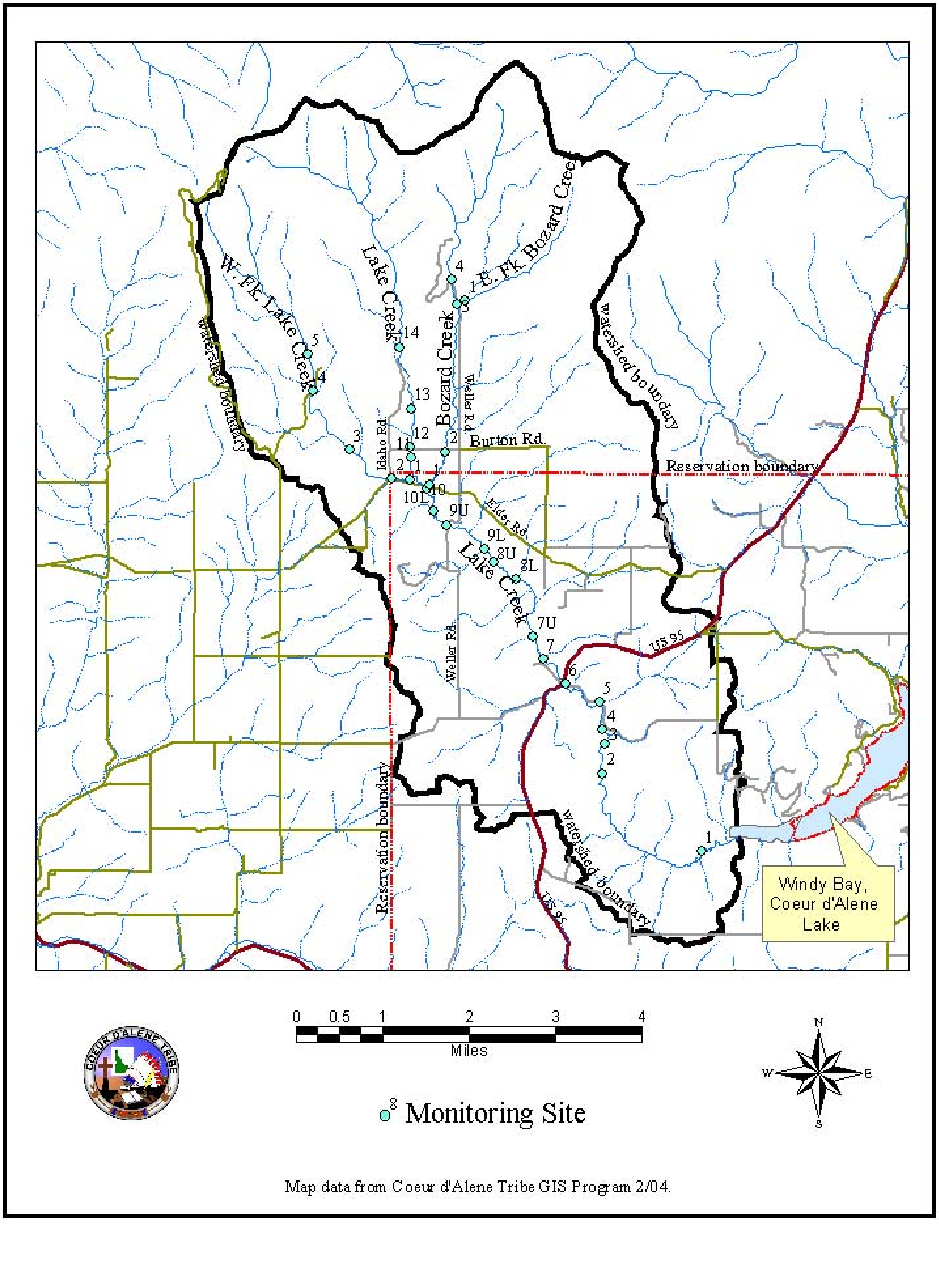

Figure 6. Map of Lake creek watershed showing fish population and stream habitat monitoring sites.

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, approximately 50% of the available habitat was occupied by cutthroat trout and much of the upper mainstem and North Fork contained no cutthroat in the sample. The highest mean densities at the watershed scale were 10.8/100m^2 and 6.9/100m^2 from Lake and Benewah creeks (*Table 2*). Maximum densities at the reach scale in each watershed were; 43.1/100m^2 in Bull Creek a tributary of Benewah Creek, 35.9/ 100m^2 in Bozard Creek a tributary of Lake Creek, 10.2/100m^2 in upper mainstem Evans Creek and 4.0/100m^2 in mainstem Alder Creek.

Non-native brook trout were found only in the Alder and Benewah creek watersheds, but were dominant in Alder Creek. The mean density of brook trout at the watershed scale in Alder Creek was 20.6/ 100m^2 (*Table 2*). The highest density of brook trout at the reach scale was 30.4/100m^2 in North Fork Alder Creek. In Alder Creek brook trout were distributed throughout the North Fork and upper mainstem reaches with relatively little spatial overlap between brook trout and cutthroat trout. When overlap did occur, brook trout were found in higher densities. In Benewah Creek, brook trout were distributed in the upper mainstem and associated tributaries with highest densities of 10.3/100m^2 and 29.7/100m^2 in the South and West forks respectively.

The estimated total number of westslope cutthroat and brook trout at the watershed scale for the ten-year time series of data from 1996-2005 are presented in Figures 7 and 8. The westslope cutthroat trout population in Lake Creek decreased from 2004 with a population of 6,326±1,211, the highest population of the four target watersheds in 2004 (Figure 7). The westslope cutthroat trout population in Benewah Creek decreased slightly from 2004 with a population of 5,226±1,030 (Figure 7). The westslope cutthroat trout population in Alder Creek was much lower than the other target watersheds and exhibits relatively low annual variation (Figure 7). The population of brook trout in Alder Creek was much higher in 2005 at 13,588±2,470 (Figure 8). The population of brook trout in Benewah Creek in 2005 was similar to 2004 at 2,129±602 (Figure 8). The brook trout population in Alder and Benewah creeks has increased since sampling began in 1996 (Figure 8).

Table 2. Density of westslope cutthroat trout and non-native brook trout, (mean±standard error) at the watershed scale from the four target watersheds in 2005. 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	0.6±0.3 (13)	6.9±2.9 (15)	5.7±1.2 (9)	10.8±2.6 (8)
brook trout	20.6±6.1 (13)	3.1±1.1 (15)		

A power analysis was done to evaluate the power to detect annual changes of cutthroat and brook trout populations at the watershed scale. The ten-year (1996-2005) 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 9). 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 for brook trout in Alder Creek is twice that of Benewah Creek (Figure 10).

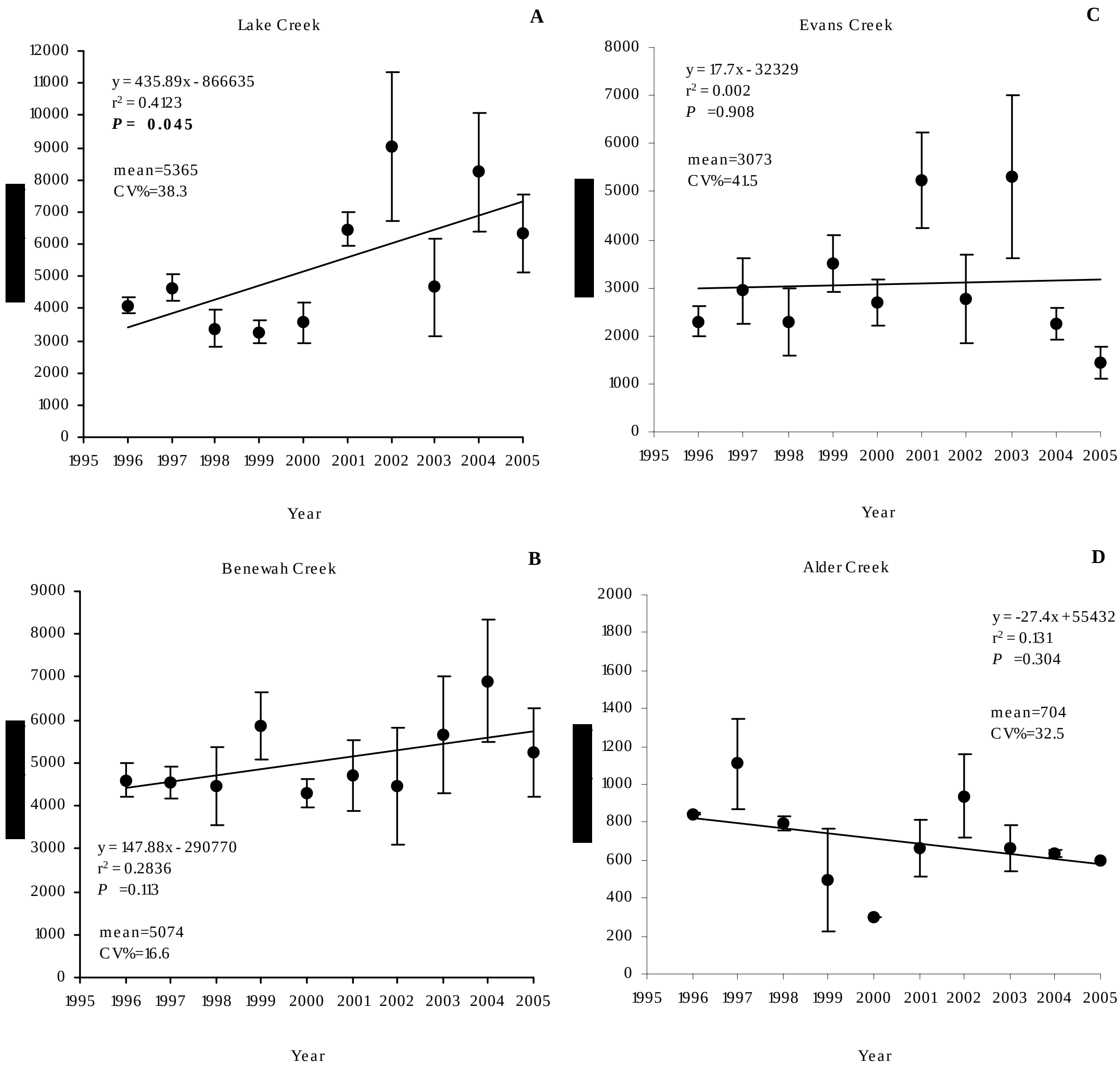

Figure 7. Population trends of westslope cutthroat trout estimated at the watershed scale in; A)Lake Creek, B)Benewah Creek, C)Evans Creek and D) Alder Creek.

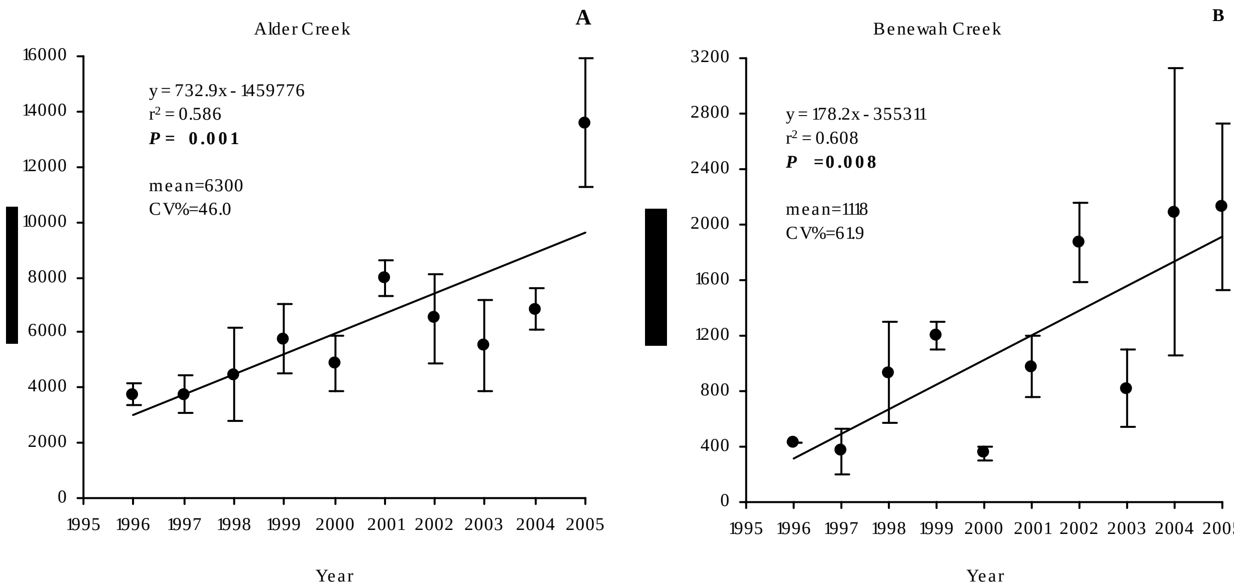

Figure 8. Population trends of nonnative brook trout estimated at the watershed scale in A) Alder Creek and B) Benewah Creek.

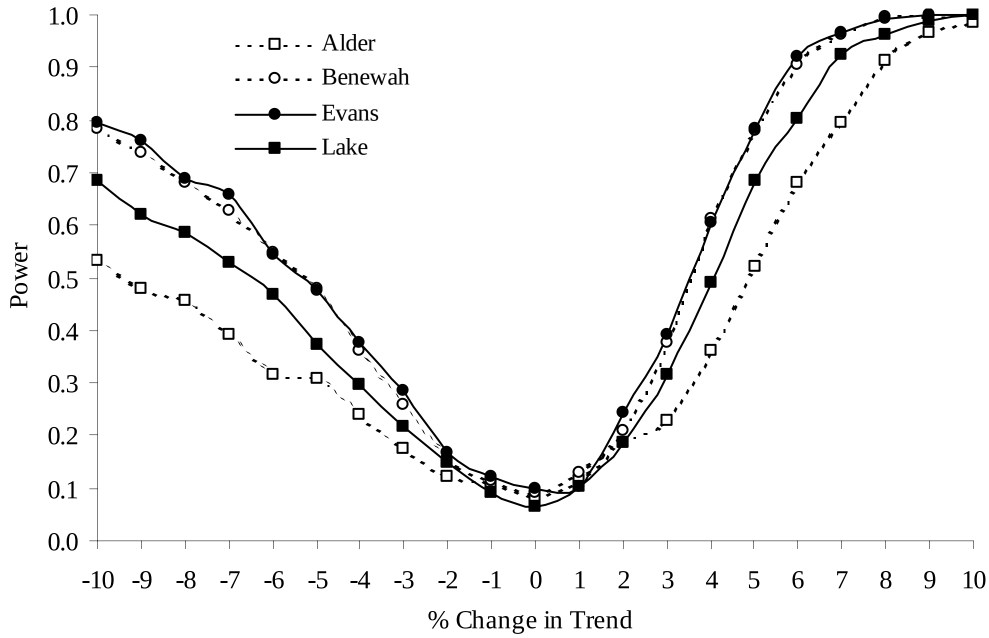

Figure 9. Power to detect annual changes in westslope cutthroat trout populations in four streams on the Coeurd' Alene Tribe Reservation (n=10 yrs, α level = 0.10).

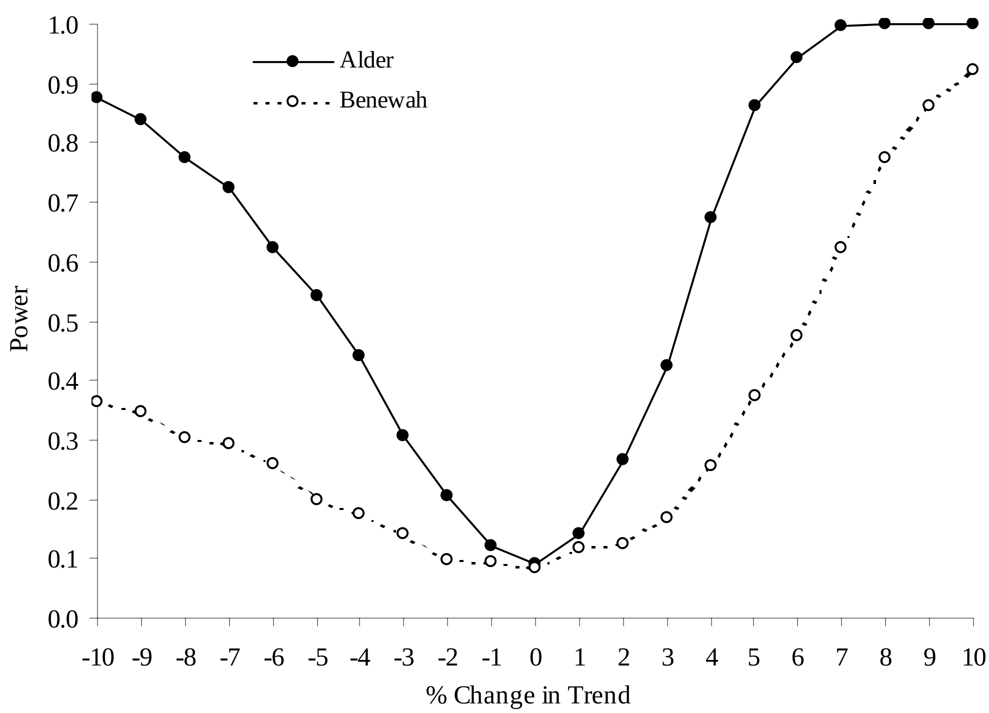

Figure 10. Power to detect annual changes in brook trout populations in two streams on the Coeurd' Alene Tribe Reservation (n=10 yrs, α level = 0.10).

Trout Production

Annual westslope cutthroat trout production in 2nd and 3rd order tributaries was 4.0 and 3.8 times greater than in 3rd and 4th order mainstems of Benewah and Lake creeks (*Table 3*). In contrast, westslope cutthroat trout production in 3rd and 4th order mainstem reaches of Evans Creek was 1.33 times greater than in 2nd and 3rd order tributaries. Non-native brook trout production in 2nd and 3rd order tributaries of Alder Creek was greater than westslope cutthroat trout production in 2nd and 3rd order tributaries of Benewah and Lake creeks, and nearly twice as high as brook trout production in Benewah Creek *(Table 3*).

Table 3. Annual production ($kg \cdot ha^{-1} \cdot yr^{-1}$), biomass ($kg \cdot ha^{-1}$), and production to biomass ratio(± 95% CI) for westslope cutthroat (WCT) and brook trout (EBT) from 2nd and 3rd order tributaries, and 3rd and 4th order mainstems of four target watersheds in the Coeur d'Alene Basin for 2005.

		Tributaries (2nd and 3rd order)			Mainstem (3rd and 4th order)		
Stream	Species	Production	Biomass	P:B	Production	Biomass	P:B
Alder[a]	WCT	-	-	-	3.5 (0.2)	5.0 (0.2)	0.7 (0.1)
Benewah	WCT	27.7 (2.1)	35.0 (1.7)	0.8 (0.1)	6.9 (0.3)	7.3 (0.4)	0.9 (0.1)
Evans	WCT	9.0 (0.6)	11.1 (0.6)	0.8 (0.1)	12.0 (0.4)	19.3 (0.3)	0.6 (<0.1)
Lake	WCT	43.0 (3.4)	52.2 (3.3)	0.8 (0.2)	11.4 (1.1)	13.2 (1.1)	0.9 (0.2)
Alder[b]	EBT	52.5 (3.3)	72.7 (2.2)	0.7 (0.1)	-	-	-
Benewah[b]	EBT	28.2 (1.8)	35.9 (1.0)	0.8 (0.1)	-	-	-

[a] *Low numbers of westslope cutthroat trout precluded production estimates.*
[b] *Low numbers of brook trout precluded production estimates.*

Trout Age and Size

The length, weight and condition factor separated by age for westslope cutthroat and brook trout sampled during population estimates is presented in *Tables 4 and 5*. Length, weight and condition factor data was tested for normality prior to applying statistical tests. The variance between data sets was not equal, thus a nonparametric Kruskall-Wallis test was selected to compare age classes between the four streams. A significant Kruskall-Wallis test was followed by a nonparametric multiple comparisons test (Zar 1999). A Mann-Whitney test was done for the comparison of brook trout in Alder and Benewah Creeks, and to compare westslope cutthroat trout and brook trout in Benewah Creek. The sample size of westslope cutthroat trout from Alder was too low and was excluded from the analysis. In addition, sample size was low for age 5 fish for both westslope cutthroat trout and brook trout and was excluded from the statistical analyses. Age 0 westslope cutthroat trout from Lake Creek were significantly smaller in length ($p<0.001$) and weight ($p<0.001$) than in Benewah and Evans Creeks (*Table 4*). Age 1 westslope cutthroat trout from Benewah Creek were significantly smaller in length ($p<0.001$) and weight ($p<0.001$) than in Lake and Evans Creeks (*Table 4*). The length of age 1 Alder Creek brook trout was significantly greater than age 1 Benewah brook trout ($p=0.038$), (*Table 5*). However, condition factor of age 1 brook trout from Benewah Creek was greater than Alder Creek age 1 fish ($p=0.020$), (*Table 5*). Brook trout had a significantly higher condition factor for age 1 (p=0.004), age 2 (p=0.002) and age 3 (p<0.001) compared to westslope cutthroat trout in Benewah Creek (*Tables 4 and 5*).

Table 4. Total lengths, weights and Fulton type condition factors (K_{TL}) for age classes of westslope cutthroat trout from Alder, Benewah, Evans and Lake creeks sampled by electrofishing summer 2005.

			Length (mm)		Weight (g)		K_{TL}	
Stream	Age	n	mean±1SD	Range	mean±1SD	Range	mean±1SD	Range
Alder	0	2	68	(60-75)	3.0	(2.0-3.9)	0.93	(0.92-0.93)
	1	2	104	(85-123)	11.8	(5.1-18.5)	0.91	(0.83-0.99)
	2	13	133±12	(117-158)	22.3±6.9	(14.4-39.5)	0.94±0.15	(0.74-1.20)
	3	9	157±20	(140-200)	35.2±19.2	(23.8-83.0)	0.85±0.09	(0.75-1.04)
	4	3	210±4	(205-213)	89.3 ±2.2	(86.9-91.0)	0.97±0.10	(0.94-1.01)
Benewah	0	66	68±7	(43-82)	3.3±0.9	(0.8-5.6)	1.0±0.14	(0.71-1.31)
	1	45	88±12	(76-118)	6.6±3.5	(3.4-16.2)	0.92±0.13	(0.69-1.16)
	2	103	130±15	(93-163)	19.6±6.3	(8.2-35.8)	0.87±0.08	(0.71-1.11)
	3	18	160±18	(126-190)	39.7±15.5	(16.1-68.6)	0.93±0.07	(0.77-1.09)
	4	3	217±20	(203-240)	100.6±37.3	(78.7-143.7)	0.95±0.08	(0.87-1.04)
	5	1	254		172		1.05	
Evans	0	17	70±6	(53-80)	3.6±1.1	(2.0-5.7)	1.02±0.20	(0.64-1.34)
	1	55	98±11	(78-119)	9.5±3.1	(3.1-16.2)	0.99±0.13	(0.64-1.25)
	2	32	132±14	(98-155)	23.3±7.4	(9.1-42.7)	0.98±0.11	(0.71-1.15)
	3	20	175±17	(146-214)	55.5±17.7	(26.7-98.8)	1.00±0.09	(0.82-1.24)
	4	15	220±14	(200-250)	110.1±19.6	(76.9-141.7)	1.03±0.10	(0.90-1.23)
	5	1	251		180.8		1.14	
Lake	0	143	64±9	(33-85)	2.7±1.0	(0.4-6.1)	1.01±0.18	(0.64-1.32)
	1	76	97±13	(68-124)	9.1 ±4.2	(2.3-21.0)	0.94±0.13	(0.65-1.26)
	2	108	129±14	(97-159)	20.3±6.6	(7.4-39.3)	0.92±0.11	(0.64-1.17)
	3	38	164±19	(128-198)	44.5±15.9	(19.9-82.7)	0.97±0.09	(0.80-1.13)
	4	3	215±16	(204-233)	101.1±11.0	(94.6-113.8)	1.02±0.11	(0.90-1.11)
	5	-						

Table 5. Total lengths, weights and Fulton type condition factors (K_{TL}) for age classes of non-native brook trout from Alder and Benewah creeks sampled by electrofishing summer 2005.

			Length (mm)		Weight (g)		K_{TL}	
Stream	Age	n	mean±1SD	Range	mean±1SD	Range	mean±1SD	Range
Alder	0	101	68±8	(45-80)	3.3±1.1	(1.0-6.4)	0.99±0.14	(0.65-1.40)
	1	110	98±14	(76-129)	9.4±4.1	(3.8-21.1)	0.95±0.13	(0.60-1.30)
	2	91	126±15	(86-157)	19.8±7.2	(5.9-40.2)	0.94±0.11	(0.73-1.25)
	3	48	168±17	(126-196)	47.1±15.3	(18.3-75.0)	0.96±0.10	(0.65-1.23)
	4	13	207±9	(194-220)	92.9±18.3	(66.8-125.4)	1.04±0.12	(0.87-1.21)
	5	2	251	(238-263)	134.5	(127.2-141.7)	0.86	(0.78-0.94)
Benewah	0	22	73±12	(47-89)	4.1±2.0	(1.0-7.0)	0.94±0.15	(0.60-1.11)
	1	16	90±9	(77-107)	7.7±2.3	(4.6-13.3)	1.02±0.09	(0.84-1.13)
	2	39	121±15	(96-144)	17.1±6.3	(7.7-28.3)	0.92±0.09	(0.68-1.16)
	3	32	165±18	(138-210)	48.4±18.4	(23.5-98.8)	1.05±0.11	(0.82-1.29)
	4	9	212±24	(171-240)	104.2±36.8	(59.3-157.9)	1.05±0.10	(0.96-1.22)
	5	2	267	(257-276)	204.0	(191.5-216.5)	1.08	(1.03-1.13)

Trout Migration

Two new trap designs were tested in Lake Creek in 2005. A resistance board weir trap was installed in Lake Creek on March 18th to capture upstream migrating adults. This was the first year the fisheries program used this type of trap. The resistance board weir trap fished 100% of the time and captured 124 adult westslope cutthroat trout (*Table 6*). This was greater than ten times the number of adults caught in any upstream trap since trapping began in 1996. Even though the new design captured more adults than in past years, more post-spawn adults were captured in the downstream trap than in the upstream trap (*Table 6*). Upstream migrants and post-spawn migrant timing overlapped (*Figure 11*). Post-spawn fish had lower condition factors compared to pre-spawn, upstream migrants (*Table 7*). An additional 57 adult post-spawners were captured between the downstream and upstream traps on April 20th and 23rd, following the installation of a downstream trap on April 19th. These fish were identified as post-spawners due to the obvious marks on their bodies, worn fins and lower condition factors. The old-style vertical weir adult trap was installed in Benewah Creek on April 5th and fished only 75% of the time, capturing 10 adult westslope cutthroat trout (*Table 6*).

A new "pop-out panel" trap design was installed in Lake Creek on April 19th to capture downstream migrating juveniles. The pop-out panel trap replaced the fixed vertical weir design that was initially installed on March 24th but only fished 8% of the time because of debris loading (Table 6). The pop-out panel trap immediately started capturing juvenile outmigrants while fishing 100% of the time (*Table 6*). Fifty percent of the juvenile outmigration was completed by May 9th (*Figure 12*). On May 17th, 194 juveniles were trapped, the most in a 24-hour period (*Figure 12*). Nearly 56% of the juveniles were age 1+ fish, only 1% were age 3+ (*Table 8*). The old-style, fixed vertical weir was fished in Benewah Creek, being installed on May 5th. The trap was installed late in the season due to high, sustained flows from heavy rains. Although the trap was considered to have fished 100% of the time, trapping efficiency was low because the trap apron did not seal to the bottom substrate tightly, allowing the juveniles to escape.

Table 6. Dates of trap deployment, trapping effort and number of adfluvial westslope cutthroat trout captured in Benewah and Lake creeks, 2005.

System	Trap Type	Installed	Removed	Days Fishing (% of total)	Days Not Fishing (% of total)	Adults captured	Juveniles captured
Benewah	Upstream	4/5/05	5/24/05	37 (76%)	12 (24%)	10	1
	Downstream	5/5/05	6/3/05	29 (100%)	0 (0%)	12	49
Lake[1]	Upstream	3/18/05	5/26/05	69 (100%)	0 (0%)	124	3
	Downstream (old)	3/24/05	4/17/05	2 (8%)	24 (92%)	1	2
	Downstream (pop-out)	4/19/05	6/16/05	58 (100%)	0 (0%)	200	1,704

[1] An additional 57 post-spawn adults were collected between the upstream and downstream traps from 4/20 and 4/23 (refer to "Trout Migration" text for additional explanation).

Table 7. Length, weight and condition factor of adult lacustrine-adfluvial westslope cutthroat trout captured in migration traps from Lake and Benewah Creeks in 2005.

			Total Length (mm)	Weight (g)	Condition Factor
Stream	Trap	n	Mean±SD	Mean±SD	Mean±SD
Lake	Upstream	124	355±22	419.6±70.7	0.94±0.09
Lake	downstream	257	359±30	382.6±89.5	0.82±0.08
Benewah	Upstream	10	304±60	284.7±144.6	0.92±0.06
Benewah	downstream	12	370±65	439.9±136.0	0.80±0.06

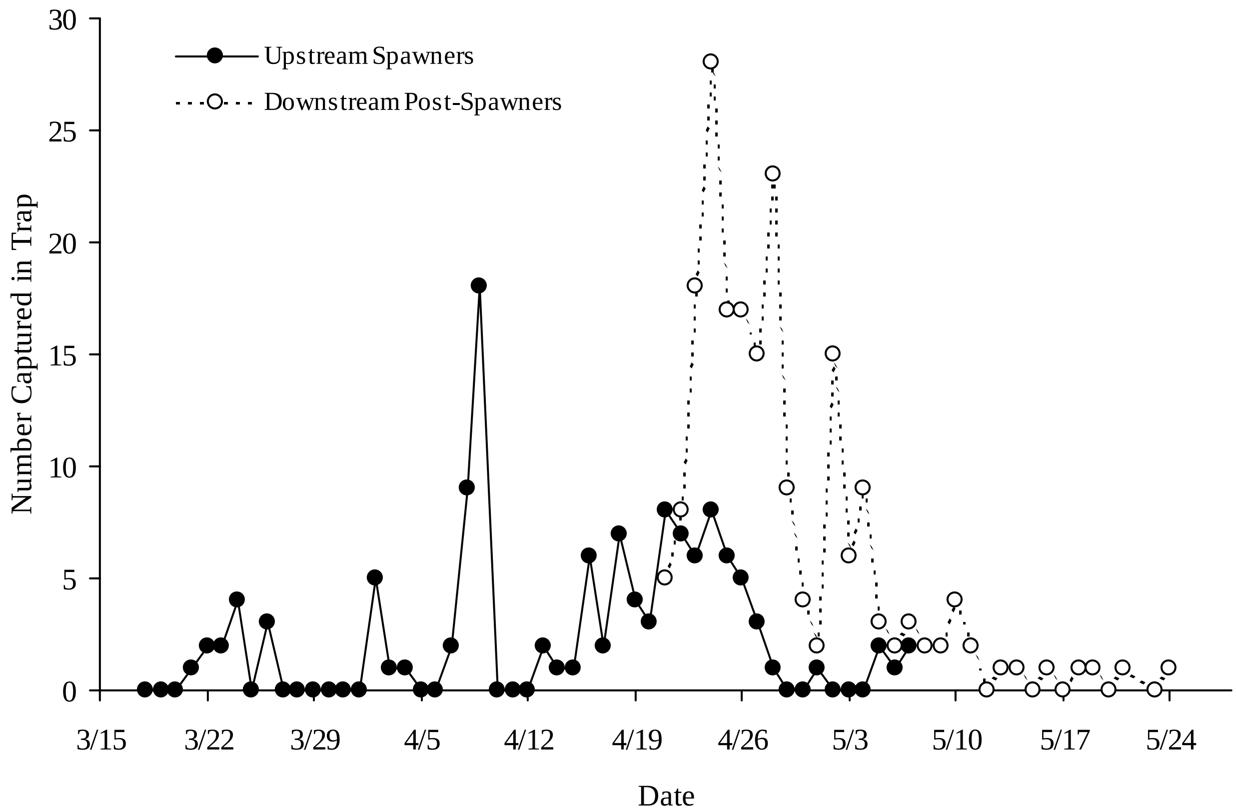

Figure 11. Timing of adult adfluvial westslope cutthroat trout spawning migration and post-spawner outmigration captured in traps from Lake Creek.

Table 8. Estimated age composition of adfluvial westslope cutthroat trout juveniles captured in the outmigrant trap compared to age composition of juveniles PIT tagged from Lake Creek 2005.

	Trapped		PIT Tagged	
Age	Number	% Composition	Number	% Composition
0+	343	20.1	144	20.9
1+	952	55.8	367	53.4
2+	392	23.0	170	24.7
3+	19	1.1	7	1.0

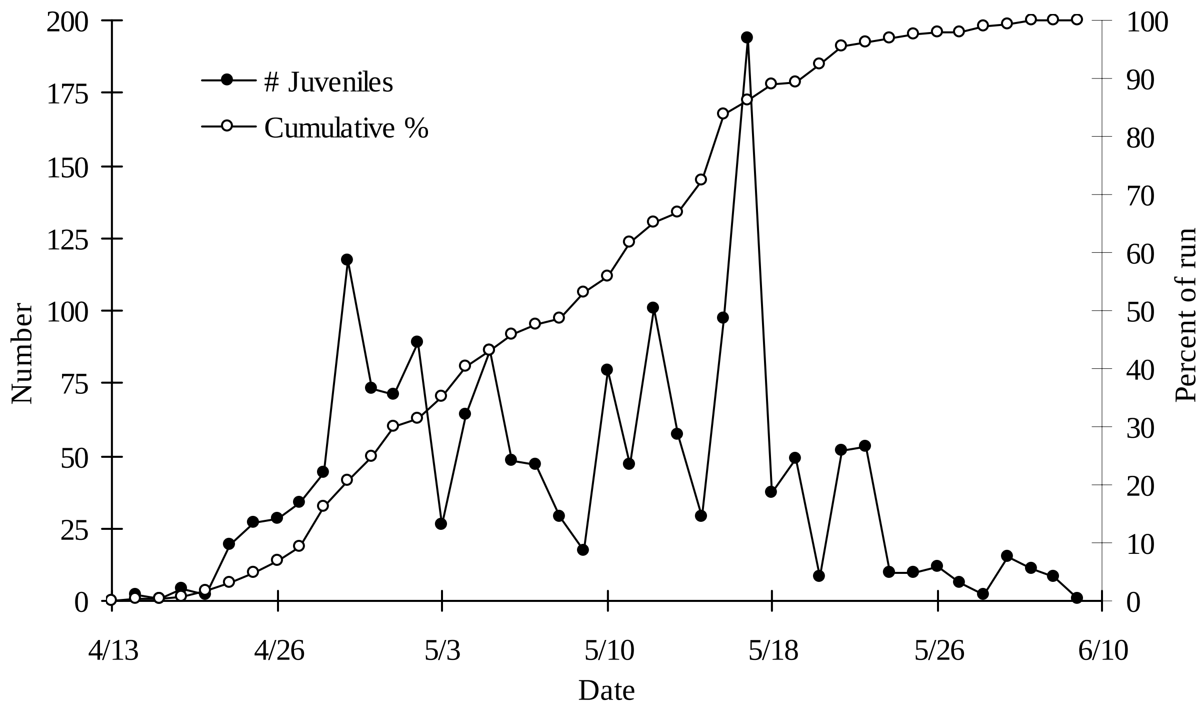

Figure 12. Timing of outmigrating adfluvial westslope cutthroat trout juveniles captured in the downstream migrant trap in Lake Creek, 2005.

<u>Westslope Cutthroat Trout PIT Tagging</u>

A total of 688 juvenile adfluvial westslope cutthroat trout were PIT tagged between April 14th and June 1st 2005 (*Figure 13*). This represented 40.3% of the total number of juveniles trapped in Lake Creek (*Figure 13*). Fifty three percent of the PIT tagged juveniles were age 1+ (*Table 8*). The age composition of PIT tagged juveniles versus juveniles captured in the outmigrant trap was not significant (*Chi Square, α 0.05, P=0.712*). More age 2+ and 3+ juveniles were PIT tagged earlier in the outmigration (*Figure 14*), similar to the age composition timing of the entire run. Three groups of at least 24 PIT tagged juveniles were held in a false-bottom net pen located in Lake Creek to measure 24-hour, post-PIT tag survival and tag retention. Survival and PIT tag retention were 100% from all three groups.

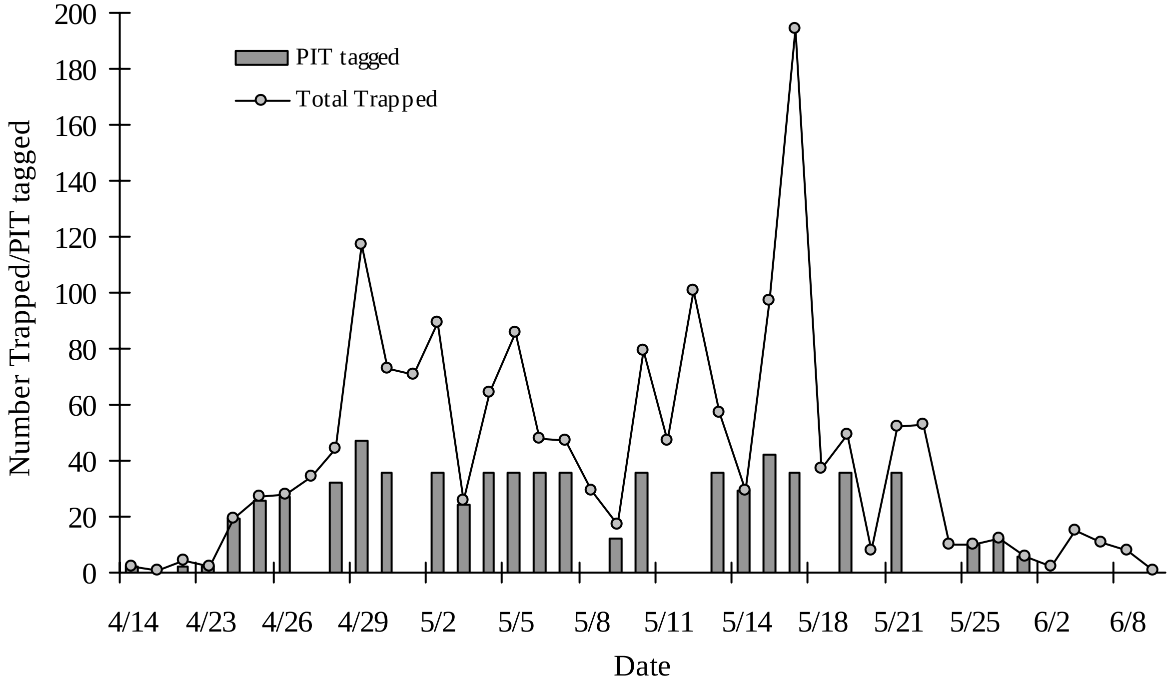

Figure 13. The number of adfluvial westslope cutthroat juveniles PIT tagged compared to the number of juveniles captured in the outmigrant trap in Lake Creek, 2005.

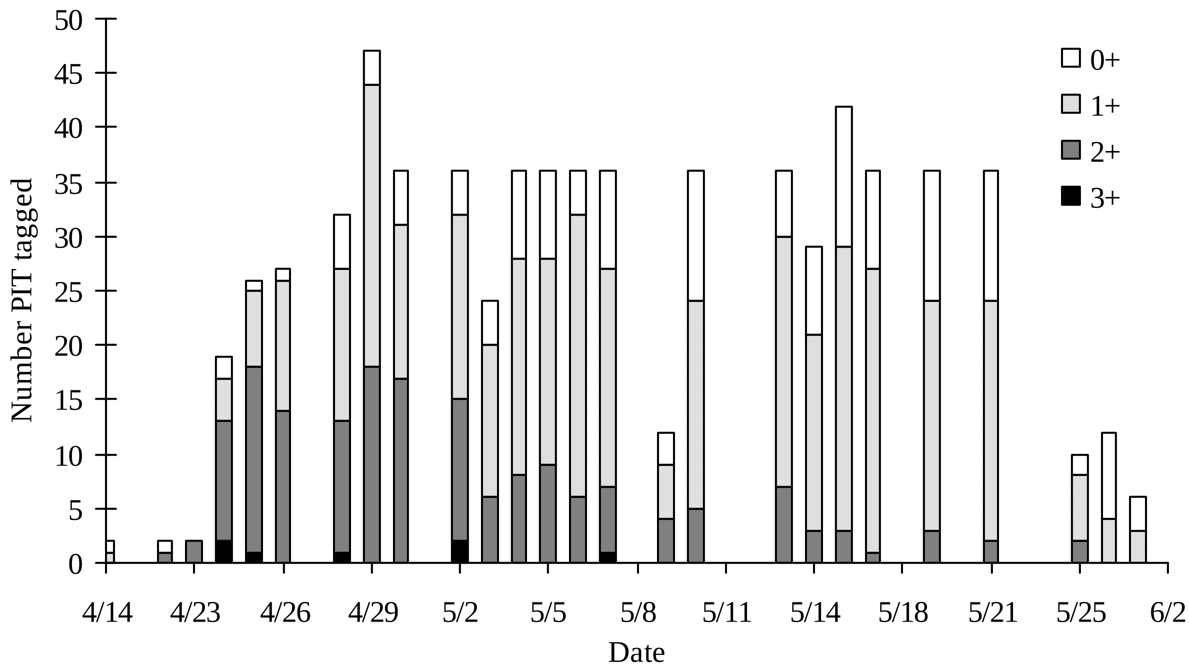

Figure 14. Estimated age composition of adfluvial westslope cutthroat trout juveniles PIT tagged after being captured in the outmigrant trap from Lake Creek, 2005.

Brook Trout Removal

The non-native brook trout *(Salvelinus fontinalis)* removal project was continued in 2005. As with 2004, attention was focused on the entire West and South Forks and the upper mainstem. However, in 2005 more of the upper mainstem was shocked. Brook trout were removed from the upper mainstem beginning at the confluence of Windfall Creek and proceeded upstream to the confluence of the West and South Forks. This increased the linear distance electroshocked by over 1,800 meters compared to 2004 (*Table 9*). All index sites associated with the population estimate sampling were sampled prior to brook trout removal. In 2005 a total of 1,396 brook trout were removed with 1,153 removed from the upper mainstem alone *(Table 9)*. Five age classes of fish were removed (Table 9). The estimated total number of mature females and males removed was 319 and 207 respectively (*Table 10*). In 2005 a higher percentage of adults were removed and the estimated number of eggs removed was 2.5 times greater than in 2004 (*Table 10*). Most of the adults removed were from the upper mainstem habitat.

The brook trout population in Alder Creek is the control to compare changes in density, production and potential changes in reproductive life history traits of brook trout following removal in Benewah Creek. A subsample of 138 brook trout from Benewah Creek, and 126 brook trout from Alder Creek were dissected in 2005 to analyze reproductive life history traits. Combined data from 2004 and 2005 reveals a significant difference in reproductive life history traits exists between female brook trout in Alder Creek and Benewah Creek. Although the relationship between number of eggs and total length does not differ between Alder Creek and Benewah Creek females (*Figure 15A*), the relationship between egg skein weight and total length is significantly different (*Figure 15C*). Female brook trout from Alder Creek produced significantly larger eggs compared to females of similar length in Benewah Creek (*Figure 15B*).

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

[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	41,293	32.9

[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 2005combined data(#of eggs= 2.95*Total Length-265.48, n=64) multiplied by the number of mature females in each 5 mm length interval.*

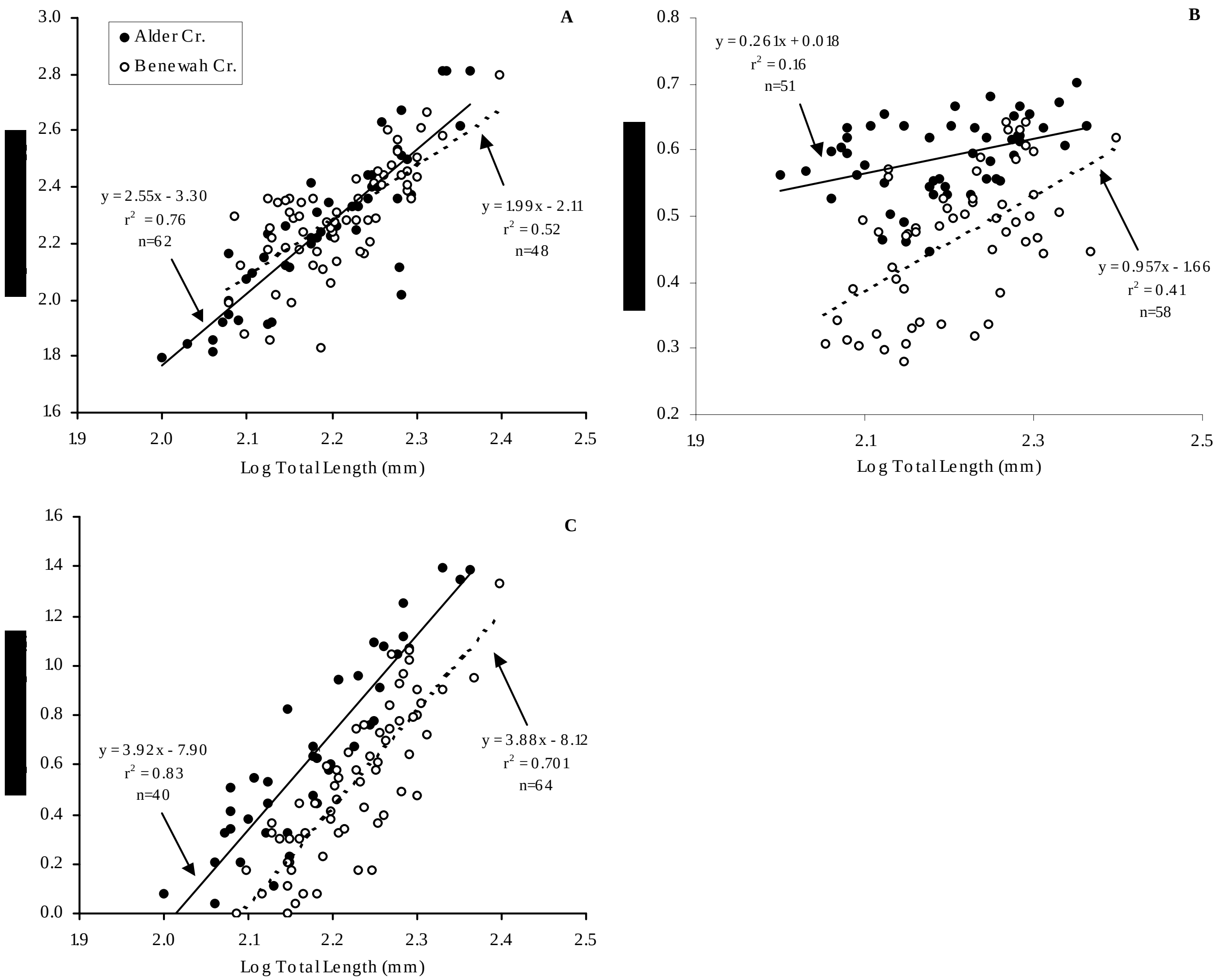

Figure 15. A) Comparison of log number of eggs and log total length relationship between Alder Creek(solid circles, solid line) and Benewah Creek(open circles, dashed line) from 2004 and 2005 combined. B) Comparison of log egg diameter and log total length relationship between Alder Creek and Benewah Creek from 2004 and 2005 combined. Elevations and slopes were significantly different (P<0.001) and (P<0.001) respectively. C) Comparison of log egg skein weight and log total length relationship between Alder Creek and Benewah Creek from 2004 and 2005 combined. Elevations and slopes were significantly different (0.01<P<0.02) and (0.005<P<0.01) respectively.

Physical Habitat Monitoring

Eleven habitat sites were surveyed and sampled in 2005 from June through August. Surveying included six sites in the Benewah Creek watershed and the only site in the Alder Creek watershed. Four sites in Evans Creek were measured in 2005. Surveying at Site #2 in Evans Creek was dropped due to lack of landowner cooperation. In this results section we are reporting values from 2005 only and do not compare specific control sites versus treatment sites. Repeat measures of habitat variables at these sites in the future will support a statistical comparison of control/treatment.

Longitudinal Thalweg Profiles & Residual Pools

The average channel slope for Evans Creek mainstem sites 3, 4 and 5 was 1.41%, with site 5 having the highest slope at 1.85% (Table 11). Evans Creek site 1 is affected by inundation from Medicine Lake and has a slope of 0.03%. The average channel slope for Benewah Creek mainstem sites 12, 14L, 14U, 16 and 17 was 0.58%, with site 17 having the highest slope at 0.86% (Table 12). Windfall Creek at site 1 is a 3rd order tributary of Benewah Creek and had a slope of 0.30%.

The mainstem Evans Creek sites had little variation in pool frequency between sites with sites 3, 4 and 5 all having 3.9 pools/100m (Table 11). In the Benewah Creek watershed, pool frequency was greatest in Windfall Creek, a 3rd order tributary of Benewah Creek with 9.2 pools/100m (*Table 12*). In the mainstem Benewah Creek, site 12 had the lowest pool frequency at 2.2 pools/100m (*Table 12*). The maximum and mean residual pool depths were greater in Benewah Creek mainstem sites compared to Evans Creek mainstem sites (*Tables 11 and 12*). In Evans Creek, mean residual pool depth was greatest (0.32 meters) at site 1 and lowest at site 4 (0.15 meters). In the Benewah Creek watershed, mean residual pool depth was greatest (0.78 meters) at mainstem sites 12 and 16, and lowest at site 14L (0.32 meters), (*Table 12*). The maximum residual pool depth for Benewah Creek was 1.33 meters at site 12.

Cross Section Profiles

Six cross sections were surveyed at each of the monitoring sites. The area of the monitored cross sections was calculated based on the surveyed profile of bed and banks and the estimated bankfull elevation. Mean bankfull widths for all cross sections ranged from 4.4 m to 14.2 m in mainstem Benewah Creek and from 6.4 m to 13.8 m for mainstem Evans Creek sites (*Tables 11 and 12*). The range of cross sectional area for mainstem Evans Creek sites was 1.63 to 6.13 m^2 (*Table 11*). The range of cross sectional area for mainstem Benewah Creek sites was higher compared to Evans Creek at 2.45 to 7.66 m^2 (*Table 12*).

Stream Substrate

Evans Creek sites 3, 4 and 5 passed the Tribal fisheries performance standards of less than 15% fines (<2mm) in riffle habitat (*Table 11*). Evans Creek site 1 had 15.8% fines, the highest of the Evans Creek sites. The highest riffle d50 (substrate size where 50% of the particles are smaller) in Evans Creek was 53.3mm at site 5. Only two mainstem sites in Benewah Creek (sites 12 and 16) passed the Tribal fisheries performance standards of less than 15% fines (<2mm) in riffle habitat (*Table 12*). Of the sites measured in the Benewah Creek watershed, Windfall Creek had the highest percent fines at 89.4%. The highest riffle d50 in Benewah Creek was 46.5mm at site 12 (*Table 12*).

Canopy Cover

Canopy density at Evans Creek mainstem sites ranged from 25.2-58.7%, with site 5 having the highest canopy density (*Table 11*). Alder Creek site 12 had a canopy density of 58.7%. Windfall Creek Site 1 had the highest canopy density (70.8%) of all sites measured in the Benewah Creek watershed in 2005 (*Table 12*).

Large Wood

Large wood debris (LWD) frequency (#/100m) in all Evans Creek mainstem sites was similar (*Table 11*). However, LWD volume differed among sites with Site 3 having the highest volume of all sites (*Table 11*). In Benewah Creek mainstem, Site16 had the highest LWD frequency (30.4 pieces/100m) and volume (30.7m^3) of all sites, followed by Site 17 (*Table 12*). Windfall Creek Site 1 (3rd order tributary) had the lowest LWD frequency (3.2 pieces/100m) and volume (0.09 m^3) of all sites (*Table 12*).

Table 11. Habitat indicator variables measured at one site in Alder Creek and sites in Evans Creek watershed, 2005. Shaded columns are untreated, control sites.

Habitat Component	Habitat Indicator	Alder Creek	Evans Creek			
		Site 12	Site 1	Site 3	Site 4	Site 5
Morphology	Bankfull width (m)[1]	7.81	6.42	13.80	6.15	7.10
	Bankfull wetted perimeter (m)[1]	8.19	7.44	14.59	6.47	7.44
	Bankfull mean depth (m)[1]	0.37	0.79	0.37	0.36	0.23
	Cross sectional area (m^2)[1]	2.82	6.13	5.20	2.48	1.63
	Length of reach measured (m)	152.4	152.4	152.4	152.4	152.4
	Riffle w/d ratio[1]	21.7	18.6	35.7	20.51	34.98
	Sinuosity	1.2	1.42	1.1	1.04	1.06
	Slope of reach (%)	1.33	0.03	1.02	1.37	1.85
	Channel type (Rosgen)	C3	C4	C4	C4	C4
Substrate	Riffle substrate d50 (mm)	14.5	13.1	32.5	35.8	53.3
	% fines <2mm in riffles	30.4	15.8	1.4	10.5	0.0
Cover	Canopy density (%)[1]	58.7	46.1	25.2	51.5	58.7
Large Woody Debris	LWD frequency (# pieces/100 m)	5.3	5.9	6.6	5.9	5.9
	LWD Volume (m^3)	0.79	0.93	6.26	3.44	2.37
	LWD loading (m^3/100 m)	0.52	0.18	1.25	0.68	0.47
Residual Pools	Pool frequency (#/100 m)	5.2	4.6	3.9	3.9	3.9
	Mean depth (m)	0.18	0.32	0.23	0.15	0.28
	Minimum depth (m)	0.11	0.16	0.10	0.10	0.21
	Maximum depth (m)	0.32	0.70	0.41	0.24	0.40

[1] Values are means from at least six measures.

Stream Temperatures

Twenty-eight stream and four air temperature data loggers were deployed in Lake, Benewah and Evans Creek in mid July of 2005. Temperature results from data loggers will be reported for the period of July 27 through August 31, the time period of maximum summer temperatures. Also, July 27th was the earliest date when temperature could be compared within, and among Benewah, Lake and Evans creeks. 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).

Of all mainstem sites measured in the Benewah Creek watershed, the site above the highest instantaneous stream temperature recorded in Benewah watershed was 25.2 °C at 3 Mile Bridge (*Table 13*). The mean daily maximum temperature at 3 Mile Bridge was (21.1°C) and the maximum daily temperature at the site exceeded the 17.0°C upper limit for optimal growth (Bear 2005), 88.9% of the time from July 27 through August 31 (*Table 13*). Of all mainstem sites measured in the Benewah Creek watershed, the site above the confluence of Windfall Creek had the lowest instantaneous temperature (17.7°C), the lowest mean daily maximum temperature (15.2°C), and exceeded the 17.0°C upper limit for optimal growth (Bear 2005), 19.4% of the time (*Table 13*). However, the temperature at the mainstem 9 Mile Bridge site was influenced by the first phase of B8.9 restoration project (described in Section 2 of this report).

Table 12. Habitat indicator variables measured at sites in Benewah Creek watershed, 2005. Shaded columns are untreated, control sites.

Habitat Component	Habitat Indicator	Windfall Creek	Benewah Creek				
		Site 1	Site 12	Site 14L	Site 14U	Site 16	Site17
Morphology	Bankfull width (m)[1]	5.01	14.18	4.40	9.95	10.80	7.35
	Bankfull wetted perimeter (m)[1]	5.47	14.70	5.15	10.86	11.67	8.37
	Bankfull mean depth (m)[1]	0.41	0.56	0.49	0.71	0.52	0.58
	Cross sectional area (m^2)[1]	2.17	7.66	2.45	6.65	6.06	4.30
	Length of reach measured (m)	152.4	903.5	152.4	152.4	167.3	152.4
	Riffle w/d ratio[1]	12.64	50.82	15.48	27.50	21.06	11.54
	Sinuosity	-	1.4	1.7	1.1	-	-
	Slope of reach (%)	0.30	0.36	0.42	0.53	0.74	0.86
	Channel type (Rosgen)	C5	C4	C4	C4	C4	C4
Substrate	Riffle substrate d50 (mm)	0.1	46.5	18.1	10.1	17.0	4.8
	% fines <2mm in riffles	89.4	0.0	28.3	23.7	14.7	43.6
Cover	Canopy density (%)[1]	70.8	0.50	33.9	39.7	15.0	51.3
Large Woody Debris	LWD frequency (# pieces/100 m)	3.2	5.8	1.3	3.3	30.4	21.0
	LWD Volume (m^3)	0.09	18.33	0.31	0.54	30.71	4.39
	LWD loading (m^3/100 m)	0.02	2.03	0.06	0.11	5.59	0.88
Residual Pools	Pool frequency (#/100 m)	9.2	2.2	5.9	3.9	3.6	3.9
	Mean depth (m)	0.41	0.78	0.32	0.47	0.78	0.61
	Minimum depth (m)	0.17	0.30	0.16	0.16	0.51	0.27
	Maximum depth (m)	0.79	1.33	0.48	0.96	1.17	1.06

[1] Values are means from at least six measures.

The highest instantaneous stream temperature recorded in Lake Creek watershed was 22.0°C at the mainstem Site 6 near Highway 95 Bridge (*Table 14, Figure 17*). The mean daily maximum temperature at mainstem site 6 was (19.0°C) and the maximum daily temperature at the site exceeded the 17.0°C upper limit for optimal growth (Bear 2005), 77.8% of the time from July 27 through August 31 (*Table 14*). Mainstem Site 10 located 6.3 km upstream and influenced by the West Fork was cooler with an instantaneous maximum stream temperature of 18.3 °C. Maximum daily temperature at Site 10 exceeded the 17.0°C upper limit for optimal growth (Bear 2005), 41.7% of the time. Both the upper mainstem at Site 11 and lower Bozard at Site 1 were warmer than the mainstem Site 10 even though the 4th order mainstem Site 10 is downstream of both 3rd order sites (*Table 14, Figure 17*). The upper Bozard Creek sites above and below the confluence of East Fork Bozard Creek at Site 1 had daily maximum temperatures below 17.0°C (*Table 14*, *Figure 17*).

Evans Creek is cooler in summer compared to Benewah and Lake creeks (*Figure 18*). The highest instantaneous stream temperature recorded in Evans Creek watershed was 16.9°C at the mainstem Site 3 (*Table 15, Figure 18*). All sites measured, including the lower mainstem at Site 3 had maximum daily temperatures below 17.0 °C (*Table 15*).

The preliminary examination of thermal heterogeneity in 2.4 km of incised channel in Benewah Creek associated with restoration project B8.9, revealed that relatively little cold, thermal refuge was present in this segment during the warmest part of the year. Only 13.1% of 84 pools surveyed showed a cooler temperature differential of 1°C or greater when compared to the temperature of associated riffles. Of these pools, 76% had temperature differentials that placed pool temperatures within the (10.3-17.0°C) range for optimal growth of cutthroat trout as reported by Bear (2005). During the thermal heterogeneity sampling, we discovered four springbrooks that were located within the bankfull channel but disconnected from the active channel during base flow conditions due to the highly entrenched channel. These springbrooks were 10-11°C when mainstem temperatures approached 18-20°C (Figure 16). During the summer, the disconnected springbrooks were inaccessible to rearing salmonids and intensive sampling using the rapid-response thermistor revealed little evidence of any cooling effect of the springbrooks on the main channel.

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 Benewah Creek for the period of July 27-Aug 31, 2005. Refer to Figure 4 for site locations.

Site	Stream order	Instantaneous maximum temperature (°C)	Mean & (CV%) of daily maximum temperature (°C)	Mean & (CV%) of daily minimum temperature (°C)	Days & (%) of days exceeding 17.0 (°C)[1]
Mainstem at 3 Mile Bridge	4	25.2	21.1 (13.6%)	12.1 (16.0%)	32 (88.9%)
Mainstem at 9 Mile Bridge	4	19.1	16.6 (10.8%)	13.9 (10.7%)	16 (44.4%)
Mainstem below Whitetail Creek	4	20.8	17.8 (11.8%)	13.3 (12.3%)	21 (58.3%)
Mainstem below Windfall Creek	4	18.4	16.1 (9.9%)	13.2 (11.7%)	14 (38.9%)
Mainstem above Windfall Creek	4	17.7	15.2 (11.2%)	12.4 (12.3%)	7 (19.4%)
Mainstem above Site 17	4	19.0	16.5 (10.7%)	11.0 (14.9%)	17 (47.2 %)
Mainstem Above Schoolhouse Creek	4	19.1	16.6 (10.4%)	11.0 (15.0%)	17 (47.2 %)
Windfall Creek Site 1	3	15.2	12.6 (12.1%)	11.1 (11.2%)	0 (0.0%)
School House Creek Site 1	3	14.9	12.9 (12.0%)	9.7 (15.0%)	0 (0.0%)

[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 Lake Creek for the period of July 27-Aug 31, 2005. Refer to Figure 6 for site locations.

Site	Stream order	Instantaneous maximum temperature (°C)	Mean & (CV%) of daily maximum temperature (°C)	Mean & (CV%) of daily minimum temperature (°C)	Days & (%) of days exceeding 17.0 (°C)[1]
Mainstem Site 6	4	22.0	19.0 (11.1%)	13.5 (12.5%)	28 (77.8%)
Mainstem Site 10	4	18.3	16.4 (9.0%)	13.9 (9.9%)	15 (41.7%)
Mainstem Site 11	3	20.7	18.2 (11.0%)	11.8 (12.1%)	26 (72.2%)
West Fork Site 1	3	17.8	15.3 (11.7%)	11.5 (16.4%)	6 (16.7%)
Bozard Creek Site 1	3	19.3	17.1 (9.8%)	14.0 (10.1%)	19 (52.8%)
Bozard Creek (Below East Fork Bozard)	3	16.4	14.7 (8.5%)	11.1 (10.8%)	0 (0.0%)
Bozard Creek Site 3 (Above East Fork Bozard)	2	16.8	15.1 (8.7%)	11.2 (9.7%)	0 (0.0%)
East Fork Bozard Creek Site	2	16.1	14.4 (8.4%)	11.2 (11.0%)	0 (0.0%)

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

Table 15. 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 5 for site locations.

Site	Stream order	Instantaneous maximum temperature (°C)	Mean & (CV%) of daily maximum temperature (°C)	Mean & (CV%) of daily minimum temperature (°C)	Days & (%) of days exceeding 17.0 (°C)[1]
Mainstem Site 3	3	16.9	15.3 (8.5%)	12.1 (7.8%)	0 (0.0%)
Mainstem Site 9 below three forks	3	14.0	12.6 (7.6%)	11.2 (8.4%)	0 (0.0%)
Mainstem Site 10 above East Fork	2	13.9	12.4 (7.8%)	11.1 (8.3%)	0 (0.0%)
East Fork Site 1	2	15.2	13.7 (7.7%)	11.7 (8.4%)	0 (0.0%)

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

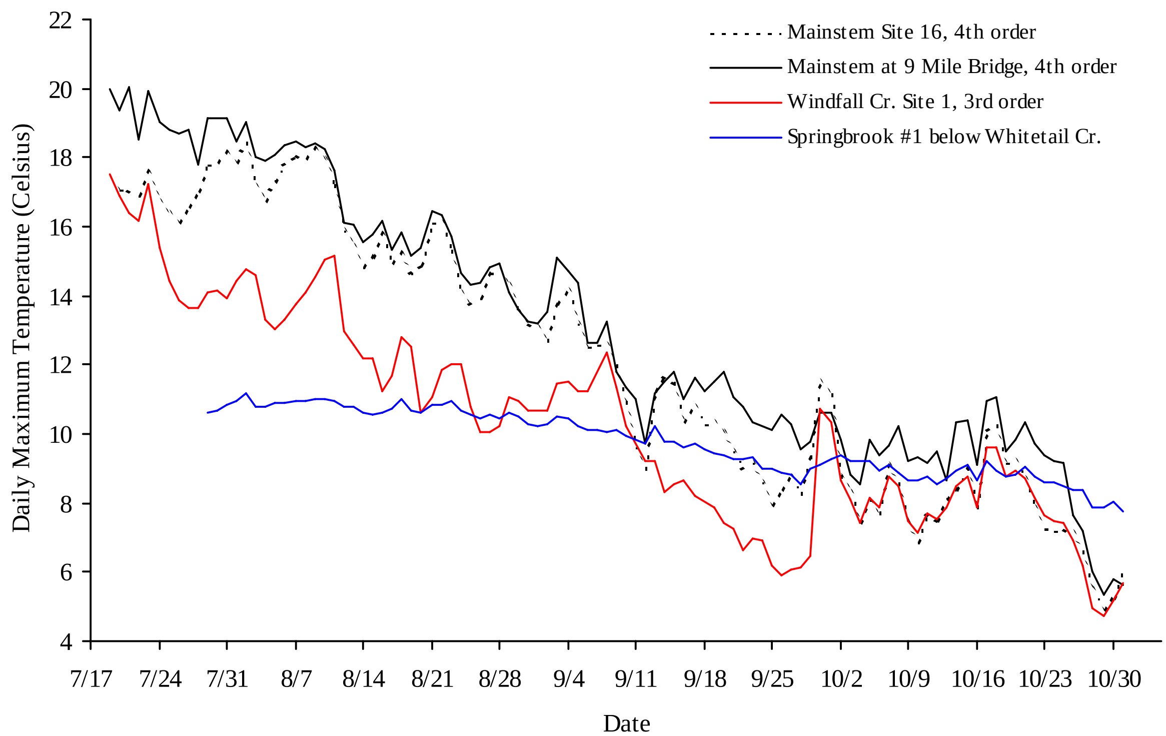

Figure 16. Daily maximum water temperature from mainstem, tributary and springbrook habitats in Benewah Creek in stream segments with, or near active restoration in 2005.

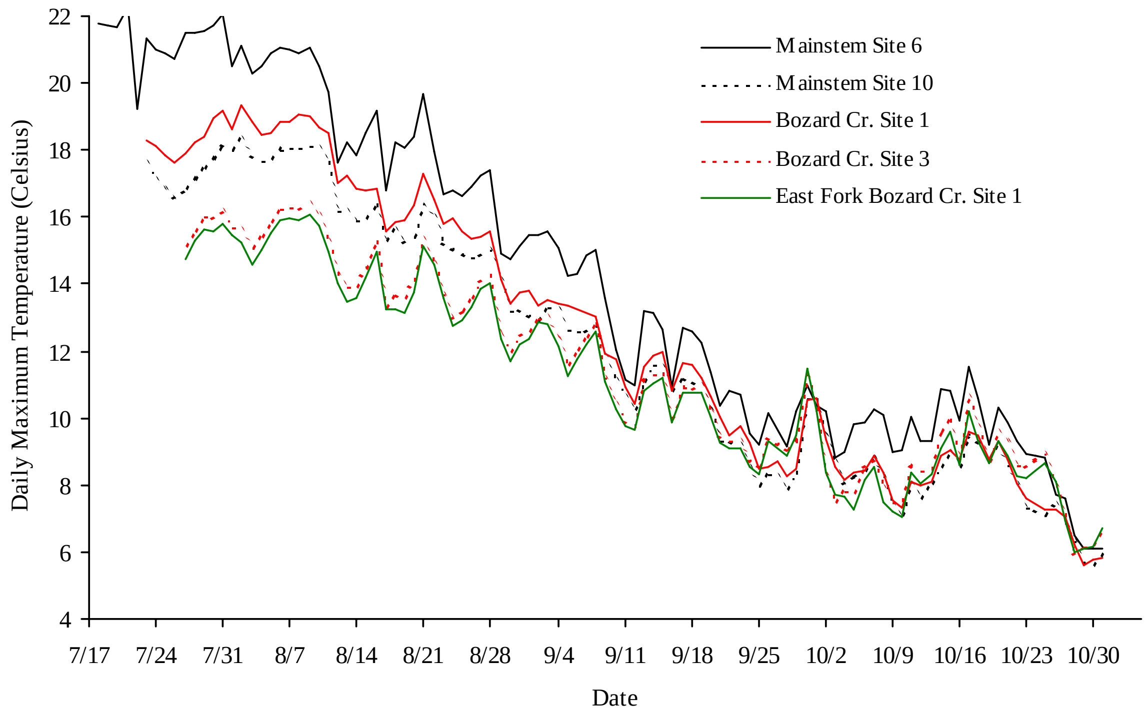

Figure 17. Daily maximum water temperature from mainstem and tributary habitats in Lake Creek 2005.

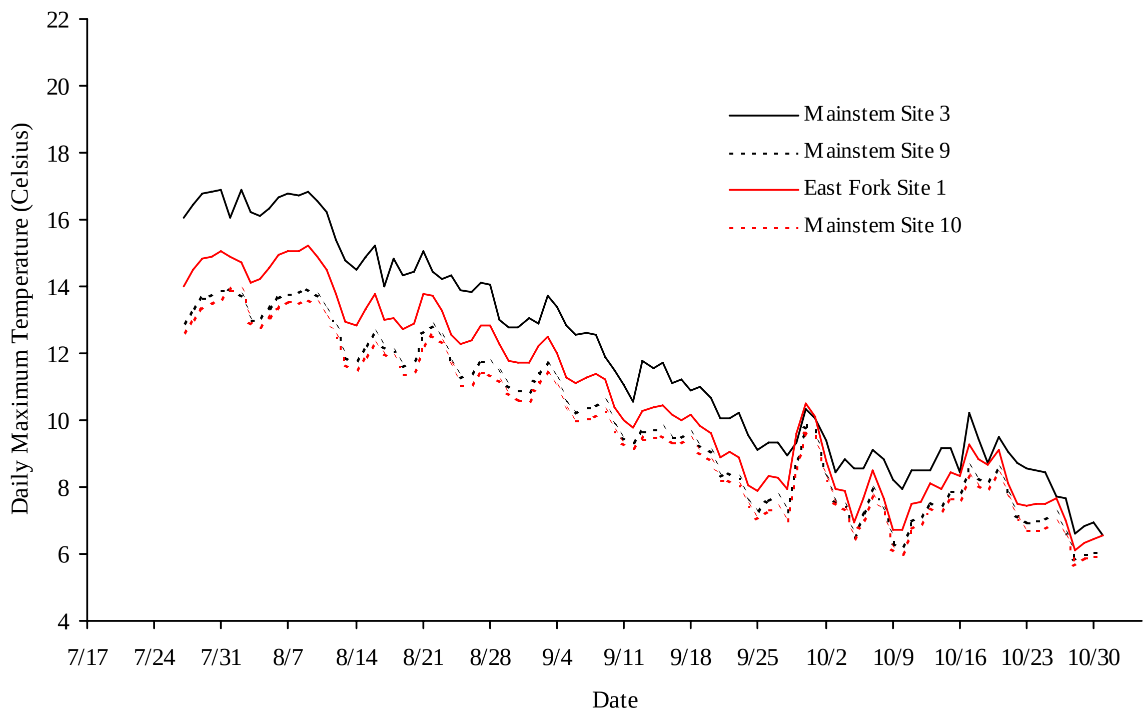

Figure 18. Daily maximum water temperature from mainstem and tributary habitats in Evans Creek 2005.

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 historical population levels in the Coeur d'Alene Lake Basin, allowing for tribal members to harvest westslope cutthroat trout as they have in the past. The lacustrine-adfluvial life history creates 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 zone; 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 techniques, or with monitoring and evaluation techniques that will provide data to refine future management decisions.

Population and Production of Westslope Cutthroat Trout

The ten-year population data set for westslope cutthroat trout indicates a statistically significant increasing trend at the watershed scale in Lake Creek and nearly significant increasing trend in Benewah Creek. The westslope cutthroat trout population in Evans Creek reveals no trend and a decreasing trend (but not statistically significant) 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 in Alder and Benewah creeks 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). Griffith (1974) found high diet overlap between juvenile brook trout and cutthroat trout and thus potential for interspecific competition during juvenile life stages. In 2005, Age 1 westslope cutthroat trout in Benewah Creek were significantly smaller (length and weight) than in Lake and Evans Creeks, suggesting that competition with brook trout is affecting the growth of juvenile westslope cutthroat trout in Benewah Creek.

Given the large amount of evidence that nonnative brook trout compete and displace cutthroat trout, the Fisheries Program began considering removing brook trout in the Benewah Creek watershed. However, the situation of brook trout removal as a component of cutthroat trout restoration in Benewah Creek is different than many brook trout removal projects currently underway in the western United States. Most brook trout removal projects throughout the west have focused on complete removal of non-native brook trout and the use of a natural or artificial passage barrier to prohibit reinvasion of the treated stream segment (Shepard et al. 2003). Along with brook trout removal, the goal of many projects is to also remove the cutthroat trout population that maintains introgressed rainbow trout genes. Following complete removal of non-native populations, genetically desirable cutthroat are then translocated from other nearby watersheds (Shepard et al 2003). This type of westslope cutthroat trout conservation is well suited to resident life history forms because a passage barrier only allows for downstream dispersal. Upstream spawning migrations to tributaries are eliminated, which theoretically prevents reinvasion of treated reaches, but also eliminates the expression of lacustrine-adfluvial or fluvial life history types. The strategy described above is appropriate to conserve the genetic integrity of headwater populations. However, at this time is not applicable to the Benewah Creek westslope cutthroat trout population because the migratory, lacustrine-adfluvial life history is a significant component of the population. In addition, the westslope cutthroat trout population in Benewah Creek shows very little hybridization with rainbow trout and no hybridization with other cutthroat subspecies (Knudsen and Spruell 1999).

Brook trout appear to be in early invasion/expansion in the Benewah Creek watershed. Complete removal of relatively low numbers of brook trout from the Benewah Creek watershed would be extremely difficult, expensive and would require trapping and hauling cutthroat spawners above a large, artificial barrier. Multiple, large scale antimycin treatments would be required and would be controversial with the private landowners in the watershed. In addition, antimycin treatment would require the additional effort of capturing, and holding westslope cutthroat trout safely until the antimycin was neutralized and fish were relocated throughout the 152 km^2 watershed. All of this could be done but at a very high cost, and a total eradication of brook trout in this size watershed would likely require multiple antimycin treatments. With regard to addressing non-native brook trout in the Benewah Creek watershed, the Fisheries Program had three options. The first option was to do nothing and measure the invasion of brook trout and their displacement of cutthroat trout in Benewah Creek. The second option was to do multiple, costly antimycin treatments, negotiate a very controversial public opinion process, install artificial barriers and artificially distribute adfluvial spawners. A third option was to use annual physical removal methods over the entire upper watershed (mainstem and tributaries) to control brook trout production at low levels, do not install barriers and allow adfluvial spawners natural access to spawning tributaries. Option number three was chosen as the best alternative, and in 2004 a brook trout control program was initiated.

In 2005 all stream habitat sampled in 2004 was re-sampled and brook trout removal was expanded 1.6 km downstream to include additional upper mainstem habitat. The upper mainstem and entire segments of West Fork, Southeast Fork and lower School House Creek were electroshocked and all brook trout captured were removed. Consistent with 2004, we verified that no fish captured during the 2005 removal period had yet spawned. Thus, in relation to spawn timing, sampling was removing adult brook trout prior to spawning. Only one year of post-removal density data exists making an evaluation of removal effectiveness impossible at this time. However, the results from the second year of removal (2005) reveal that the density of brook trout in the upper mainstem was higher than anticipated based on annual population estimates. In 2005, three times more adults were removed compared to 2004, and most of the adults removed came from the mainstem habitat. The ratio of adults to juveniles removed was greater than in 2004, which suggests that the mainstem is likely the largest source of adults, which drives the future production potential in the watershed. Thus, in 2006, the amount of mainstem sampled will be expanded to include all of the mainstem above Whitetail Creek and the same tributaries will be sampled as in 2004 and 2005. 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.

Habitat

Human alterations to the landscape in the target watersheds have harmed the aquatic environment through alteration of natural physical and biological processes that maintain habitat complexity and sustain high production of salmonids. Streamside riparian canopy has been reduced in each of the target watersheds and the older riparian stands that have a moderating affect on stream temperature, provide large organic debris, and affect nutrient input and cycling (Beschta et al. 1987; Murphy and Meehan 1991) have been particularly affected. The extent of riparian harvest ranges from less than 13% in Evans Creek, between 13%-33% for Alder and Lake creeks, and greater than 33% in Benewah Creek. Within the four target watersheds the lack of large woody debris, both within the stream channel and the adjacent floodplain, is a contributor to poor habitat quantity and quality in 3rd and 4th order segments. Wood volume and frequency influences and maintains natural processes that create habitat complexity. Many studies indicate that most pools in moderate-gradient, cobble- and gravel-bed forest streams are either formed by or strongly influenced by wood (Andrus et al. 1988; Robison and Beschta 1990; Abbe and Montgomery 1996). Buffington (1998) theorized that wood roughness can lead to the deposition of spawning gravels in steep drainages that otherwise would be inhospitable to salmonids because of high sheer stresses. In the four target watersheds large woody debris (LWD) frequency and volume varied considerably among sites, and results of our habitat surveys were consistently indicative of stream reaches with altered or modified riparian plant communities and an obvious lack of LWD. The restoration sites where wood had been placed in the channel and floodplain had more wood than sites where wood was not artificially added. This was especially apparent for Site 16 in Benewah Creek. Clearly the lack of large woody debris is apparent in the sites surveyed in Benewah and Lake Creeks. Large wood additions will continue to be a priority restoration technique used especially in Lake and Benewah creeks. In addition to LWD, the habitat created by beaver dams is important for rearing (Pollock et al. 2004) and overwinter habitat (Lindstrom and Hubert 2004). Beaver activity maintains habitat complexity by producing pools, and modifying stream hydrology and temperature through aquifer recharge (review by Pollock et al. 2003). Beaver activity is greatest in Lake and Benewah Creeks, but beaver density is likely not near historical levels. In the future repeat measures of the reaches with beaver activity will provide estimates of the effects of beavers on the stream morphology.

In addition to riparian canopy cover and low volume of LWD, channel incision affects approximately 2.4 km and 8 km of mainstem habitats in Lake and Benewah creeks, respectively. Channel incision can effectively reduce the potential for hyporheic groundwater connectivity and exchange with the stream channel (Brunke and Gonser 1997). Increased hyporheic groundwater connectivity can produce thermal heterogeneity and cold-water refugia. Researchers have identified cold-water patch frequency and area as explanatory variables associated with increased salmonid densities (Torgersen et al. 1999; Ebersole et al. 2001 and 2003) and reductions in total energy expenditures (Berman and Quinn 1991). Elevated stream temperatures are an important physical effect resulting from land-use practices, with consequences for aquatic ecosystems. The dendritic drainage patterns of Benewah, Alder and upper Lake creeks suggest that several mainstem reaches are particularly conducive to creating a spatial pattern of thermal patchiness associated with cooler tributary inputs and groundwater inputs from broad alluvial valleys. Our preliminary examination of thermal heterogeneity in 2.4 km of incised channel in Benewah Creek, however, revealed relatively little cold, thermal refuge was present in the upper mainstem during the warmest part of the year. Only 13.1% of 84 pools surveyed showed a cooler temperature differential of 1°C or greater when compared to the ambient temperature of associated riffles. Of these pools, 76% had temperatures that placed pool temperatures within the range of optimal growth (10-17°C, Bear 2005) for cutthroat trout. We identified and measured temperature in several springbrooks that were located within the bankfull channel but disconnected from the active channel during base flow conditions, and therefore inaccessible to summer rearing fishes. These springbrooks were approximately 10°C when mainstem maximum temperatures were 18-20°C. Reconnecting incised reaches of the 3rd and 4th order mainstem habitat with the floodplain will increase hyporheic dynamics, reduce summer water temperature, and increase thermal heterogeneity in both summer and winter seasons. Restoring these conditions at multiple reaches within a valley segment will increase westslope cutthroat trout production through use of mainstem habitats for rearing. The current restoration projects (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.

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 should 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. In addition to the new juvenile fish trap design, starting in 2006 trap efficiency will be estimated using release groups of PIT tagged fish (see below). The trap efficiency will be used to estimate the total number of outmigrant juveniles with confidence intervals using methods described by (Carlson et al. 1998).

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.

SECTION 2: RESTORATION AND ENHANCEMENT ACTIVITIES

OVERVIEW

The focal point of restoration/enhancement activities during this contract period, June 2005-May 2006, was the property in the Benewah Creek watershed that was secured through the Albeni Falls Wildlife Mitigation Project (BPA project #9206100) in 2001. This purchase represented a significant development in the evolution of this project in several regards. First, the property is both large, encompassing 420 acres of critical habitat with nearly 3 miles of perennial streams, and strategically located with regard to the production and enhancement opportunities for westslope cutthroat trout in the watershed. Two of the principle spawning tributaries, Windfall and Whitetail creeks, flow directly onto the property and its location effectively links several established enhancement sites with the most productive tributary reaches. Secondly, this property was identified as the highest priority for enhancement based on the limiting factor analysis presented in the Habitat Protection Plan, which was developed as a guidance document for this project (Vitale et al. 2002B).

An initial assessment of geomorphic and hydraulic processes on this property was conducted in 2002 and led to the development of several long-term restoration prescriptions for the property (Inter-Fluve, Inc. 2002). Subsequently, a 30% design appropriate for fit in the field reconstruction of the lower 8600 feet of stream channel was completed in early 2005. The goal of implementing these prescriptions is to restore connectedness of stream habitats, improve stream channel stability, habitat complexity and stream/groundwater interaction through habitat restoration and enhancement. The strategies focus on addressing the factors limiting fish production, including: riparian function, stream channel stability, instream habitat complexity, and summer water temperature. We hypothesize that improving trends for key habitat indicators will increase production potential for early and juvenile rearing life stages of westslope cutthroat trout.

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 follows. In several locations, multiple treatments have been implemented to meet the objectives for larger sites. These treatments are described together 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 lower 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 2005 for BPA Project #199004400.

Project Description			**Project Chronology**				
Project ID	**Activity**	**Treatments (Metrics)**	**2001**	**2002**	**2003**	**2004**	**2005**
B_8.9	Plant Vegetation	Riparian enhancement (48.1 ha; 3,689 m of streambank)	Property purchased; cultural resources inventory completed; boundary surveyed	Panted 8,957 trees (12 ha)	Planted 13,611 conifers and 2,013 deciduous trees (23 ha)	Planted 8,500 conifers, 3,650 deciduous trees, and 4,800 herbaceous plugs (11.3 ha)	Planted 8,000 conifers, 15,850 herbaceous plugs, 4,100 deciduous trees (1.8 ha of floodplain, 3,271 meters of stream bank)
B_8.9	Stream Channel Construction	Constructed 518 m of channel (Increased channel length by 168 m)	Property purchased; cultural resources inventory completed; boundary surveyed	Completed baseline HEP; channel assessment and development of restoration prescriptions			Channel design finalized; NEPA completed; Constructed lower 518 m of channel on the property
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

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	

Site Characteristics:

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

Other: Project restores the stream channel to its historic location in the valley and restores a stable channel configuration to 518 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. 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. Lowering of the water table has resulted in a 40% or greater reduction in wetlands compared with historic conditions. The incised channel is further characterized by unstable streambanks with high erosion potential. Active streambank erosion was measured in 26% of the surveyed area and erosion rates were estimated at 0.02-0.06 tons/yr/ft with an estimated sediment yield of between 81.7-245.1 tons/yr for the reach located between river miles 8.9 and 11.9.

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.

The lower 518 m of channel construction was completed in 2005. At the lower end of the project site, a grade control structure was constructed where the valley narrows at what used to be the embankment for the original county road, constructed circa the 1940's. The grade control has the appearance of a cascade and lifts the design channel to the elevation of the historic channel over a distance of 46 m, and provides the grade control to prevent channel incision in the future (*Figure 1)*. Upstream of the grade control eight riffles were constructed using a total of approximately 1530 cubic meters of imported gravel (*Figure 2*). In addition, several sections of the existing incised channel were filled to create new floodplain habitat using approximately 3823 cubic meters of imported fill. Approximately 55 MBF of large wood was placed both in the channel to provide cover and increase habitat complexity and on floodplain surfaces to increase roughness and stability (*Figure 3*).

Figure 1. Completed grade control structure on Benewah Creek following construction in October 2005.

Figure 2. Completed riffle at station 15+00 following construction in October 2005.

Figure 3. In channel and floodplain large wood placements as part of stream restoration in Benewah Creek.

The project added 168 m of new stream channel, increased sinuosity by 50%, and increased belt width and floodprone width by 214% within the treatment area.

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. Permit authorization were received by July and construction of the lower 518 m of the project was completed between July and October. Construction of the remaining 2,103 m of channel in the completed design will occur over the next three to four field seasons, depending on funding, staffing and other logistical considerations.

Project Goals & Objectives: Implement 2621 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.

Relationship to Scope of Work: This project fulfills the Program commitments for WE 7 in the 2006 Scope of Work and Budget Request (Inter-Governmental Contract #10885) for the contract period June 2005 - May 2006.

Project E_1.3: Instream/Floodplain Wood Additions

Project Location:

Watershed: Evans Creek | Legal: 47 N, R2W, S3, SE 1/4

Sub Basin (River Mile): RM 1.3

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 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 to create pools during summer low flows. These dams are washed out each 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: This project involved placing 4 MBF of natural wood and 16 ELWD™ (Type 20 N) structures along 152 ft of Evans Creek. The natural wood 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. Rock was added to the center of the structures, which were hollow, to add weight. Hand-crews put together 9 of the ELWD™ structures over three days. Representatives from Forest Concepts provided training on the first day. The other ELWD™ structures and all of the natural wood were placed using the excavator. These remaining ELWD™ structures were left banded together and no rocks were placed in the hollow interior. The natural wood was placed in the floodplain and along a meander bend in conjunction with the ELWD™. Approximately 44 pieces of natural wood were placed on the site. To secure the site, nine of the ELWD™ structures were cabled in place. 25 potted plants along with 50 grass plugs were planted at the Evans Creek site in disturbed areas. The site was surveyed before and after construction using the Total Station. Data collected included longitudinal profiles and the location of the ELWD™ structures. Pictures were also taken of the site.

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.

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 project fulfills the Program commitments for WE 8 in the 2006 Scope of Work and Budget Request (Inter-Governmental Contract #10885) for the contract period June 2005 - May 2006.

Figure 1. Tribal staff putting together an ELWd™ structure on the Evans Creek project site.

Figure 2. ELWd™ structures in Evans Creek following completion of project, October 2005.

Figure 3. Large wood placement at a meander on Evan Creek following completion of the project, October 2005.

Project B_8.9: Riparian/Planting

Project Location:

Watershed: Benewah Sub Basin (River Mile): RM 8.9	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 specifically treats the 1036 meters of streambanks and 1.82 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 will 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.

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 15,8500 herbaceous plugs and 4,100 woody trees and shrubs were planted in fall 2005 on 1,036 m of streambank and 1.6 ha of floodplain that was associated with construction. In addition, all floodplain surfaces and 0.22 acres 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 2006, 900 live willow poles were planted to complete the first full season of revegetation work. Early indications of vegetation response appear very favorable (*Figures 1 and 2*).

Project Timeline: Annual plantings will be completed in the fall and the spring immediately following stream channel construction, beginning in Fall 2006 and continuing until channel construction is completed. 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 10 in the 2006 Scope of Work and Budget Request (Inter-Governmental Contract #10885) for the contract period June 2005 - May 2006.

Figure 1. Planting on new floodplain surfaces immediately following construction, November 2005.

Figure 2. Vegetation response on new floodplain surfaces one year post construction, October 2006.

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 2005.

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 four-year period from 2002-2005 with room for approximately 76 hectares of additional plantings (*Figure 1*). 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 to 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, treating 11.3 ha and 1,879 linear meters of stream channel. Portions of the 2004 plantings were associated with side channel construction and the culvert replacement at Windfall Creek. A total of 8,000 conifers were planted in April 2005 as part of this contract period. This project has treated a total of 3,689 linear meters of stream channel and 46.3 hectares of associated floodplain from 2002 to 2005.

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 19*). 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 11 in the 2006 Scope of Work and Budget Request (Inter-Governmental Contract #10885) for the contract period June 2005 - May 2006.

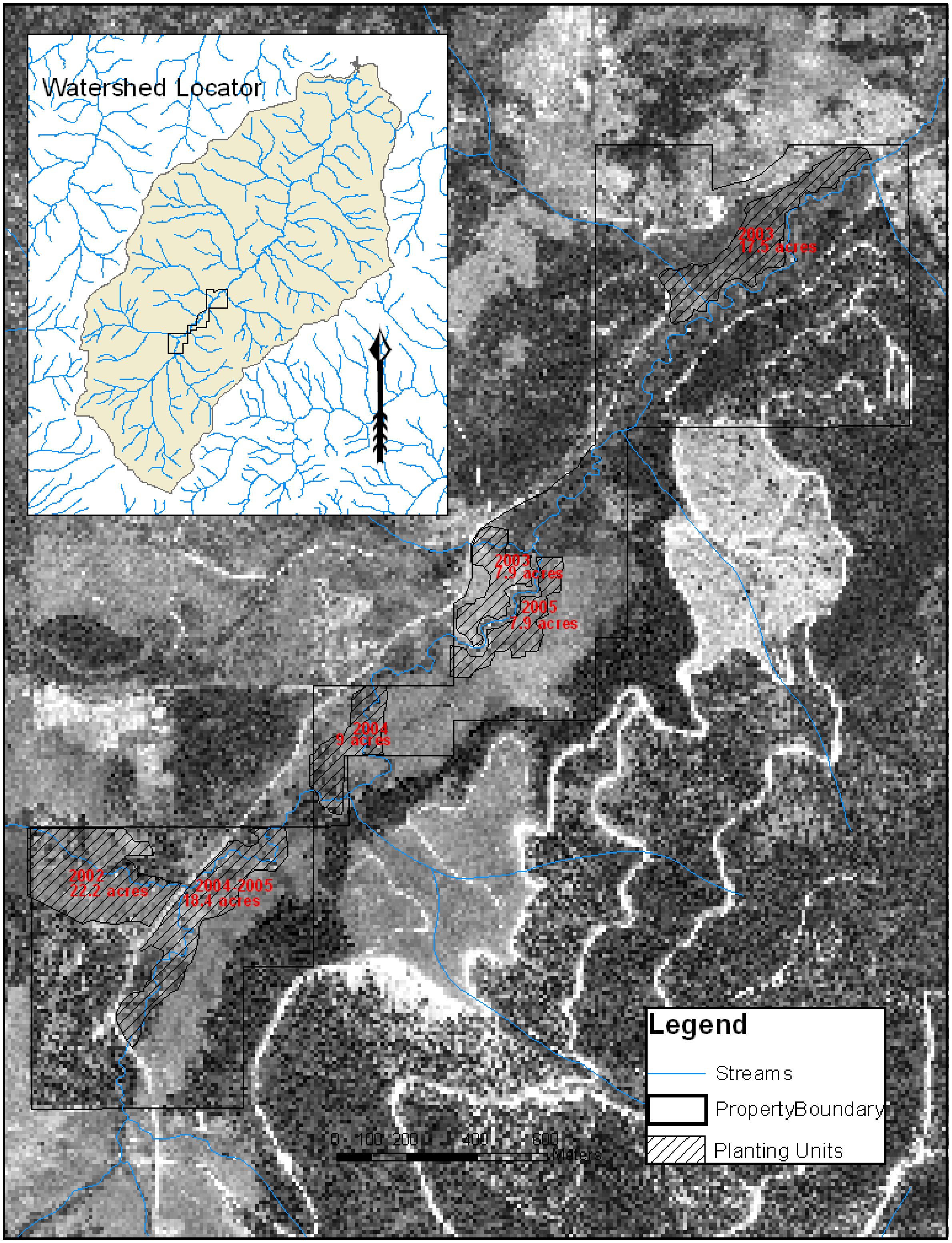

Figure 19. Locations of planting units on the Benewah Creek WMU, 2002-2005

SECTION 3: OUTREACH AND EDUCATION

OVERVIEW

Early in the planning stages of this project, Tribal staff envisioned the use of outreach to the general public and the development of educational opportunities related to the natural resources as a means to facilitate a holistic watershed protection process on the Reservation. The staff holds a common belief that responsible management must address the needs of the larger community that collectively affects the fisheries resource and critical habitats. By adopting Tribal recommendations, the Northwest Power Planning Council (NPPC) concurred with this concept and recognized public education and outreach to be a necessary and integral component of fisheries enhancement efforts on the Coeur d'Alene Reservation (NWPPC 1995).

Several related objectives and tasks were pursued in 2005 to address the general goals for the education and outreach portion 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. This report discusses accomplishments associated with each objective and task, and evaluates the overall effectiveness of education and outreach efforts using various performance criteria.

DESCRIPTION OF RESULTS

The text below presents details of the outreach and education work performed by the Fisheries Program and other cooperators during the period June 2005 – May 2006. The methods and results are presented in a manner that is consistent with the outline found in the *Scope of Work and Budget Request* for this project. *Table 17* present summaries of the outreach efforts and associated completion dates by objective and task.

Objective 1: Coordinate Restoration and Management Activities

Task 1a: Continue meeting with watershed work groups comprised of private landowners, agency representatives and other interested parties to discuss restoration and cooperative opportunities on the Reservation.

The Fisheries Outreach Specialist coordinated three meetings of the Interagency Work Group during this contract period (*Table 17*). The group is primarily focused on coordinating projects at the watershed scale. At each meeting, participants shared information on project accomplishments and on additional resources that might be needed to improve coordination and cooperation. As a result of these meetings, the group continues to refine the understanding of how the Tribe and other resource agencies can better manage the natural resources in the Reservation area and how they can promote education regarding land stewardship. Participation in this planning process is a critical step in applying uniform management standards in watersheds targeted by BPA funded projects and in forming partnerships that improve the cost-effectiveness of implementation efforts. Records were kept and minutes were taken for each meeting along with a list of participants.

Program staff also met multiple times with different watershed working groups during this contract period. The Benewah Creek Watershed Working Group is a highly organized group with very active participants. They have their own regular meetings and the Tribe participated in two meetings during the past year to provide project updates, describe additional planned efforts and introduce new information to the group. The Tribe held one meeting with the Lake Creek Watershed Working Group during 2005 and provided additional information on projects through publication and distribution of the program newsletter. Three 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.

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*. Plans for the upcoming year include direct mailing of questionnaires to inquire how to better serve the needs of all who live in the target watersheds and to help better inform the public about our projects. These efforts are intended, in part, to facilitate new partnerships for restoration efforts on the Reservation.

<u>Task 1b: 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.</u>

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 a series of meetings during this contract period that resulted in publication of the IRMP Draft PEIS and the Notice of Availability in the Federal Register in September 2005. Additional meetings were held following the 75-day public comment period. Program staff helped respond to technical comments and inquiries related to fisheries and water resources and assisted in the overall effort to prepare the errata and finalize the IRMP PEIS for publication.

Objective 2: Provide Cultural and Educational Opportunities

<u>Task 2a: Publish a quarterly newsletter that highlights Program activities, recognizes cooperative efforts, and serves as a forum for discussing land management issues.</u>

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 customer 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 in Reservation waters. 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".

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

Objective/ Task	**Description**	**Completion Dates (2005/2006)**	**Status**	
			Completed	**Not Completed**
Objective 1:	***Coordinate Restoration and Management Activities***			
Task 1a:	Coordinate and facilitate meetings with interested parties	3/15, 10/12 (Benewah Creek); 8/05 (Lake Creek); 8/17, 10/4, 4/11 (IAWG)	X	
Task 1b:	Participate in Tribal IDT processes	8/28, 3/23, 5/20,	X	
Objective 2:	***Provide Cultural and Educational Opportunities***			
Task 2a:	Publish a quarterly newsletter	6/17, 9/18, 12/17, 3/18	X	
Task 2b:	Provide educational programs for the local community	On-going throughout the school year.	X	
Task 2c:	Provide summer internships for high school students Natural Resource Camp co-hosted by Panhandle National Forest and Coeur d’Alene Tribe on the Reservation at Camp Larson on Coeur d’Alene Lake.	3 students sponsored from 6/13 to 9/2 Planning meetings: 11/05, 1/06, 5/06 and 5/06; Camp to beheld 6/26 to 7/1/06	X	
Task 2d:	Work with the University of Idaho Extension Office to develop and implement education programs.	Ongoing - numerous dates between 6/05-5/06	X	

Task 2b: Provide educational programs for the local community to increase the understanding of project related activities and the relationship between cultural practices and tribally significant plants and animals.

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 18*).

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 300 students and teachers during the weeklong workshops, which were held May 9-13. 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 (185 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 two successive days, October 27, 28. 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 (*Table 18*).

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). This park was an area in which Chief Gary taught school to local tribal people. 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 Omak, WA October 16-20. The Outreach Specialist moderated a panel on Northwest Indian Youth at this meeting.

Task 2c: Provide summer internships for interested high school students to assist with implementation of project activities and to expose students to natural resource management issues.

During the summer of 2005 the Fisheries Program employed four summer youth and one college intern. The youth worked with biologists and technician staff from June 13 through September 3. The youth helped with T&E 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 camp was hosted by the US Forest Service and held at Chewelah Pecks Learning Center near Chewelah, WA on the Colville Ranger District, June 13 - 18. 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.

Task 2d: Work with the University of Idaho Extension Agent to develop and implement educational programs focusing on fish, water and wildlife resources and protection of the Reservation environment.

The Outreach Specialist worked closely with the local University of Idaho Extension Offices to present various educational programs at 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 2005 through May 2006.

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."

The Outreach Specialist/Extension Educator team hosted a youth camp at the Benewah County fair grounds on July 12, 2005. 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 2005. They also worked together to recruit students for the Intertribal Natural Resources Camp in early June of 2006.

The Outreach Specialist worked with staff from the Extension Office to develop several grant opportunities. The first of these was developed for the Indian Land Tenure Foundation, an organization whose mission is to restore land within reservation boundaries to tribal management and ownership. The proposal was to adapt and teach the Foundation's curriculum on the Reservation, with lesson plans for K-12, as well as an adult course that may be offered for college credit. 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. The grant application was accepted and funded, beginning in June of 2005. The first adult course was offered in the fall 2005 in St. Maries, targeting a non-tribal audience, and 21 non-tribal participants from the communities of Harrison, St. Maries, Tensed and Tekoa completed the course. A second course was offered in Plummer in January 2006 with 13 adults completing the course. All participants reported a significant knowledge gain. A second grant application was developed in response to an EPA solicitation for Wetlands Education grants. The grant proposed to plan and develop a Wetlands Youth Leadership program. Unfortunately, the proposal was not funded for FY '06 or FY '07. The project has been temporarily tabled in order to seek new sources of funding.

The Outreach Specialist and the Extension program also collaborated with TANF and the Plummer Worley School District to hold a career fair in April 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.

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 perhaps 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 in the Scope of Work and reiterated 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

Task 1a: Continue meeting with watershed work groups comprised of private landowners, agency representatives and other interested parties to discuss restoration and cooperative opportunities on the Reservation.

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. These meetings were effective in increasing awareness of fish habitat improvement projects and future needs to watershed landowners. The future effectiveness of these meetings will be measured through the use of questionnaires or survey forms that will be developed and made available at the Watershed Working Group meetings for participants to provide comments, suggestions, or questions regarding the activities of the program.

Table 18. Summary of education and outreach activities (Objective 2), June 2005- May 2006.

Category	Activity/Description	Location(s)	Attendance	Dates
Field Camps	Water Awareness Week	Lake Creek watershed	>300 students/teachers	5/9-13/06
	Native Plant ID/Collection	Turnbull Wildlife Refuge, Cheney, WA	18 students/ teachers, parents	6/6/05; 5/4/06
	Arbor Day/Mother Earth Day Celebrations	Kootenai High (Harrison, ID); Worley Elementary, Worley, ID; Q'emiln Riverside Park, Post Falls, ID	455 students/ 15 teacher, parents	4/20,26-27/06; 5/5/06
	Youth Fishing Trips	Various locations	245 students/ 10 teachers, parents	6/2/05; 8/3,9/05; 11/10/05; 5/6/06;
	Natural Resource Field Day	Farragut State Park/Post Falls Elementary (Post Falls, ID)	275 students/ teachers	6/ 3/05
	Inter-Tribal Natural Resource Field Camp	Chewelah Peak Learning Center, Chewelah, WA	27 students/ teachers	6/13-18/05
	Rockin' The Rez	Camp Larson, Worley, Idaho	185 youth/ teachers	7/12-8/11/05
	Water Potato Day	Chatcolet Lake	~ 425 students/ teachers	10/27,28/05
	Water Relay For Life	Q'emiln Park, Post Falls,ID	35 general public	4/29/06
Classroom Programs	Indian Land Tenure	St. Maries, ID; Cd'A Tribal School, DeSmet, ID; Plummer, ID	70 students	10/05 to 4/06
	4-H Youth Activities	St. Maries, ID	15 youth	7/12-14/05
	After School Program	Plummer/Worley Middle School	38 students	11/29/05 to 5/19/06
Miscellaneous Lectures	Indian Education Summit	Coeur d'Alene Casino, Worley, ID	125 students, teachers	10/6,7/05
	Significance of Native Plants	Native American Fish & Wildlife Society Annual Meeting, Okanogan, WA	75 professionals	10/16-20/05
	Tribal Stories/Post Falls Historic Society	Q'emiln Riverside Park, Post Falls, ID	550youth/ teacher, parents	5/17/06
	Science Lecture Series	Kootenai High School, Harrison, ID	21 students	Ongoing throughout school year
Other Activities	Arbor Day-Environmental Education	North Idaho College, Coeur d'Alene, ID	25 general public	4/21/06
	Clean Up Day!	Drumheller Spring Park, Spokane, WA	25 students/10 staff	7/13-8/3/05
	Environmental/Cultural Education Booth	Kootenai County Fair, Coeur d'Alene, ID	>350 general public	8/26-28/05
	Job Fair/Career Day	Spokane Community College, Spokane, WA; Havermale High, Spokane, WA; CDA Casino, Worley, ID	515 students/40 professionals	1/5/06; 3/8/06; 4/20/06
	Antelope Run	DeSmet, ID	65 student	5/26

Task 1b: Participate in Tribal inter-disciplinary processes to review and comment on issues related to the management of natural resources on the Reservation and in the Tribe's ceded territory.

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

Task 2a: 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.

Task 2b: Provide educational programs for the local community to increase the understanding of project related activities and the relationship between cultural practices and tribally significant plants and animals.

Criteria: Does the Outreach Specialist's sponsorship of and attendance at miscellaneous meetings and activities (as outlined above) promote the education and outreach cause?

Effectiveness: The Outreach Specialist's attendance at all workshops, classes, and events provided many opportunities to make presentations about fisheries program activities and the relevance of these activities to tribal culture. 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.

Water Awareness Week.

Criteria: Was the Water Awareness Workshop an effective educational forum to increase awareness?

Effectiveness: This is one of the most important events that the Tribal Natural Resource programs put on for the regional communities. More than 300 students, teachers and parents participated in the event, with each school having approximately one half day to work through the seven learning stations. Future participation can be slightly increased through better coordination and advanced scheduling with the attending schools.

Kootenai High School Classroom Lecture Series

Criteria: Were these lecture sessions effective educational forums to increase awareness?
Effectiveness: Eight to twelve students attended each of the five lectures.

Coeur d'Alene Tribal School Classroom Teaching

Criteria: Was this an effective educational forum to increase awareness?
Effectiveness: eighteen to forty students and their teachers attended.

Rock n' the Rez Youth Program

Criteria: Was the conference an effective educational forum to increase awareness?
Effectiveness: There were over 185 youth that attended and participated in all the activities.

Kootenai County Fair

Criteria: Was this trip an effective educational forum to increase awareness?
Effectiveness: Approximately 350 people visited our booth.

North Idaho College– Arbor Day-Environmental Education

Criteria: Was this class an effective educational forum to increase awareness?
Effectiveness: Approximately 75 students, businessmen, and teachers attended.

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.

Post Falls Historic Society – Tribal Stories

Criteria: Was this class an effective educational forum to increase awareness?
Effectiveness: Approximately 550 students, teachers, and parents attended.

Water Potato Day

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

Indian Education Summit

Criteria: Was this workshop an effective educational forum to increase awareness?
Effectiveness: 125 community members participated in workshop.

Native American Fish & Wildlife Society Pacific Region Conference

Criteria: Was this trip an effective educational forum to increase awareness?
Effectiveness: Approximately 75 people attended this workshop.

Task 2c: Provide summer internships for interested 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 and each remained 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.

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 Coeur d'Alene Tribe co-sponsored this event for the first time since its inception 12 years ago. A total of 30 students attended the weeklong camp and all attendees reportedly benefited in some way.

Task 2d: Work with the University of Idaho Extension Agent to develop and implement educational programs focusing on fish, water and wildlife resources and protection of the Reservation environment.

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.

Choices curriculum

Criteria: Was this curriculum an effective educational forum to increase awareness?
Effectiveness: 70 students attended.

4-H Workshops

Criteria: Were these workshops effective educational forums to increase awareness?
Effectiveness: 20 to 30 students attended each session.

BIBLIOGRAPHY

Abbe, T.B. and D.R. Montgomery. 1996. Interaction of large woody debris, channel hydraulics and habitat formation in large rivers. Regulated Rivers Research & Management 12: 201-221.

Adams, S.B., C.A. Frissell and B.E. Rieman. 2001. Geography of invasion in mountain streams: consequences of headwater lake fish introductions. Ecosystems 296-307.

Adams, S.B., C. A, Frissell and B.E.Rieman. 2000. Movements by nonnative brook trout in relation to stream slope. Trans. Am. Fish. Soc. 129: 623-638

Anders, P., J. Cussigh, D. Smith, J. Scott, D. Ralston, R. Peters, D. Ensor, W. Towey, E. Brannon, R. Beamesderfer, J. Jordan. 2003. Coeur d'Alene Tribal Production Facility, Volume I of III, Project No. 1990-04402, 424 electronic pages. BPA Report DOE/BP-00006340-2.

Andrus, C.W., B.A. Long, and F.H. Froehlich. 1988. Woody debris and its contribution to pool formation in a coastal stream 50 years after logging. Can. J. Fish. Aquat. Sci. 45: 2080-2086.

Arend, K.K. 1999. Macrohabitat Identification. Pages 75-93 in M.B. Bain and N.J. Stevenson, editors. Aquatic Habitat Assessment: Common Methods. American Fisheries Society. Bethesda, Maryland.

Armour, C.L., K.P. Burnham, and W.S. Platts. 1983. Field methods and statistical analyses for monitoring small salmonid streams. USDI, Fish and Wildlife Service. FWS/OBS-83/33.

Berenbrock, Charles. 2002. Estimating the magnitude of peak flows at selected recurrence intervals for streams in Idaho. U.S. Geological Survey Water-Resources Investigations Report 02-4170. 59 pages.

Berman, C.H., and T.P. Quinn. 1991. Behavioral thermoregulation and homing by spring Chinook salmon, *Oncorhynchus tshawytscha* (Walbaum), in the Yakima River. Journal of Fish Biology 39:301-312.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. In *Streamside Management: Forestry and Fishery Interactions,* ed. E.O. Salo and T.W. Cundy, pp. 191-232. Institute of Forest Resources, University of Washington, Seattle, WA.

Binns, N.A. 1994. Long-term response of trout and macrohabitats to habitat management in a Wyoming headwater stream. North American Journal of Fisheries Management 14: 87-98.

Brunke M. and T. Gonser. 1997. The ecological significance of exchange processes between rivers and groundwater. Freshwater Biology 37: 1-33.

Buffington, J.M. 1998. The use of streambed texture to interpret physical and biological conditions at watershed, reach, and subreach scales. Doctoral dissertation. University of Washington, Seattle.

Bustard D. R., and D. W. Narver. 1975. Preferences of juvenile coho salmon (*Oncorhynchus kisutch*) and cutthroat trout (*Salmo clarki*) relative to simulated alteration of winter habitat. Journal of Fisheries Research Board of Canada. 32: 681-687.

Carlander, K.D. 1981. Caution on the use of the regression method of back-calculating lengths from scale measurements. Fisheries 6:2-4.

Carlson, S.R., G.L. Coggins Jr. and C.O. Swanton. 1998. A simple stratified design for mark-recapture estimation of salmon smolt abundance. Alaska Fishery Research Bulletin 5 (2) 88-102.

Castro, J.M. and P.L. Jackson. 2001. Bankfull discharge recurrence intervals and regional hydraulic geometry relationships: patterns in the pacific northwest, USA. Journal of the American Water Resources Association. 37(5): 1249-1262.

Castro. J.M. and P.L. Jackson. 2001. Bankfull discharge recurrence intervals and regional hydraulic geometry relationships: patterns in the Pacific Northwest, USA. Journal of the North American Water Resources Association 37(5): 1249-1262.

CDA Tribe 2003. Lake Creek Pond Monitoring Plan. Fisheries Program. Plummer, ID. 58 pp.

CDA Tribe. 2003b. Water Quality Monitoring Quality Assurance Project Plan. Water Resources Program, Plummer, ID.

CDA Tribe. 2003c. Stormwater Pollution Prevention Plan for Construction Activities at Benewah Creek, Benewah County, ID. Fisheries Program. Plummer, ID.

Cederholm, C.J. and W. J. Scarlett. 1991. The beaded channel: a low-cost technique for enhancing winter habitat of coho salmon. Pages 104-108 in J. Colt and R. J. White, editors. Fisheries bioengineering symposium. American Fisheries Socity, Symposium 10, Bethesda, Maryland.

Coeur d'Alene (CDA) Tribe. 1993. Fisheries Habitat Evaluation on Tributaries of the Coeur d'Alene Indian Reservation; 1991 Annual Report to Bonneville Power Administration, Division of Fish and Wildlife. Portland OR. 106 pp.

Cohen, J. 1988. Statistical power analysis for the behavioral sciences. Academic Press, New York, NY. 474 pp.

Conlin, K. and B.D. Tuty. 1979. Juvenile salmon field trapping manual. Dept. of Fisheries and Oceans. Fisheries and Marine Service Resource Services Branch, Habitat Protection Division, Vancouver, B.C. 136p.

Dunham, J., G. Chandler, B. Rieman, and D. Martin. 2005. Measuring stream temperature with digital data loggers: A user's guide. General Technical Report. RMRSGTR-150WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 15pp.

Ebersole, J.L., W.J. Liss, and C.A. Frissell. 2001. Relationship between stream temperature, thermal refugia and rainbow trout Onchorhynchus mykiss abundance in arid-land streams in the northwestern United States. Ecology of Freshwater Fish 10: 1-10.

Ebersole, J.L., W.J. Liss and C.A. Frissell. 2003. Thermal heterogeneity, stream channel morphology and salmonid abundance in northeastern Oregon streams. Can J. Fish. Aquat. Sci. 60:1266-1280.

Gibbs, J.P. 1995. Monitor: Users Manual. Department of Biology, Yale University, New haven Connecticut. 44 pp.

Graves, S., K.L. Lillengreen, D.C. Johnson and A.T. Scholz. 1990. Fisheries Habitat Evaluation on Tributaries of the Coeur d'Alene Indian Reservation. 1990 Annual Report to Bonneville Power Administration. Portland, OR.

Griffith, J.S. 1974. Utilization of invertebrate drift by brook trout (*Salvelinus fontinalis*) and cutthroat trout (*Salmo clarki*) in small streams in Idaho. Transactions of the American Fisheries Society 103:440-447.

Griffith, J.S. 1988. Review of competition between cutthroat trout and other salmonids. Pages 134-140. *in* R.E. Gresswell, editor. Status and Management of interior stocks of cutthroat trout. American Fisheries Society symposium 4. Bethesda, Maryland.

Gulland, J.A. and A.A. Rosenberg. 1992. A review of length-based approaches to assessing fish stocks. FAO Fisheries Technical Paper. No. 323. Rome, FAO. 100p.

Hillman, T.W. and A.E. Giorgi. 2002. Monitoring protocols: Effectiveness monitoring of physical/environmental indicators in tributary habitats. Bonneville Power Administration, Portland, OR. 104pp.

Hogel, J.S. 1993. Salmonid habitat and population characteristics related to structural improvement in Wyoming streams. Master's thesis. University of Wyoming, Laramie.

Inter-Fluve, Inc. 2002. Beneawh Creek Assessment and Restoration Prescriptions. Preliminary report, Submitted to Coeur d'Alene Tribe Fisheries Program, Plummer, Idaho. December.

Inter-Fluve, Inc. 2005. Benewah Creek Restoration Reach D1 Design. Design report, Submitted to Coeur d'Alene Tribe Fisheries Program, Plummer, Idaho. January.

Jearld, T. 1983. Age determination. *In*: Nielsen, L.A. and D.L. Johnson (eds.), Fisheries Techniques. American Fisheries Society, Bethesda, MD. 468p.

Johnson, R. A. and G. K. Bhattacharyya. 2001. Statistics: principles and methods, 4th edition. John Wiley & Sons, New York.

Kershner, J.L., B.B. Roper, N. Bouwes, R. Hendersen and E. Archer. 2004. An analysis of stream habitat conditions in reference and managed watersheds on some federal lands within the Columbia River watershed. North American Journal of fisheries Management 24:1363-1375.

Knudsen, K.L. and P. Spruell. 1999. Genetic analysis of westslope cutthroat trout in tributaries of Coeur d'Alene Lake. Coeur d'Alene Tribe Fisheries Program, Final Report WTSGL99-106, Plummer, Idaho.

Leopold, L.B. 1994. A View of the River. Harvard University Press, Cambridge, MA. 298 pp.

Lillengreen, K.L., A.J. Vitale, and R. Peters. 1996. Fisheries habitat evaluation on tributaries of the Coeur d'Alene Indian Reservation, 1993-1994 annual report. USDE, Bonneville Power Administration, Portland, OR. 260p.

Lindstrom, J.W. and W.A. Hubert. 2004. Ice processes affect habitat use and movements of adult cutthroat trout and brook trout in a Wyoming foothills stream. North American Journal of Fisheries Management. 24:1341-1352.

Lux, F.E. 1971. Age determination of fishes (revised). NMFS, Fishery leaflet 637. 7p.

Mallet, J. 1968. St. Joe River fisheries investigations, 1967. Idaho Fish and Game Department, Boise, Idaho. 26 pp.

Murphy, M.L. and W.R. Meehan. 1991. Stream ecosystems. American Fisheries Society Special Publication 19:17-46.

Natural Resource Conservation Service (NRCS). 2000. Conservation Practice Standard for Ponds, Code 378. Boise, ID.

Newman, R.M. and F.B. Martin. 1983. Estimation of fish production rates and associated variances. Canadian Journal of Fisheries and Aquatic Sciences 40:1729-1736.

O'Neill, M.P. and A. D. Abrahams. 1984. Objective identification of pools and riffles. Water Resources Research 20(7): 921-926.

Paulsen, C., S. Katz, T. Hillman, A. Giorgi, C. Jordan, M. Newsom, and J. Geiselman. 2002 (Review Draft). Guidelines for action effectiveness research proposals for FCRPS offsite mitigation habitat measures.

Peck, D.V., J.M. Lazorchak & D.J. Klemm (eds). 2001. Western Pilot Study DRAFT Field Operations Manual for Wadable Streams. Environmental Monitoring and Assessment Program - Surface Waters, Corvallis, OR.

Peterson, D.P. and K.D. Fausch. 2003. Upstream movement by non-native brook trout (*Salvelinus fontinalis*) promotes invasion of native cutthroat trout (*Oncorhynchus clarki*) habitat. Can. J. Fish. Aquat. Sci. 60: 1502-1516.

Peterson, N.P. 1982. Population characteristics of juvenile coho salmon (*Oncorhynchus kisutch*) overwintering in riverine ponds. Canadian Journal of Fisheries and Aquatic Sciences. 39: 1303-1307.

Platts, W.S., C. Armour, G.D. Booth, M. Bryant, J.L. Bufford, P. Cuplin, S. Jensen, G.W. Lienkaemper, G.W. Minshall, S.B. Monsen, R.L. Nelson, J.R. Sedell and J.S. Tuhy. 1987.

Methods for Evaluating riparian Habitats with Applications to Management. General Technical Report INT-221. USDA Forest Service, Ogden, UT.

Pollock M.M., G.R. Pess, T.J. Beechie and D.R. Montgomery. 2004. The importance of beaver ponds to coho salmon production in the Stillaguamish River Basin, Washington, USA. North American Journal of Fisheries Management. 24:749-760.

Pollock, M.M., Beechie, T.J., Chan, S.S. & Bigley, R. 2005. Monitoring of restoration of riparian forests. *In* P. Roni, ed. *Monitoring stream and watershed restoration*, pp. 67-96. Bethesda, MD, American Fisheries Society. 350 pp.

Quillan, E.W., and W.A. Harenberg. 1982. An Evaluation of Idaho Stream-Gaging Networks. USGS Open-File Report 82-865.

Rantz, S. E. 1983. Measurement and Computation of Streamflow; Volume 1. Measurement of Stage and Discharge. USGS Water Supply Paper 2175. US Geological Survey, Washington DC.

Reynolds, J.B. 1983. Electrofishing. *In*: Nielsen, L.A. and D.L. Johnson (eds.), Fisheries Techniques. American Fisheries Society, Bethesda, MD. 468p.

Rich, B.A. 1992. Population dynamics, food habits, movement and habitat use of northern pike in the Coeurd'Alene Lake system, Idaho. Completion Report F-73-R-14, Subproject No.: VI, Study No.: 3. 95 pages.

Richmond, A.D. and K.D. Fausch. 1995. Characteristics and function of large woody debris in subalpine Rocky Mountain streams in northern Colorado. Can. J. Fish. Aquat. Sci. 52: pp 1789 - 1802.

Ritter, J.R. 1967. Bed-material Movement. Middle Fork Eel River, CA. US Geological Survey Prof. Paper 575-C: pp. C219-C221.

River4m, Ltd. 1999. Reference Reach Spreadsheet, A Stream Channel Assessment Tool, Version 2.2L (Microsoft Excel). Distributed by Ohio Department of Natural Resources, Columbus, OH.

Robison, E.G. and R.L. Beschta. 1990. Coarse woody debris and channel morphology interactions for undisturbed streams in southeast Alaska, USA. Earth Surface Processes and Landforms 15: 149-156.

Rosenfeld, J. 2003. Assessing the habitat requirements of stream fishes: An overview and evaluation of different approaches. Trans. Am. Fish. Soc. 132:953-968.

Rosgen, D. L. 1993. Applied Fluvial Goemorphology, Training Manual for River Short course. Wildland Hydrology, Pagosa Springs, CO. 450 pp.

Rosgen, D.L. 1994. A classification of natural rivers. Catena 22:169-199.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Schultze, R.F., and G.I. Wilcox. 1985. Emergency measures for streambank stabilization: an evaluation, p. 59-61. In R.R. Johnson, et al. (Eds.), Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. USDA Forest Service, General Technical Report RM-120

Schuett-Hames, D., A.E. Pleus, J. Ward, M. fox and J. Light. 1999. TFW Monitoring Program Method Manual for Large Woody Debris Survey. Publication #DNR 106, prepared for WDNR under Timber, Fish and Wildlife Agreement TFW-AM9-99-004.

Seber, G.A.F., and E.D. LeCren. 1967. Estimating population parameters from catches large relative to the population. Journal Animal Ecology 36:631-643.

Shepard, B.B. 2004. Factors that may be influencing nonnative brook trout invasion and their displacement of native westslope cutthroat trout in three adjacent southwestern Montana streams. North American Journal of Fisheries Management. 24:1088-1100.

Stewart, R. 2002. Resistance board weir panel construction manual. Regional Information Report No. 3A02-21. Alaska Department of Fish and Game, Division of Commercial Fisheries Arctic-Yukon-Kuskokwim Region.

Tobin, J.H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report Number 22, Kenai, Alaska.

Torgersen, C.E., D.M. Price, H.W. Li and B.A. McIntosh. 1999. Multiscale thermal refugia and stream habitat associations of chinook salmon in northeastern Oregon. Ecol. Appl. 9:301-319.

U.S. Army Corps of Engineers. 2001. HEC-RAS, River Analysis System, Users Manual. January.

U.S. Environmental Protection Agency (EPA). 2001. Western Pilot Study DRAFT Field Operations Manual for Wadable Streams. Environmental Monitoring and Assessment Program - Surface Waters. Corvallis, OR.

U.S. Environmental Protection Agency (USEPA). 1979. Methods for the Chemical Analysis of Water and Wastes (EPA/600/4-79/020)

U.S. Environmental Protection Agency (USEPA). 1993. Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600/R-93/100).

U.S. Forest Service. 1998. Biological assessment: St. Joe River Basin/North Fork Clearwater. U.S. Fish and Wildlife Service, bull trout Section 7(a)2 consultation. 145p.

US Environmental Protection Agency (EPA). 1998. Idaho's Impaired Waters List Approved by EPA for 1998 (CWA Section 303(d) List). Washington, DC.

Vitale, A.J., D. Lamb, and J. Scott. 2003. Implementation of Fisheries Enhancement Opportunities on the Coeur d'Alene Reservation. 2002. Annual Report. Project No. 1990-04400, 111 electronic pages, (BPA Report DOE/BP-00010885-1)

Vitale, A.J., D. Lamb, R. Peters, and D. Chess. 2002A. Coeur d'Alene Tribe Fisheries Program Research, Monitoring and Evaluation Plan. USDE, Bonneville Power Administration, Portland, OR. 93p.

Vitale, A.J., D.A. Bailey, and R. Peters. 1999. BPA Annual Report, 1998: Implementation of fisheries enhancement activities on the Coeur d'Alene Reservation. U.S. Department of Energy, Bonneville Power Administration, Portland, OR. Project Number 90-044.

Vitale, A.J., F.M. Roberts, R.L. Peters and J. Scott. 2002B. Fish and wildlife habitat protection plan. U.S. Department of Energy, Bonneville Power Administration, Portland, OR. Project Number 1990-044-00.

Waters, T.F. 1992. Annual production, production/biomass ratio, and the ecotrphic coefficient for management of trout in streams. North American Journal of Fisheries Management. 12:34-39

Wolman, M.G. 1954. A method of sampling coarse carrier-bed material. Transactions of American Geophysical Union Volume 35, pp 951-956.

Zar, J.H. 1999. Biostatistical analysis, 4th edition. Prentice-Hall, Englewood Cliffs, New Jersey.

Zippen, C. 1958. The removal method of population estimation. Journal of Wildlife Management 22:82-89.