FY 2008-2009 F&W Program Accords (MOA) Proposal Review

Narrative

Table 1. Proposal Metadata

Project Number	2008-109-00
Proposer	Confederated Tribes of the Colville Reservation
Project Name	Resident Fish RM&E
Short Description	Spawning and overwintering movement and habitats of rainbow trout in the San Poil Subbasin
Province(s)	Intermountain
Subbasin(s)	San Poil
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Information transfer:

A. Abstract

The goal of this project is to improve the basic understanding of the population dynamics of rainbow trout (*Oncorhynchus mykiss*) within the San Poil Subbasin by examining movements and winter ecology among life histories. Specific project objectives include identification of spatiotemporal patterns in movements and spawning areas among life histories within the San Poil Subbasin, the identification of overwintering areas of rainbow trout, and the investigation of how winter ecology of each present life history is associated with warm groundwater presence, river ice, and other habitat parameters to assist in determining where essential thermal refugia habitat exists to aid the Tribes in management decisions on where conservation and enhancement actions will provide the greatest benefit to the fish.

B. Problem statement: technical and/or scientific background

At least two genetically distinct subspecies of rainbow trout are present within the San Poil Subbasin. Redband trout are native to the drainage, while coastal rainbow trout were introduced to the area (Gillin and Pizzimenti 2004). The native redband may be genetically similar to the native, summer steelhead populations that were once abundant within the system (Leary 1997, cited by Gillan and Pizzimenti 2004). Although genetic testing has revealed introgression among subspecies, genetically pure redband trout still exist above barriers (Leary 1997, cited by Gillan and Pizzimenti 2004). Young et. al. (2007) indicated that greater than 75% of the adfluvial

rainbow trout in the Sanpoil system are non-hybridized redband stocks. This is a much lower degree of hybridization than had been previously anticipated.

Much of the data collected on the different strains of rainbow trout within the San Poil Subbasin has not been separated by subspecies. Thus, the use of the term rainbow trout hereafter does not specify one subspecies or the other, unless otherwise noted. Although rainbow trout are known to be both resident and migratory within the San Poil Subbasin (Gillin and Pizzimenti 2004), there is a general lack of knowledge regarding how many and what life history strategies exist within the subbasin. In general, fluvial trout occupy streams for their entire lives (Northcote 1997) while migratory trout travel to spawn in streams that flow into lakes (lacustrine-adfluvial; Varley and Gresswell 1988; Northcote 1997), that flow out of lakes (allacustrine), or that move from rivers into tributaries (fluvial-adfluvial) to spawn (Northcote 1997, Dupont et al. 2007). This proposal addresses a lack of information for both resident and migratory rainbow trout within the San Poil River Basin. Although it is currently unknown whether resident rainbow trout in the San Poil River Basin exhibit the fluvial or fluvial-adfluvial life history strategy, for the purposes of this proposal rainbow trout that remain within the San Poil River or tributaries throughout their life history are hereafter referred to as fluvial and rainbow trout that migrate from Lake Roosevelt to the San Poil River or tributaries are hereafter referred to as lacustrine-adfluvial.

Rainbow trout tributary spawning habitat is limited within the San Poil Subbasin (Gillin and Pizzimenti 2004) and early fisheries investigations indicated that a lack of high quality spawning and rearing habitat was a limiting factor to adfluvial rainbow trout production in Lake Roosevelt (Scholz et al. 1986, cited by Gillin and Pizzimenti 2004). Further, considerable introgression has been documented between redband and coastal rainbow trout in areas of the Colville National Forest below barriers (Gillin and Pizzimenti 2004) however, lacustrine-adfluvial rainbow trout located within the Colville Reservation showed minor introgression between both stocks with high genetic diversity (Young et. al. 2008). Thus, the first objective of this study is to document spatiotemporal patterns in spawning areas and movements among life histories within the San Poil Subbasin. We hypothesize that rainbow trout have several different life history strategies within the San Poil Subbasin. Radio telemetry will be used to examine their spawning behavior to allow their life histories to be documented.

In addition to the lack of information on the various life histories of the spawning populations in the basin, little information exists regarding the winter ecology of rainbow trout within the San Poil Subbasin. Recruitment of adfluvial rainbow trout into Lake Roosevelt is likely highly dependent on surviving the first winter in spawning tributaries or the mainstem of the San Poil River. Furthermore, abundance estimates drastically decline between the fall and spring within the San Poil Subbasin (Kirk Truscott, Colville Confederated Tribes, Personal communication). As water temperatures decrease in fall and early winter, the metabolism of fish decreases and defense of feeding positions becomes less important to fish while the search for suitable winter habitat becomes more important (Cunjak and Power 1986; Cunjak 1996; Lindstrom and Hubert 2004). This leads to shifts in habitat use and movements, and many larger juvenile and adult fish abandon feeding territories and aggregate in areas where they can find winter refuges (Hartman 1965; Cunjak and Power 1986; Brown and Mackay 1995a; Jakober et al. 1998). Smaller fish may exhibit similar behavior; however, smaller fish likely move shorter distances and hide within interstitial spaces of the stream bottom during the day (Hartman 1965, Griffith and Smith 1993). Seasonal shifts in habitats usually involve larger fish moving to areas with lower velocities and greater depths. As water temperatures decrease in the fall, fish such as riverine

salmonids often make lesser use of shallower areas with higher water velocities and greater use of deeper, slower habitats (Hartman 1965; Cunjak and Power 1986; Chisholm et al. 1987; Baltz et al. 1991; Heggenes et al. 1993; Brown and Mackay 1995a; Jakober et al. 1998). Therefore, the likelihood that trout will be found in aggregations in rivers and streams increases as water temperature decreases (Brown 1999). The occurrence of winter aggregations of fish is correlated not only with water temperatures, but also the inflow of relatively warm groundwater into the water column (Brown and Mackay 1995a; Brown 1999). Although aggregating may decrease the risk of individual predation (Pitcher 1986), it may leave fish more vulnerable to human disturbance or angling and parasite or disease outbreak since large numbers of fish are located in a confined area.

The areas fish aggregate in during the fall may not represent areas used for the entire winter. Winter habitats of fish can range from very stable (areas insulated from thermal extremes) to constantly in flux due to changes in river ice and water temperature. In some river environments, the solid surface ice cover formed early in the winter seals the fish under a stable sheet of ice. Further, snow can bridge small streams and provide stable overwintering habitats (Chisholm et al. 1987; Hubert et al. 2000). As snow accumulates on the surface ice of pools, habitat stability appears to increase (Lindstrom and Hubert 2004). However, habitats can also be unstable during the winter due to the presence of groundwater inflow or dynamic river ice conditions (Brown 1999; Lindstrom and Hubert 2004; Barrineau et al. 2005). Anchor ice can form over large parts of river channels forcing fish to move (Brown and Mackay 1995a). However, in smaller streams, snow can bridge the entire stream insulating it from super-cooling events and thus frazil and anchor ice formations. Habitats in these areas will be more stable and fish may move less than those in areas influenced by frazil and anchor ice (Brown 1999).

Winter ecology is an important yet often overlooked aspect to fisheries management that may represent capacity limiting factors for many populations. Little is known about the winter ecology of rainbow trout within the San Poil Subbasin. Therefore, an objective of this study is to identify overwintering areas of rainbow trout within the San Poil Subbasin and investigate how winter ecology of each present life history type is associated with warm groundwater presence, river ice, and other habitat parameters to determine optimal areas for habitat protection and enhancement. We hypothesize that larger juvenile and adult rainbow trout will aggregate in areas with warm groundwater influx and moderate to deep water depth. Identification of warm groundwater areas will not only provide information on valuable winter habitats, but these groundwater areas can also provide thermal refugia for fish during summer when ambient water temperatures reach high levels.

C. Rationale and significance to regional programs

Rainbow trout are a focal species in the San Poil Subbasin under the Intermountain Province (IMP) Subbasin Plan due to their recreational value as a sport fish and their cultural significance to the Colville Confederated Tribes (CCT) (Gillin and Pizzimenti 2004). The first priority for the aquatic objectives in the San Poil Subbasin is to begin implementation of habitat strategies for addressing identified limiting factors for all focal species and native fishes. However, the limiting factors that are listed as being addressed by this objective are limited to riparian habitat, water quality, nutrients, and sediment (Gillin and Pizzimenti 2004). Little published information exists regarding other parameters that may be limiting to one or more life histories of rainbow trout within the San Poil Subbasin despite the identification of other limiting factors being listed

as a specific strategy within the subbasin (Gillin and Pizzimenti 2004). Therefore, the proposed research is designed to examine spawning movements and winter ecology of all life histories of rainbow trout present within the subbasin. This will aid in identifying other possible limiting factors within the subbasin (i.e., spawning and winter habitat) that may prove critical in meeting the second highest ranked objective (i.e., Objective 2A2) for the San Poil Subbasin: protect and enhance redband trout populations and preserve their genetic integrity while maintaining their subsistence and recreational fishery (Gillin and Pizzimenti 2004). Enhancement of redband populations may also be important as extirpated steelhead runs were of the redband subspecies (Behnke 1992). It may be possible to recover steelhead in the future with fish passage through Chief Joseph and Grand Coulee dams. Thus, it is important to preserve redband trout not only because of their cultural significance and native species status, but also because they may provide a native donor stock for future anadromous reintroduction.

D. Relationships to other projects

Stream surveys identified fish passage barriers as limiting production within the San Poil River (Gillin and Pizzimenti 2004). Objective 1B1 for the San Poil Subbasin is to inventory all barriers within the subbasin and to begin implementing necessary passage improvements associated with man-made barriers (Gillin and Pizzimenti 2004). The CCT Lake Roosevelt Rainbow Trout Habitat/Passage Improvement Project (LRHIP) addresses this objective. The proposed research will provide supplementary data regarding fish passage barriers and the efficacy of recent fish passage improvements through extensive radio-telemetry operations; albeit, the assessment of fish passage is not a direct objective of the proposed research. The use of telemetry will allow us to examine movements of fish past areas that are thought to be barriers or past areas that were modified to improve passage. Although a large part of the rainbow trout may not be examined in these areas, the fish that are implanted with transmitters should provide an indication of whether these areas are passable.

The LRHIP conducts habitat and passage enhancements for rainbow trout and the Chief Joseph Kokanee Enhancement Project (CJKEP) has started addressing these issues for kokanee. The results of the studies will aid in evaluating habitat improvements completed by the LRHIP and CJKEP. Results will also identify additional passage barriers, habitat improvement opportunities or critical habitat protection opportunities currently unknown. This information will be passed on to the projects listed above for conservation action.

The Colville Tribal Hatchery Project (198503800) currently releases and monitors redband rainbow trout into tributaries of the San Poil River. The stock origin is a mixed stock of San Poil Basin and Phalon Lake. Factors such as time of release, migratory patterns and habitat have been identified as limitations and/or critical unknowns for the survival of these releases (Ed Shallenberger, CCT, Personnel communication). The proposed project will help identify limiting factors and management strategies specifically designed to restore and enhance redband rainbow trout populations (Objective 2A2) in the San Poil Basin.

The Chief Joseph Kokanee Enhancement Project (199501100) is tasked with enhancing kokanee in the San Poil Basin. The project currently monitors a permanent resistance weir near the mouth of the San Poil which will be used to capture migratory rainbow trout. In addition, a habitat survey will be conducted this summer (09) and information obtained from this will be used in the proposed study to determine potential overwintering areas. The Kokanee project will

also donate the use of telemetry receivers for fixed sites and mobile surveys currently used in kokanee spawning surveys.

Table 2. Relationship to existing projects

Funding Source	Project #	Project Title	Relationship (brief)
BPA	199001800	Lake Roosevelt Habitat/Passage Improvement Project	Provides fish movement data pertinent to current fish passage barriers and through areas where passage and habitat improvements have been made. The proposed project will target areas for protection and enhancement actions by the LRHIP and CJKEP projects. Project will share equipment as needed. LRHIP is planning on installing radio-telemetry tags in out-migrant adfluvial RBT and post spawn adults to track movement and will be using the receiver array established with this project to track the tagged fish.
BPA	19850380	Colville Hatchery	Identifying habitat types and areas where stocked fish would have the highest of survival. Project will share equipment as needed.
BPA	19950110	Chief Joseph Kokanee Enhancement	CJKEP provides fish capture assistance and habitat analysis. Project will share equipment as needed.

E. Project history (for ongoing projects)

This is a new (proposed) project consistent with the Accords agreement between CCT and BPA for RM&E under the Resident Fish Projects.

F. Proposal biological/physical objectives, work elements, methods, and metrics

Objectives:

Objective 1. Identify spatiotemporal patterns in movements and spawning areas among life histories within the San Poil Subbasin.

Task 1.1. Identify all life histories of rainbow trout within the San Poil Subbasin.

Methods. Life histories will be identified through field observations and the use of radio-telemetry. Specific life history types thought to be present within the subbasin include fluvial redband trout located above barriers to migration, fluvial-adfluvial rainbow trout located within the San Poil River or tributaries, spring migrating lacustrine-adfluvial rainbow trout, and summer migrating lacustrine-adfluvial rainbow trout. Fluvial redband trout will be identified based on their location above barriers to fish passage. Spring and summer migrating lacustrine-adfluvial rainbow trout will be identified based on

migration timing and movement data. Migration timing will be evaluated using catch information from the weir located near the mouth of the San Poil River. Movement will be evaluated using radio-telemetry data (see below and schedule of activities in Table 1). Fluvial-adfluvial rainbow trout will be identified as fish captured within the San Poil River or tributaries during the winter and validated using movement data from radio-telemetry (see below). Genetic samples will also be taken from all fish implanted with radio transmitters. Although analysis of these samples is not within the scope of this study, the samples will be analyzed along with samples collected by the Lake Roosevelt Habitat Improvement Project's as part of the Project's ongoing redband genetic work to examine if possible genetic differences exist among the different life history types. Samples and data will be made available to the Lake Roosevelt Evaluation Program as part of a broader rainbow trout investigation beginning in 2010.

Task 1.2. Examine timing and location of spawning for all life histories of rainbow trout within the San Poil Subbasin.

Methods. Radio-telemetry will be used to assess spawning time and the location of spawning areas for rainbow trout within the subbasin. During the late winter of 2010, a combination of electrofishing, angling and snorkeling may be used to sample fluvial redband trout above migration barriers within the San Poil subbasin and to sample fluvial-adfluvial rainbow trout below migration barriers. Spring migrating lacustrine-adfluvial rainbow trout will be sampled at the continuously operated San Poil weir during their migration into the San Poil River 2010. Radio-transmitters will be surgically implanted in 15 individuals from each life history (i.e., fluvial, fluvial-adfluvial, and spring migrating lacustrine-adfluvial) following sampling. These per season sample sizes are similar to other published research (Brown and Mackay 1995b) and are limited by budgetary constraints.

Movements of radiotagged individuals will then be recorded using both passive and active radio-telemetry. Passive telemetry will be conducted using autonomous telemetry stations placed at the mouths of eight tributaries to the San Poil River. Autonomous stations will be erected in March of 2010 and maintained until March of 2012. Each autonomous station will be comprised of a Lotek SRX receiver, two deep-cycle batteries, a housing unit, solar panels, and two to four Yagi antennas. When possible, antennas will be placed to provide coverage of both the main stem San Poil River and the tributary of interest. Autonomous stations will be maintained and downloaded every two weeks when individuals with active transmitters are located within the subbasin. These data will be used to determine large scale movements within the subbasin and to determine which fish are in each reach to aid in the finer scale manual tracking. In addition, these receivers can be used to track fish implanted with transmitters from other projects such as the CJKEP and LRHIP.

Manual tracking will be conducted throughout the spawning season using a Lotek SRX receiver and Yagi antennae. General locations of individuals will be determined from vehicle and walking surveys. Precise locations will then be obtained through triangulation or by using the power function of the receiver. A global positioning system (GPS) will be used to record locations of tagged individuals and spawning areas. Visual observation (when water clarity permits) of tagged individuals will be used to confirm spawning time and location (e.g., redd construction, spawning, etc.).

Radio-transmitters will also be implanted in 15 summer migrating lacustrine-adfluvial rainbow trout during their migration into the San Poil River in July, August, and September of 2010. However, spawning movements for these individuals will be monitored during the 2011 fiscal year (FY). The aforementioned radio-telemetry operations will be repeated for fluvial, fluvial-adfluvial, and spring migrating lacustrine-adfluvial during FY2011 as well.

Task 1.3. Analyze data related to the timing and location of spawning for all life histories of rainbow trout within the San Poil Subbasin.

Methods. All data downloaded on radio receivers will be transferred to laptop computers and transferred to the Pacific Northwest National Laboratory for analysis. The date and time and location of fish will be placed in a spreadsheet and overlaid in a geographical information system. The distances and rates of fish movement will be determined. Migration corridors and spawning areas will be documented in a geographical information system. Life history types will be identified based upon origin of fish, extent of pre-spawning migrations, spawning areas and post-spawning migrations. Distances moved and rates of movements will be compared among life history types.

Objective 2. Identify overwintering areas of rainbow trout within the San Poil Subbasin and investigate how winter ecology of each present life history type is associated with warm groundwater inflow, river ice, and other habitat parameters to determine optimal areas for conservation and enhancement.

Task 2.1. Identify overwintering locations of rainbow trout.

Methods. During the first fiscal year of the project (2010), visual and video surveys will be conducted to identify locations of overwintering rainbow trout. One survey will be conducted in late fall (likely in early November) before the onset of ice cover. Another survey will be conducted later in the winter after ice cover is well established. Surveys will be conducted in the mainstem of the San Poil River, and in several tributaries. Areas above barriers where isolated redband rainbow trout are located will also be targeted. Visual and video techniques (described in Mueller et al. 2006) will be used to identify overwintering locations. Having known locations of overwintering fish is valuable for other objectives of this study. These fish can be implanted with transmitters in late winter and tracked to spawning areas the following spring. These same areas can be targeted to look at thermal regulation during summer high temperatures.

During the second fiscal year of the project (i.e., FY2011), locations of overwintering areas through visual surveys will be augmented by tracking fish implanted with radio transmitters. Fish that were implanted in the spring or summer and that remain in the basin will be tracked to overwintering areas. Movements during the fall and winter will be monitored at least every two weeks. Fish will be manually tracked and their overwintering locations documented and logged using a Global Positioning System (GPS). The extent of groundwater (length of stream above ambient stream temperatures) and river ice at the locations of the fish will be determined. In addition, if fish moved

since their previous tracking, the groundwater and river ice conditions will be described at their previous location to possibly determine why it was vacated (for example if it is chocked with anchor ice).

Overwintering methods will be repeated again during the third year of the project (FY2012). However, additional emphasis will be placed on evaluating juvenile rainbow trout during this time. Fifteen juvenile rainbow trout will be sampled by electro-fishing or angling during the late fall of 2011. These individuals will be surgically implanted with radio-transmitters and their movements monitored using the aforementioned telemetry methods. Snorkeling surveys may also be used to supplement the overwintering data during the final year of the project.

Task 2.2. Quantify the extent and thermal properties of warm groundwater areas

Methods. Warm groundwater areas will be located because they can prevent river ice formations during the winter and can be a source of winter refugia (Power et al. 1999). These areas may also be important because the use of habitats can be much different when groundwater is available versus when streams are ice covered or contain anchor ice. Groundwater surveys will be conducted in the fall and will be supplemented with observations made during other surveys and through the tracking of fish implanted with transmitters. After river ice begins to form in fall, areas lacking ice cover will be identified as starting points for finding warm groundwater effluents. The length of open water areas will be mapped using a GPS and GIS system. Within potential groundwater areas, temperatures will be recorded every 100 -500 m, depending on the length of the area influenced by groundwater effluent. Changes in temperature in these areas will be re-evaluated on subsequent surveys and the extent of ice encroachment and anchor ice formation in these areas will be examined.

Task 2.3. Analyze data related to overwintering locations of rainbow trout and warm groundwater areas within the San Poil Subbasin.

Methods. All data downloaded on radio receivers will be transferred to laptop computers and transferred to the Pacific Northwest National Laboratory for analysis. The date and time and location of fish will be placed in a spreadsheet and overlaid in a geographical information system. The distances and rates of fish movement will be determined. Migration corridors and overwintering areas will be documented in a geographical information system.

Locations of surveyed warm groundwater areas will be entered into a geographical information system. The location and temperature of groundwater at each location will be organized in a spreadsheet. Locations with observed fish will also be associated with these data.

Table 1. Proposed schedule for spawning and winter ecology research in the San Poil Subbasin.

FY	Date	Spawning	Summer adfluvial	Winter survey	Juveniles	Radio- tracking
2010	Oct-09					
	Nov-09			Winter surveys		

	Dec-09					
	Jan-10	Tag adfluvial				
	Feb-10	Tag fluvial				
	Mar-10					
	Apr-10	Install receivers				Monitor Receivers
	May-10	Track spawning				
	Jun-10					
	Jul-10		Tag			
	Aug-10		Track			
	Sep-10					
2011	Oct-10					
	Nov-10			Winter surveys		
	Dec-10					
	Jan-11	Tag adfluvial				
	Feb-11	Tag fluvial				
	Mar-11					
	Apr-11	Track spawning				
	May-11					
	Jun-11					
	Jul-11					
	Aug-11					
	Sep-11					
2012	Oct-11				Tag	
	Nov-11			Winter survey	Track	
	Dec-11					
	Jan-12					
	Feb-12					Remove receivers
	Mar-12					
	Apr-12					
	May-12					
	Jun-12					
	Jul-12					
	Aug-12					
	Sep-12					

This timeline does not show any scheduled data analyses or writing reports, etc.

G. Monitoring and evaluation

The product of this research will be information on movements (and locations) used by rainbow trout for both spawning and overwintering. No historical data relating to this goal currently exists on the Colville Reservation and more specifically the San Poil River. These data will be used as a management tool to determine where habitats should be protected or improved to

increase the population of rainbow trout in the San Poil Subbasin. Additionally, results will aid in evaluating habitat improvements completed by the Lake Roosevelt Rainbow Trout Habitat Improvement Project (LRHIP) and Chief Joseph Kokanee Enhancement Project (CJKEP). Results will also identify additional passage barriers, habitat improvement opportunities or critical habitat protection opportunities currently unknown. This information will be passed on to the projects listed above for conservation action. The Colville Tribes Fish and Wildlife will prioritize each action for future implementation. Once these actions are implemented, the rainbow trout population will be monitored and evaluated through the CJKEP and LRHIP using juvenile and adult migration traps to determine the significance of each action through abundance monitoring. In addition, habitat improvement actions will be monitored and evaluated based on pre-treatment, implementation, and effectiveness checklists that will allow the Colville Tribe to determine if a project was implemented correctly and met stated goals.

The proposed sample sizes of radio-tagged rainbow trout are justified as the number of fish implanted with transmitters is similar to or greater than those found in similar published studies. In addition, further expansion of sample sizes are precluded by budgetary limitations.

The majority of the information gathered will be qualitative rather than quantitative and may not withstand rigorous statistical analysis. However, movements may be compared among groups of fish or among years of research. Similar to other published research on these topics, comparisons between groups or years will likely be conducted with t-tests or Mann-Whitney U tests and comparisons among groups or years will likely be conducted using ANOVA or Kruskal-Wallis tests, depending on the normality of the data.

Results from this study will be communicated to BPA and Colville Tribes Fish and Wildlife through annual reports, and if appropriate, publication in peer-reviewed journals. Quarterly status reports will be submitted to BPA through PISCES.

H. Facilities and equipment

PNNL will provide the necessary office space and computer and office support for this project. Much of the video equipment needed for field work is available from PNNL at no cost to this project. Equipment purchases that will be required include radio-transmitters, receivers, and components for autonomous stations. Trucks and snow machines will be rented when necessary and the tribe will donate the use of ATV’s and other equipment at no cost. Attempts will also be made to transfer or loan equipment such as radio receivers owned by the US Corps of Engineers to BIA for use on this project. PNNL and Colville Tribe currently have the digital thermometers, thermisters, flow meters, dry suits, snorkeling gear, waders and other miscellaneous equipment necessary to complete the project.

References

Baltz, D. M., B . Vondracek, L. R. Brown, and P B. Moyle. 1991. Seasonal changes in microhabitat selection by rainbow trout in a small stream. Transactions of the American Fisheries Society 120:166-176.

Barrineau, C. A., W. A. Hubert, P. D. Dey, and T. C. Annear. 2005. Winter ice processes and pool habitat associated with two types of constructed instream structures. North American Journal of Fisheries Management 25:1022-1033.

Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6.

Brown, R. S. 1999. Fall and early-winter movements of cutthroat trout, *Oncorhynchus clarki*, in relation to water temperature and ice conditions in Dutch Creek, Alberta. Environmental Biology of Fishes 55:359-368.

Brown, R. S., and W. C. Mackay. 1995a. Fall and winter movements and habitat use by cutthroat trout in the Ram River, Alberta. Transactions of the American Fisheries Society 124:873-885.

Brown, R. S., and W. C. Mackay. 1995b. Spawning ecology of cutthroat trout (*Oncorhynchus clarki*) in the Ram River, Alberta. Canadian Journal of Fisheries and Aquatic Sciences 52:983–992.

Chisholm, I. M., W. A. Hubert, and T. A. Wesche. 1987. Winter stream conditions and use of habitat by brook trout in high-elevation Wyoming streams. Transactions of the American Fisheries Society 176-184.

Cunjak, R. A. 1996. Winter habitat of selected stream fishes and potential impacts for land-use activity. Canadian Journal of Fisheries and Aquatic Sciences 53:267-282.

Cunjak, R. A., and G. Power. 1986. Winter habitat utilization by stream-resident brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*). Canadian Journal of Fisheries and Aquatic Sciences 43:1970-1981.

Dupont, J. M., R. S. Brown, and D. R. Geist. 2007. Unique allacustrine migration patterns of a bull trout population in the Pend Oreille River drainage, Idaho. North American Journal of Fisheries Management 27:1268-1275.

Gillin, G. and J. Pizzimenti. 2004. Intermountain province subbasin plan. Report to the Northwest Power and Conservation Council, Portland, Oregon.

Griffith, J. S., and R. W. Smith. 1993. Use of winter concealment cover by juvenile cutthroat and brown trout in the South Fork of the Snake River, Idaho. North American Journal of Fisheries Management 15:42-48.

Hartman, G. F. 1965. Role of behavior in the ecology and interaction of underyearling coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 22:1035-1081.

Heggenes, J., O. M. W. Krog, O. R. Lindas, J. G. Dokk, and T. Bremnes. 1993. Homeostatic behavioral responses in a changing environment: brown trout become nocturnal in winter. Journal of Animal Ecology 62:295-308.

Hubert, W. A., C. A. Pru, and T. A. Wesche. 2000. Spatial and temporal variation in physical habitat conditions of low-gradient reaches of Rocky Mountain streams during fall and winter. Journal of Freshwater Ecology 15:219-228.

Jakober, M. J., T. E. McMahon, R. F. Thurow, and C. G. Clancy. 1998. Role of stream ice on the fall and winter movements and habitat use by bull trout and cutthroat trout in Montana headwater streams. Transactions of the American Fisheries Society 127:223-235.

Leary, R. F. 1997. Hybridization between introduced and native trout in waters of the Colville National Forest. Report No. 97/3. Division of Biological Sciences, University of Montana, Missoula, Montana.

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.

Mueller, R. P., R. S. Brown, H. Hop, and L. Moulton. 2006. Video and acoustic camera techniques for studying fish under ice: a review and comparison. Reviews in Fish Biology and Fisheries 16:213-226.

Northcote, T. G. 1997. Potamodromy in Salmonidae—living and moving in the fast lane. North American Journal of Fisheries Management 17:1029–1045.

Pitcher, T. J. 1986. Functions of shoaling behaviour in teleosts. Pages 294–337 *in*: T.J. Pitcher editor. The Behaviour of teleost fishes. The Johns Hopkins University Press, Baltimore, Maryland.

Young, S. F., C. Bowman, D. K. Hawkins, and K. I. Warheit, 2008. A genetic analysis of trout from tributaries on the Colville Reservation – Part 2. WDFW Molecular Genetics Laboratory, Olympia, Washington.

Scholz, A.T., J.K. Uehara, J. Hisata, and J. Marco. 1986. Feasibility report on restoration and enhancement of Lake Roosevelt fisheries *in* Northwest Power Planning Council. Applications for amendments. 3A:1375-1489.

Varley, J. D., and R. E. Gresswell. 1988. Ecology, status, and management of the Yellowstone cutthroat trout. Pages 13–24 in R. E. Gresswell, editor. Status and management of interior stocks of cutthroat trout. American Fisheries Society, Symposium 4, Bethesda, Maryland.

J. Key personnel

Bret Nine, Colville Confederated Tribes, Fish and Wildlife (principal investigator)

Dr. Richard S. Brown, Pacific Northwest National Laboratory (principal investigator, project manager, subcontractor)

Eric W. Oldenburg, Pacific Northwest National Laboratory (project manager, subcontractor)

Sheri Sears, Colville Confederated Tribes, Fish and Wildlife, Resident Fish Division Manager

Bret Nine, Colville Confederated Tribes, Fish and Wildlife

Education:

Master of Science, March 2005: Fisheries, Eastern Washington University
Bachelor of Science, March 2003: Zoology, Eastern Washington University

Work Experience:

July 2006 – Present: Fisheries Biologist III, Colville Tribes Fish and Wildlife, Inchelium, WA.
January 2006 – July 2006: Lead Entity Coordinator (Salmon Recovery) for Pend Oreille County, WA.
May 2005 – January 2006: Independent Contractor for Pacific Northwest National Laboratory, Richland, WA
April 2003 – March 2005: Graduate Assistant. Eastern Washington University, Cheney, WA.
December 2002 – October 2004: Research Assistant for Pacific Northwest National Laboratory, Richland, WA.
January 2001 – December 2002: Fisheries Technician, WDFW and EWU.

Research Experience:

- Distribution of non-native fishes on the Turnbull National Wildlife Refuge. Eastern Washington University.
- Genetic characterization of wild origin kokanee in Lake Roosevelt. Colville Tribes Fish and Wildlife and Washington Department of Fish and Wildlife.
- Assessment of the movements and survival of adult and juvenile bull trout below and above Albeni Falls Dam, Pend Oreille River, Idaho. Eastern Washington University and Pacific Northwest National Laboratory.
- Effects of strobe lights on prey species of zooplankton and the relative level of opportunistic feeding that occurs when the prey species are illuminated by strobe lights. Pacific Northwest National Laboratory.
- Fishery and limnological survey of an oligotrophic lake in northeast Washington. Eastern Washington University.

Duties:

Currently is the Project manager for the Chief Joseph Kokanee Enhancement Project, Lake Roosevelt Fisheries Evaluation Project and Sturgeon Recovery Project for the Colville Tribes Fish and Wildlife Department. Primary responsibilities include: management of all assigned fishery projects, planning, developing, designing, and oversight of professional biological studies, research, or resource assessments and completes analysis for written reports and/or publication. Participates as a Lake Roosevelt co-manager and helps develop management plans that work towards measureable goals and objectives. For BPA projects, develops and uploads SOW, budgets, inventories and quarterly and final reports into PISCES and coordinates these and other activities with COTR.

Richard S. Brown, Ph. D, Pacific Northwest National Laboratory

Dr. Brown has extensive experience studying riverine salmonids and is a leading expert in the field of winter ecology. He has years of experience refining methods to observe and study fish during the very challenging winter season. Also, he has a major interest in the interactions between fish and groundwater and examining the different challenges fish face during winter in groundwater influenced habitats as compared to ice covered areas. Dr. Brown also has nearly two decades of experience using radiotelemetry. Dr. Brown has extensive experience researching spawning behavior and migratory patterns of salmonids. He is also a leading expert on techniques used to implant transmitters in fish and on tag effects.

Education:

Doctor of Philosophy, December 1999**:** Biology, University of Waterloo, Waterloo, Ontario
Master of Science, June 1994: Zoology, University of Alberta, Edmonton
Bachelor of Science, December 1988: Wildlife and Fisheries Sciences, South Dakota State University, Brookings

Work Experience:

2002 – present Senior Research Scientist, Ecology Group, Pacific Northwest National Laboratory
2000-2002 Post-doctoral fellow, Ecology group, Pacific Northwest National Laboratory, Richland, WA.
1993-96 Owner, FRM Environmental Consulting Ltd., Edmonton, AB

Most relevant publications

Brown, R. S. 1999. Fall and early winter movements of cutthroat trout, *Oncorhyncus clarki*, in relation to water temperature and ice conditions in Dutch Creek, Alberta. Environmental Biology of Fishes 55:359-368.

Brown, R. S. and W. C. Mackay. 1995. Fall and winter movements of and habitat use by cutthroat trout in the Ram River, Alberta. Transactions of the American Fisheries Society 124:873-885.

Brown, R. S. and W. C. Mackay. 1995. Spawning ecology of cutthroat trout (*Oncorhyncus clarki*) in the Ram River, Alberta. Canadian Journal of Fisheries and Aquatic Science 52:983-992.

Brown, R. S., G. Power, and S. Beltaos. 2001. Winter movements and habitat use of riverine brown trout, white sucker, and common carp in relation to flooding and ice break-up. Journal of Fish Biology 59:1126-1141.

Brown, R. S., G. Power, S. Beltaos, and T. A. Beddow. 2000. Effects of hanging ice dams on winter movements and swimming activity of fish. Journal of Fish Biology 57:1150-1159.

DuPont, J. M., R. S. Brown, and D. R. Geist. 2007. Outlet spawning behavior of bull trout in the Pend Oreille drainage, Idaho. North American Journal of Fisheries Management 27:1268-1275.

Mueller, R. P., R. S. Brown, H. Hop, and L. Moulton. 2006. Video and acoustic camera techniques for studying fish under ice: a review and comparison. Reviews in Fish Biology and Fisheries 16:213-226.

Power, G., R. S. Brown, and J. G. Imhof. 1999. Groundwater and fish - insights from northern North America. Hydrological Processes 13:401-422.

Eric W. Oldenburg, Pacific Northwest National Laboratory

Academic Background

- Master of Science in Biological Sciences. Montana State University, Bozeman, Montana. 2008.
- Bachelor of Science in Biological Sciences. Montana State University, Bozeman, Montana. 2004.

Employment

2007-present: Fisheries Research Scientist, PNNL, Richland, WA.
2005-2007: Graduate Research Assistant, M.S., MSU, Bozeman, MT
2003-2004: Fisheries Research Technician, Montana State University, Bozeman, MT
2002: Fisheries Fieldworker, Montana Fish, Wildlife & Parks, Lewistown, MT
1998-2001: Range Technician, U. S. Fish and Wildlife Service, multiple locations

Awards

- C.J.D. Brown Memorial Award, Montana State University (2004)

Professional Societies

- American Fisheries Society (AFS; 2003-present)
- Montana Chapter of the American Fisheries Society (2003-2007)
- Montana State University student sub-unit of the AFS (2004-2007)
- Vice President, MSU AFS (2005)

Research

- Comparative performance of acoustic tagged and passive integrated transponder tagged juvenile Chinook salmon. Pacific Northwest National Laboratory, Richland, WA.
- Effects of acclimation on post-stocking dispersal of age-1 pallid sturgeon. Montana State University, Bozeman, MT.
- Trammel net efficiency for sampling juvenile pallid sturgeon and shovelnose sturgeon. Montana State University, Bozeman, MT.

Publications

Guy, C. S., E. W. Oldenburg, and P. C. Gerrity. *In press*. Conditional capture probability of Scaphirhynchus spp. in drifting trammel nets. North American Journal of Fisheries Management.

Sheri L. Sears, Colville Confederated Tribes Fish and Wildlife.

Education:
Eastern Washington University, 1995, B.S. Environmental Biology
Kaiser Foundation School of Nursing, 1972 R.N. ICU CCU Certified
Contra Costa College, California, 1972 A.A.S. Nursing

Employment History:
July 2006 – Present ~ Colville Confederated Tribes, Resident Fish Division Manager Biologist IV

November 2001 – June 2006 ~ Colville Confederated Tribes, Lake Roosevelt Habitat Improvement Project Manager Biologist II

June 1999 – November 2001 ~ Colville Confederated Tribes, Habitat Biologist I

March 1999 – June 1999 ~ USGS – Biological Division, Rufus Woods Total Dissolved Gas Impact Assessment Project Field Biologist

September 1997 – November 1998 ~ Steven County Conservation District, Field Technician Stream surveys Steven's county watersheds.

1996 –1997 ~ Department of Ecology, ERO, Environmental Intern - Worked with Washington State Attorney General on development of Grass Seed burning ban and developed library of literature to support rule decision.

March 1995 – July 1995 ~ Waste Water Treatment Intern City of Cheney, Tested effluent and wrote manual on identification of aquatic organisms beneficial to waste water treatment.

Professional Affiliations:

2009 - President of the Columbia Basin Fish and Wildlife Authorities (CBFWA) Resident Fish Advisory Committee
2008 – Vice President of the Columbia Basin Fish and Wildlife Authorities (CBFWA) Resident Fish Advisory Committee
2007 – Present - Columbia Basin Water Management Plan representative and conducted assessment for EIS on proposed actions impacts to Lake Roosevelt.
2006 – Present - CCT Representative Lake Roosevelt Managers
2008 - Present - Member of Army Corp of Engineer's (USACE) Technical Management Team (TMT) working with the Bureau of Reclamation (BOR), USACE, various tribes, and the states of Washington, Oregon, Idaho, and Montana on Columbia River and Snake River dam operations and flow coordination
2003 – Present - Wildland Fire Situation Analysis (WFSA) Team Leader
2001 – Present - Burned Area Emergency Rehabilitation (BAER) Team – Wildfire impacts to fish and wildlife and documentation of Emergency Stabilization and Rehabilitation Plans for all fires on the Colville Reservation.
2001 – Present Upper Columbia River Remedial Investigation and feasibility study (RI/FS)

Duties:
Coordinate with state, tribal, federal and international entities on a variety of aquatic and fish management issues. I have worked with other Tribal departments on the development and revision of Tribes' Hydraulic, Forest Practices Act, and Water Quality codes and the review of land use applications. Reviewed, prepared, and approved all hydraulic permit applications for activities on the Colville Reservation and have completed multiple Environmental Impact Statements (EIS), biological assessments, NEPA compliance documentation, and worked extensively with Global Information System (GIS) mapping and analysis (ArcView, ArcMap, and Terrain Navigator). Provided assistance in the development and review of the Tribe's Integrated Resource Management Plan, the EIS, Record of Decision (ROD), and the Tribe's Fish and Wildlife Management Plan.

Responsibilities include project, personnel, and budget management and daily operations of BPA project. Prepared quarterly and annual reports developed scope of work and conducted field data collection on fish migration, habitat conditions, stream surveys, water quality and statistical analysis of data. Development, management, and implementation of multiple habitat and passage projects and obtained all necessary permits and environmental compliances under BIAM 30 and National Historic Preservation Act. Developed protocols and quality assurance plans,