Mainstem Methow habitat effectiveness monitoring of stream restoration: Study Plan update for FY2011 and FY2012

Pre-treatment phase: October 2008—May 2013
Post-treatment phase: June 2013--September 2015

Background, Questions, Assumptions, Hypotheses, Objectives, and Tasks

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Background

River restoration projects are becoming widely implemented throughout the Pacific Northwest and other regions in the U.S. (Bernhardt et al. 2007); however, project monitoring has rarely been conducted in scientifically valid experimental designs and timeframes (Katz et al. 2007). Monitoring is of critical importance to inform future restoration efforts and project designs, and it is in need of more practice and research. In their survey of restoration projects in the Pacific Northwest representing expenditure of hundreds of millions of dollars, Rumps et al. (2007) concluded that we know little about the effectiveness of restoration projects for fish because of inadequate investment in monitoring. While many projects are being conducted with the goal of improving riverine habitat for fish, Katz et al. (2007) show that most of these projects lack designs to link restoration actions with the response of the targeted species.

Without incorporation of an appropriate spatial and temporal context to assess the potential fish response, the real effectiveness of the restoration efforts could be under or over estimated (Cooper and Mangel 1999, Isaak and Thurow 2006). Due to fish behavior and the linear dependence of riverine communities, the effects of restoration projects should be expected to extend beyond the limits of the restoration project. The connectivity between spawning and rearing life stages of anadromous salmonids can link widely dispersed habitat areas (Kocik and Ferreri 1998, Mangel et al. 2006). Focusing entirely on the reach level can yield little or misleading information about the scale that fish populations are affected (Fausch et al. 2002).

What constitutes effective restoration for salmonids needs to be assessed by how it improves existing habitat and biotic linkages (Jansson et al. 2007, Lake et al. 2007), but this needs to be considered within the historical capacity for habitat linkage within a system (McKean et al. 2008). As a word of caution, Rahel (2007) explains how efforts to connect habitats can go wrong if the habitats reconnected were separated by true biogeographical barriers that preceded human intervention, or when a renewed linkage allows access by a subsequently established invasive species. With the depletion of target species over several decades, other native fish and aquatic species may have become more prominent. It is possible that the subsequently established community could offer a degree of biotic resistance (Ward et al. 2008) and limit the reintroduction or enhancement of formerly prominent target species.

Our primary goal is to measure the response of target fish species (steelhead, Chinook salmon) to an intensive stream restoration project planned by Reclamation in 2014. Because we wish to measure the response of highly mobile fish populations, fish sampling will need to extend beyond the bounds of the restoration project. We have identified reasonable bounds for initial sampling based on the geomorphic characteristics of the Methow system (Reclamation, unpublished data) and on recent literature regarding the extent of spatial relationships for fish species important to the restoration efforts in the Methow watershed: Chinook (Isaak and Thurow 2006, Neville et al. 2006, McKean et al. 2008), steelhead (Hendry et al. 2002), and bull trout (Baxter and Hauer 2000, Rieman and Dunham 2000). Sampling of fish in similar unconstrained reaches upstream and downstream of the project area, and constrained areas between these reaches, will allow an assessment of the role of habitat size and connectivity. In recognition of the potential scale needed to assess the fish response (Fausch et al. 2002, Schick and Lindley 2007, McKean et al. 2008), the project reach will be surrounded with fish monitoring devices (e.g., smolt traps, PIT tag interrogation systems) to detect movement in and out of the project area. We will collaborate with existing fish monitoring efforts within the Methow. With funding from Douglas County PUD and NMFS, biologists from the Washington Department of Fish and Wildlife (WDFW) will be simultaneously conducting smolt trapping, PIT tagging, and detecting PIT tagged fish with PIT tag interrogation systems in the mainstem Methow and lower Twisp River. We plan to collaborate with biologists from Yakama Nation, who are planning to conduct nutrient enhancement studies to test effect on fish production. These activities will benefit data collection and result in cost efficiencies for both projects.

Study design protocols developed by the action agencies for effectiveness monitoring research (Hillman and Giorgi 2002, Hillman 2003) require that studies adhere to statistically valid study designs that implement treatment and control sites and/or a pre- and post-treatment design. This project incorporates the statistical rigor called for by Isaak and Thurow (2006), and it uses a set of validated methods of evaluation and reporting called for by Palmer et al. (2005). Information gained from this intensive and extensive project will help ensure that the millions of dollars planned to implement riverine restoration in the Methow watershed and the greater Pacific Northwest will be available for adaptive learning. A key question for the region that will be addressed is: Can large river restoration efforts be effective enough to meet Reclamation's fisheries enhancement goals as required by the NMFS's Federal Columbia River Power System Biological Opinion?

The degree of retention of natal fish and amount of movement from and into a stream reach are important indicators of the value of the reach to fish production (Harvey 1998). Longitudinal differences in habitat availability, food availability, stream temperature, and predation risk within a stream present habitat and bioenergetic heterogeneity for fish survival and growth. These differences can also exist between tributary habitats and downstream mainstem river habitat. This heterogeneity promotes differential potential for survival and growth between those fish that remain in natal areas and those that move upstream or downstream to new habitat. Van Horne (1983) showed that abundance and density can be misleading indicators of habitat quality, especially for fish that are territorial, such as steelhead, Chinook, and bull trout. Increase in abundance and density may not be the primary response to improved habitat conditions. To measure the effects of restoration efforts on habitat quality and productivity, we will use retention (Harvey 1998) and movement (Winker et al. 1995) data in conjunction with abundance and density data. To assess differential biological performance, we will compare age structure, growth, and age at smolting between those fish that stay in natal areas versus those fish that move. To assess retention in, and movement from or into, the restoration reach, we will use a combination of within reach and out-of-reach sampling. We will use PIT tags, a network of instream PIT tag interrogation systems, and smolt traps to assess differences in biological performance and the magnitude of retention in, and movement from and into, the restoration reach.

Update for 2011-2012: Throughout the rest of this document, the original text, but not primary headings, of the January 2009 Statement of Work was set in italics to differentiate it from the text that has been added for this updated Statement of Work. The questions, assumptions, and hypotheses presented in the 2009 Statement of Work remain unchanged. No new Objectives were added, but some new tasks were added and some tasks were revised. These changes in the tasks were prompted from the assessment of the adequacy and breadth of the progress made since January 2009 and the data gathered since 2008 (Data gathered in 2008 helped formulate the January 2009 Statement of Work). A description of progress is offered for 2009 and 2010 to give the reader context for the reason behind some of the changes planned for 2011 and 2012.

Below we present key questions, assumptions, and hypotheses for this study.

Questions (Q)

The pre-treatment phase of the project is designed so that specific questions about the response of target fish species (Chinook, steelhead, and bull trout) to the restoration actions can be addressed. During the pretreatment phase, we will conduct modeling to predict response to treatment, and we will update the model with empirically-derived data as these data become available. This modeling effort is expected to inform us about data gaps, sensitivity of key variables, and ability to detect response based on variability of data. The primary questions we intend to address are:

Q1) What is the difference in habitat availability and suitability between the restoration reach and geomorphically similar reaches upstream and downstream?

Q2) What is the difference in fish productivity between the restoration reach and geomorphically similar reaches upstream and downstream?

Q3) Will and did the implementation of the project in the restoration reach increase stage-specific survival of target fish species?

Q4) Will and did the implementation of the project in the restoration reach increase parr and/or smolt production?

Q5) Was the response of the target species large enough to make a difference in the probability of their persistence in the Methow watershed?

As a part of this study, we will collaborate with a graduate student, Ryan Bellmore of Dr. Colden Baxter's laboratory at Idaho State University, to address key components of the food web dynamics in the restoration reach prior to restoration. Three of the important questions that he will address are:

Q6) How much food is currently available to fuel fish production?

Q7) How does food availability compare to the demand by fish for those resources?

Q8) How much additional fish production could be supported in the restoration segment of the Methow River via the restoration of off-channel habitats?

Assumptions (A)

Several assumptions are inherent in our approach to ensure that these questions can be answered after implementation of the restoration actions:

A1) Current fish productivity in the restoration reach is limited by reach-specific habitat conditions. [Limiting factors concept]

A2) The primary factors contributing to pattern and magnitude of growth of fish are stream temperature, food quantity, and food quality. [Bioenergetics concept]

A3) Growth of juvenile fish is a determinant of age at smolting and degree of residualism. [Bioenergetics concept]

A4) Degraded longitudinal and lateral habitat connectivity and life-stage connectivity are currently limiting fish production. [Connectivity concept]

A5) The restoration reach does or could provide an important rearing capacity for juvenile fish spawned within the reach ("natal") and for fish spawned elsewhere in the Methow watershed ("non-natal"). [Connectivity concept]

A6) Production of target fish species relies on longitudinal connectivity with other spawning and rearing areas. [Connectivity concept]

A7) The restoration effort will substantially increase the habitat quality and degree of lateral connectivity with the floodplain. [Implementation success]

A8) Past and current hatchery management practices for production of steelhead and Chinook may limit response to restoration efforts depending on the remaining genetic diversity in the Methow system. [Biotic resistance concept: wild and hatchery fish interactions]

A9) Presence and response of existing non-target fish and aquatic species could limit the response of the targeted fish species to the restoration actions. [Biotic resistance concept: aquatic community interactions]

Hypothesis (H)

Our "working hypotheses" are present below in roughly the chronological order that they will be addressed during the life of the project.

Role of habitat in fish productivity and expression of anadromy

H1: Pre-treatment expression of anadromy is limited by current physical habitat conditions within the treatment reach. [Limiting factors concept]

H2: Pre-treatment growth of parr and/or age at smolting is limited by temperature and/or food. [Bioenergetics concept]

H3: Pre-treatment fish growth, survival, and expression of anadromy are limited by lack of connectivity of habitats within the treatment reach. [Intra-connectivity concept]

H4: Pre-treatment fish growth, survival, and expression of anadromy are limited by lack of connectivity of habitats between the treatment reach and neighboring stream reaches. [Inter-connectivity concept]

Effectiveness of restoration for increasing fish productivity and expression of anadromy (Pre vs Post Treatment)

H5: Restoration efforts increased capacity for targeted fish species by improving and/or increasing spawning and rearing space in the restoration reach. [Limiting factors concept]

H6: Restoration efforts increased capacity for targeted fish species by improving thermal properties and/or food production in the restoration reach. [Bioenergetics concept]

H7: Restoration efforts improved survival of natal parr: Parr that are natal to the restoration reach but move, downstream or upstream, have similar or different growth, age structure at smolting, and survival to those that stay in this section. [Intra-connectivity concept]

H8: Restoration efforts improved survival of non-natal parr: Parr that move from other natal areas and into the restoration reach have similar or different growth, age structure at smolting, and survival to those that stay in their natal area. [Inter-connectivity concept]

H9: Past or current hatchery management practices did not limit the response of the targeted fish species. [Biotic resistance concept: wild and hatchery fish interactions]

H10: Response from other members of the fish assemblage (e.g., non-anadromous rainbow trout, mountain whitefish, brook trout, and sculpin) and other members of the aquatic community (e.g., competitors, predators) did not limit the response of the targeted fish species. [Biotic resistance concept: aquatic community interactions]

Project-Specific Objectives and Tasks

A list of the major activities and planned in 2009-2014 is provided in Table 1. The location and timing of the activities is presented in Table 2 and under the objective or task where appropriate. The general location of the "restoration reach" referred to below is that portion of the mainstem Methow River labeled as "M2" (rkm 66-79) in Figure 1. Two reference reaches have been identified based on relative lack of disturbance, proximity to the restoration reach, and relative unconfined geomorphology: 1) Upper Methow River (the unconfined reach within Big Valley and downstream of Wieman Bridge, rkm 85-90), and 2) Chewuch River (rkm 4-11). A control reach has been identified based on similar disturbance as that found in the restoration reach, proximity to the restoration reach, and relative unconfined geomorphology: mainstem Methow River downstream of the restoration reach (rkm 57-64).

Update for 2011-2012: Based on findings and experience gained in the last three years, 2009-2010, some changes to the original Study Plan, which was submitted in January 2009, are described below for the next two years, 2011-2012.
A description of progress during the past two years is offered as well to give the planned changes the necessary context. The original task elements are in italics to differentiate them from the planned changes for 2011 and 2012.

A. Determining the importance of connectivity to fish production: downstream, upstream, and lateral

Objective 1. Assess productivity and connectivity of the restoration reach and neighboring reaches, and their tributaries, with emphasis on target fish species Chinook, steelhead, and bull trout.

Task 1.1. *Conduct continuous fish snorkeling surveys in the restoration, reference, and control reaches multiple times within the year.*

Timing: March 2009-September 2010.

Methodology: In the reference reach, conduct snorkel efforts multiple times during the year: one time in March before high flows, one time in July after high flows, two times per month during August and September, and one time during October and November. In the reference and control reaches, the snorkel efforts will be conducted once during the months of March, August, September, and October. A continuous sampling approach within 5 km of stream will be conducted, from upstream to downstream counting fish over 150 mm in length, largely following protocols developed by Brenkman and Connolly (2008), which corresponds with previous work by Torgersen et al. (1999), Torgersen (2002), and Fausch et al. (2002).

Progress: *2009:* Snorkel surveys were conducted at four sites: M2 reach, Chewuch River, Upper Methow River, and Lower Methow River. The M2 reach was sampled seven times, once in March, once in July, once every other week from August through September, and once in October and November. The Chewuch River, Upper Methow, and Lower Methow were sampled four times (July, once during August/September, October, and November). Surveys were conducted by crews of three to four snorkelers and completed within a single day's effort. A description of location of sites and the effort expended are presented in Attachment 2: Table 2.1.

2010: Snorkel surveys were conducted at the same four sites sampled in 2009 (M2 reach, Chewuch, Upper Methow, and Lower Methow). The M2 reach was sampled five times, once in March, once in July, once in August, and two times in September. The Chewuch, Upper Methow, and Lower Methow sites were sampled two times (July, September). Surveys were conducted by crews of three to four snorkelers and completed within a single day's effort. Data are currently being entered and compiled.

Task 1.1 (updated plan for 2011 and 2012). Conduct fish snorkeling surveys at established sections in the restoration, reference, and control reaches multiple times within the year.
Timing: August 2011-October 2012.
Methodology: Snorkel surveys will be conducted at four sites: the treatment reach (M2), two reference reaches (Chewuch, Upper Methow), and the control reach (Silver Reach of the Lower Methow). These surveys will be done twice each month in August and September, and once in October, for a total of five times a year at each site.

Task 1.2. *Conduct point-abundance surveys at fixed-sites by electrofishing in the restoration, reference, and control reaches multiple times within the year.*
Timing: March 2009-September 2010.
Methodology: We will sample three sections of treatment reach (upper, middle, lower) and one section in the reference and control reaches. In each section of the reaches, we will sample stream margins of one bank of a contiguous section of three pools and three non-pools. These surveys will be conducted multiple times during the year: one time in March before high flows, one time in July after high flows, and one time in late September or October. This approach is largely derived from Connolly and Brenkman (2008), which corresponds with previous work by Janac and Jurajda (2007) and Quist et al. (2006).
Progress: *2009:* Point-abundance surveys were conducted at three sites in the M2 reach and one location in the Chewuch River, Upper Methow, and Lower Methow. Point abundance surveys were conducted one time in March, July, and September. All individual sites were completed in a single day's effort. For each site, we sampled a minimum of three pool and three non-pool habitat units at each site. Data entry and analysis have been initiated.
2010: Point-abundance surveys were conducted at three sites in the M2 reach and one location in the Chewuch River, Upper Methow, and Lower Methow. Point abundance surveys were conducted one time in March and September. All individual sites were completed in a single day's effort. For each site, we sampled a minimum of three pool and three non-pool habitat units at each site. Data entry and analysis have been initiated.

Task 1.2 (updated plan for 2011 and 2012). Conduct point-abundance surveys at fixed-sites by electrofishing in the restoration, reference, and control reaches multiple times within the year.
Timing: March 2011-October 2012.
Methodology: We will sample three sections of the M2 treatment reach (upper, middle, lower) and one section in the reference (Chewuch, Upper Methow) and control reaches (Silver Reach of the Methow). These surveys will be conducted multiple times during the year: one time in March before high flows, one time in July after high flows, and one time in late September or October. One addition to these surveys will be to extend sampling beyond the established downstream and/or upstream limits of the Point Abundance sites in an attempt to get more age-0 fish to the hand. All fish captured in the extended sampling areas will be tracked separately from those captured at the established sites. These extra fish to the hand are sought to help with seasonal growth analysis of age-0 fish with enhanced length-frequency data.

Task 1.3. *Conduct mark-recapture and/or pass-removal electrofishing surveys to derive fish assemblage, abundance, and density estimates in 4-6 side-channels, including the side-channels chosen for install of PIT tag interrogation systems (see Task 1.5).*
Timing: July 2009-September 2010.
Methodology: Mark-recapture will follow PNAMP protocols (http://www.pnamp.org/web/workgroups/documents.cfm#18, accessed 4 February 2008). Pass-removal methodology will follow Connolly (1996), Peterson et al. (2004), and Martens and Connolly (2008). Just prior to these sampling efforts, we will conduct intensive habitat

surveys of sampling sections. The data collected during these intensive surveys will include habitat type (e.g., pool, glide, riffle), habitat unit dimensions (length, width, maximum depth), and instream and overhead cover.

Progress: *2009:* Multiple pass-removal population estimates were performed on five side channels: three in the M2 reach (SC-1, SC-2, and SC-3) and two in the Upper Methow River (SC-4 and SC-5). Side-channel sampling for population estimates were conducted in June, August, and October. On sections of the side channels that were too deep for multiple pass-removal population estimates, we used mark-recapture or snorkeling to gain estimates. Data entry and analysis have been initiated.

2010: Multiple pass-removal population estimates were performed on 10 side channels: 4 in the M2 reach, 3 in the Upper Methow, 2 in the Chewuch River, and 1 in the M3 (Silver) reach. Side-channel sampling for population estimates were conducted in March (only in the 5 side channels sampled in 2009), August (all 10 side channels), and September/October (all 10 side channels). On sections of the side channels that were too deep for multiple pass-removal population estimates, we used mark-recapture or snorkel to gain estimates. Data entry and analysis have been initiated.

Task 1.3 (updated plan for 2011 and 2012). Conduct mark-recapture and/or pass-removal electrofishing surveys to derive fish assemblage, abundance, and density estimates in 10 side-channels at multiple times per year, including the side-channels chosen for install of PIT tag interrogation systems (see Task 1.5).

Timing: March 2011-October 2011.

Methodology: Mark-recapture will follow PNAMP protocols (*http://www.pnamp.org/web/workgroups/documents.cfm#18*, accessed 4 February 2008). Pass-removal methodology will follow Connolly (1996), Peterson et al. (2004), and Martens and Connolly (2008). Just prior to these sampling efforts, we will conduct intensive habitat surveys of sampling sections. The data collected during these intensive surveys will include habitat type (e.g., pool, glide, riffle), habitat unit dimensions (length, width, maximum depth), and instream and overhead cover. Surveys will be conducted at each of the 10 side channels 3 times each year: in March, late July/August, and late September/October.

Task 1.4. *Conduct mark-recapture and/or pass-removal electrofishing surveys to derive fish assemblage, abundance, and density estimates in one reach (500-1000 m) in each of two tributaries chosen for install of PIT tag interrogation systems in reference reaches upstream of the restoration reach (Wolf and Eightmile creeks are primary candidates) and in two tributaries that enter below the restoration reach (Beaver, Gold, and Libby creeks are primary candidates).*

Timing: March 2009-September 2010.

Methodology: Methods used will be identical to those described in Task 1.3. As envisioned, Beaver Creek will be sampled each year, and it will be combined with Gold Creek (2008 [completed], 2010) and Libby Creek (2009, 2011) in alternating years.

Progress: *2009:* We conducted population assessments by multiple pass-removal in Eightmile, Wolf, and Beaver creeks. Due to increased M2 sampling and the addition of extra side channel population surveys, we were not able to conduct a second survey below the restoration reach, originally planned for Libby Creek. Data entry and analysis have been initiated.

2010: We conducted population assessments by multiple pass-removal in Wolf Creek, Libby Creek, and two sites in Beaver Creek. Due to high water in the fall, we could not sample Eightmile Creek, so we replaced Eightmile Creek with Libby Creek. Data entry and analysis have been initiated.

Task 1.4 (updated plan for 2011 and 2012). Conduct mark-recapture and/or pass-removal electrofishing surveys to derive fish assemblage, abundance, and density estimates in a 500-m section of Wolf and Eightmile creeks and in two reaches of Beaver Creek.
Timing: March 2011-September 2012.
Methodology: Methods used will be identical to those described above in Task 1.3 (updated plan for 2011 and 2012).

Task 1.5. *Install and run three PIT tag interrogation systems (PTIS; with multiple antennas and multiplex capability) at key locations above and below the treatment reach: 1) in the mainstem Methow River just above its confluence with the Chewuch River, 2) in the Chewuch River near its mouth, and 3) in the mainstem Methow River just above its confluence with the Twisp River.*
Timing: Install two systems by September 2009, install additional system by September 2010; maintain all through September 2014.
Methodology: See Figure 1 for a general depiction of where these PTIS will be installed. Installs are expected to be similar to those described by described in Martens and Connolly (2008), and data procurement will follow recommendations of Connolly et al. (2008). These interrogators will be maintained for continuous operation throughout the year. Stationary PIT-tag readers offer the potential for full-year, everyday monitoring of fish movement in and out of a stream system (Armstrong et al. 1996; Nunnallee et al. 1998; Zydlewski et al. 2001, 2006; Connolly et al. 2005). Efficiency of detection is expected to vary with size of the PIT tag unit, site characteristics, and size of the system. Following Connolly et al. (2008), estimates of detection efficiency will be determined when and where feasible. The amount of detection efficiency achieved will guide us as to how many PIT tags we will need to deploy in order to adequately detect an acceptable level of change in various fish metrics as a result of stream restoration (see Task 2.1 for more information on planned power analyses).
Progress: *2009:* We built and installed two multiplexing PIT tag interrogator systems. One was installed on 28 September 2009 in the downstream end of the M2 reach of the Methow River, just above the confluence with the Twisp River (rkm 65), and the other was installed on 21 September 2009 in the upper Methow River next to the U.S. Fish and Wildlife Service's (USFWS) Winthrop National Fish Hatchery (rkm 81). Both sites were up and running during this performance time and detected fish (Attachment 2: Table 2.2).

2010: We built and installed a multiplexing PIT tag interrogator in the Chewuch River. Because high water in spring 2010 uprooted and destroyed some antennas, we had to rebuild and install portions of the Chewuch and M2 sites. Because of high noise at the hatchery site, we moved the Upper Methow system upstream to just below Wolf Creek in September 2010. All sites are currently up and running in good condition. All sites are registered and all data are being uploaded into PTAGIS. We collaborated with USFWS to use releases of PIT-tagged hatchery steelhead smolts for tests of efficiency at various flow levels in spring 2010.

Task 1.5 (updated plan for 2011 and 2012). Maintain and assess efficiency of three multiplexing PIT tag interrogation sites formerly installed in the upper Methow, Chewuch, and M2 sites in 2009-2010.
Timing: October 2010-September 2012.
Methodology: Following Connolly et al. (2008), estimates of detection efficiency will be determined when and where feasible. We plan to continue collaborating with USFWS to use releases of PIT-tagged hatchery steelhead smolts for testing efficiency of the interrogation systems at various flow levels in spring.

Task 1.6. *Install and run small PIT tag interrogation systems (with single antennas) in side-channels of the restoration and reference reaches.*

Timing: July 2009-September 2014.

Methodology: We plan to install these small PIT tag interrogators in at least four side channels, at least two within the restoration reach and at least two within a reference reach. See Figure 1 for a general depiction of where these PTIS will be installed. As with the larger PTIS described in Task 1.5, these interrogators will be maintained for continuous operation throughout the year, and estimates of detection efficiency will be determined when and where feasible.

Progress: *2009:* We installed two single-antenna PIT tag interrogators in a side channel (SC-2) in the M2 reach (Table 2.2, Figure 1). We installed a single-antenna PIT tag interrogation systems in side channel SC-3 of the M2 reach and in two side channels in the Upper Methow (Attachment 2: Table 2.2, Figure 2.2).

2010: We maintained five single-antenna PIT tag interrogation systems in side channels: three in two side channels in the M2 reach and one each in two side channels in the Upper Methow. Due to high water and loss of antennas, we did not have any antennas in SC-2 and SC-3 by year's end. In addition, we lost one antenna in the SC-4 side channel due to theft. We plan to replace antennas in March 2011 before the onset of high water in the side channels.

Task 1.6 **(updated plan for 2011 and 2012).** Maintain five single-antenna PIT tag interrogation systems in four side-channels, and add additional single-antenna systems when feasible.

Timing: October 2010-September 2012.

Methodology: As with the larger PTIS described in Task 1.5, these interrogators will be maintained for continuous operation throughout the year (when sites are wetted), and estimates of detection efficiency will be determined when and where feasible. We will add antennas when and if funding is available to do so.

Task 1.7. *Maintain and manage data from four existing PIT tag interrogation systems in lower Methow tributaries: one in lower Beaver Creek, one each in lower Libby, and two in lower Gold creeks.*

Timing: March 2009-September 2014.

Methodology: These systems and locations are described in Martens and Connolly's (2008) report. The PIT tag detections by these systems have shown a high degree of habitat-use connectivity between upstream mainstem Methow reaches and lower Methow tributaries for juvenile and adult steelhead and Chinook. See Figure 1 for general location. As with the PTIS described in Task 1.5 and 1.6, these interrogators will be maintained for continuous operation throughout the year, and estimates of detection efficiency will be determined when and where feasible.

Progress: *2009:* All four existing single-antenna, PIT tag interrogation systems were maintained in 2009. Sites were visited one to two times a week to change batteries and download batteries. Data were uploaded monthly to the PTAGIS website. Additional single-antenna PIT tag interrogators were installed and maintained in Eightmile and Wolf creeks (Attachment 2: Table 2.2).

2010: All six existing single-antenna, PIT tag interrogation systems were maintained in 2010. With funding and collaboration of USFS, we were able to add an additional system in Eightmile Creek just above a small falls, which is helping us assess the use of the stream above the falls by anadromous and fluvial adult fish. Sites were visited one to two times a week to change batteries and download batteries. Data were uploaded monthly to the PTAGIS website. In late September, we removed the South Fork Gold PIT tag interrogator and moved it to Beaver Creek Reach 2 (rkm 12).

Task 1.7 (updated plan for 2011 and 2012). Maintain and manage data seven single-antenna PIT tag interrogation systems in Methow tributaries: one in lower Libby Creek, one in lower Gold Creek, two in Beaver Creek, two in Eightmile Creek, and one in Wolf Creek.
Timing: October 2010-September 2012.
Methodology: These systems and locations are described in Martens and Connolly's (2008) report. The PIT tag detections by these systems will be used to assess habitat-use and connectivity between upstream mainstem Methow reaches and Methow River tributaries for juvenile and adult steelhead and Chinook. As described in Task 1.5 and 1.6, these interrogators will be maintained for continuous operation throughout the year, and estimates of detection efficiency will be determined when and where feasible.

Task 1.8. *Install and run a rotary screw trap in the Chewuch River upstream and near its confluence with the Methow River.*
Timing: July-November 2009; March-November 2010-2014.
Methodology: We will check the trap on a daily basis. All fish will be identified, measured for length and width (a subsample may be derived on large catch days), all or some PIT tagged, and released. To test capture efficiency, we will mark fish (largely with PIT tags), and release fish over a 100 m upstream in order to have a chance to catch them again and calculate recapture rate.
Note: The budgeting for this task assumed a 5-foot rotary screw trap will be available from Reclamation. Season and hours per day of trapping will largely depend on state and federal permit limitations.
Progress: *2009:* We installed a rotary screw trap in the Chewuch River on 21 July 2009. The trap was attached to the Hwy 20 Bridge in the town of Winthrop, Washington (Attachment 2: Figure 2.1). The trap was operated for one week and ceased when slow water rendered the trap unusable. Flow conditions limited trap use at the site until late fall. In 2009, we were able to operate the trap for 21 days. We collected 84 longnose dace, 75 Chinook, 13 rainbow trout/steelhead, 7 cutthroat trout, and 4 bridgelip suckers (Attachment 2: Table 2.3). In November, the trap was removed due to ice.

2010: We installed the rotary screw trap in the Chewuch River on 4 March 2010 at the same site used in 2009. The trap was check daily from until 21 April 2010, when it was removed due to high water. The trap was deployed again on 3 May 2010 and ran through 12 May 2010, until high water rendered the trap unsafe for fish and humans. The trap was redeployed on 7 July 2010 and ran from Monday through Friday each week until 27 August 2010, when the trap was removed due to low fish numbers. The trap was redeployed in October and operated through 18 November 2010, when it was pulled before pending ice-up. In an effort to assist WDFW, we performed periodic tests of efficiency by releasing freshly captured and PIT tagged fish upstream of the trap.

Task 1.8 (updated plan for 2011 and 2012). Install and run a rotary screw trap in the Chewuch River upstream and near its confluence with the Methow River.
Timing: March-November 2011-2012.
Methodology: We will check the trap on a daily basis March through July. We will operate the trap Monday-Friday from August through November when flows allow. All fish will be identified, measured for length and width (a subsample may be drawn on large catch days), all or some PIT tagged, and released. To test capture efficiency, we will mark fish (largely with PIT tags), and release fish upstream at selected times during the year.

Task 1.9. *Insert PIT tags in fish caught during electrofishing (see Task 1.2-1.4), smolt trapping (see Task 1.8), or other means (e.g., seining, angling). Total PIT tags expected to insert is about 5,000-6,000 per year. Species to be tagged include: Chinook, coho, steelhead, rainbow trout, bull trout, cutthroat trout, whitefish, and brook trout.*

<u>Timing:</u> March 2009-September 2014.

<u>Methodology:</u> Both 12-mm and 8-mm tags (full duplex) will be deployed, reserving the 8-mm tags for fish too small to PIT tag with 12-mm tags (e.g., juvenile Chinook between 55-70 mm). All PIT tagging of juveniles will follow the procedures outlined by Columbia Basin Fish and Wildlife Authority (1999). See Table 3 for locations and site-specific numbers. We plan to tag 250-500 steelhead and 250-500 Chinook salmon at each major reach or tributary in the study. Based on projections presented in Attachment 1, tagging 250 individual steelhead or Chinook will, at a minimum, result in information from about 50 or more fish to analyze for smolt age structure and survival. Based on information gathered on realized performance of the PIT tag interrogation systems in 2009, number of recaptured PIT tagged fish, and the variability in the types of data collected for analyses (see Objective 2), we will conduct a power analysis to adaptively assess if we need to enhance the detectability of interrogators, increase effort to recapture PIT tagged fish, and/or increase the number of fish to be PIT tagged (see Task 2.1).

<u>Progress:</u> *2009*: We PIT tagged 3,599 fish of 10 species in the Methow River watershed (Attachment 2: Table 2.3). We collected pre-treatment data on presence and absence, relative abundance, and size and age structure of competitors and predators in tributaries, side channels and mainstem Methow. Sampling was completed using snorkeling, electrofishing, hook and line sampling, and “snetting”. Snetting is a combination of snorkeling with active floating gill nets through pool and glide habitat units. We found snetting to be an effective method for collecting fish >200 mm in the mainstem Methow River. In 2009, we used snetting to collect fish for PIT tagging and diet analysis (see Objective 4) on seven occasions that resulted in 328 mountain whitefish, 51 westslope cutthroat trout, 15 bull trout, and 9 rainbow trout/steelhead. PIT tag data were entered and uploaded into the PTAGIS database.

2010: PIT tags were deployed from 1 March 2010 through 30 September 2010. Sampling was completed using snorkeling, electrofishing, hook and line sampling, and snetting. Data are currently being entered and will be uploaded into the PTAGIS database.

Task 1.9 (updated plan for 2011 and 2012). Insert PIT tags in fish caught during electrofishing (see Task 1.2-1.4), smolt trapping (see Task 1.8), or other means (e.g., seining, angling, and snetting). Total PIT tags expected to insert is about 5,000-6,000 per year. Primary species to be tagged include: Chinook, coho, steelhead, rainbow trout, bull trout, cutthroat trout, mountain whitefish, and brook trout.

<u>Timing:</u> March 2011-September 2012.

<u>Methodology:</u> (No change from that as originally planned)

Task 1.10. *Mark targeted fish species collected in the upper Methow River (reference reach) that are too small to PIT tag with 8-mm tags by an alternative method.*

<u>Timing:</u> October 2008-September 2014.

<u>Methodology:</u> Marking these fish will be an exploratory attempt to assess amount and importance of movement of young-of-year from upper Methow River to the restoration reach downstream. One method we plan to explore is the use of a calcein bath to batch mark these fish (Mohler 2003). It is anticipated that we will be able to mark hundreds of young-of-year steelhead and Chinook by this method, and that we will be able to recapture these fish during subsequent electrofishing and smolt trapping efforts. The degree of movement, growth, and

condition of recaptured fish will be determined to help assess the relative benefits and risks of staying in or moving from natal areas.

Progress: *2009:* As an exploratory project, we marked 34 juvenile *O. mykiss* with calcein treatments on one sampling occasion in July 2009. Fish were clearly identifiable after marking with a dark blanket and calcein reader. No fish were recaptured with a calcein mark. We determined that future sampling should be done earlier in the year when more juvenile fish can be easily collected and marked.

2010: Because of uncertainty of retention and readability of the calcein mark tried in 2009, other methods for tagging fish were explored. Over 800 juvenile Chinook and steelhead were tagged with VIE tags in the Upper Methow and Chewuch River in the spring and early summer. Fish were tagged with pink in the Upper Methow and yellow in the Chewuch River. Two fish were recaptured from the Chewuch River: one in a side channel during our population surveys and one in our screw trap in the lower Chewuch River. Both marks were easy to identify in the late summer.

Task 1.10 (updated plan for 2011 and 2012). Mark targeted fish species collected in the upper Methow River (reference reach) and Chewuch River that are too small to PIT tag with 8-mm tags with VIE tags.

Timing: October 2011-September 2012.

Methodology: We will continue to mark fish too small for PIT tagging with VIE tags to assess movement of young-of-year from upper Methow River to the restoration reach downstream. It is anticipated that we will be able to mark hundreds of young-of-year steelhead and Chinook by this method, and that we will be able to recapture these fish during subsequent electrofishing and smolt trapping efforts. The degree of movement, growth, and condition of recaptured fish will be determined to help assess the relative benefits and risks of staying in or moving from natal areas.

Task 1.11. *Collect and store tissue samples (such as fin clips) for genetic analysis from a subsample of naturally-produced steelhead and Chinook salmon collected during fish sampling efforts.*

Timing: March 2009-September 2014.

Progress: *2009:* Fin clips were taken for genetic samples on 918 fish in 2009 (Attachment 2: Table 2.4). Genetic samples were organized and stored for analysis.

2010: Fin clips were taken for genetic samples in 2010. Genetic samples have been organized and stored for analysis.

Task 1.11 (updated plan for 2011 and 2012). Collect and store tissue samples (such as fin clips) for genetic analysis from a subsample of naturally-produced steelhead and Chinook salmon collected during fish sampling efforts associated with other tasks.

Timing: October 2011-September 2012.

Methodology: (No change from that as originally planned)

Task 1.12. *Collect and archive otoliths from fish mortalities encountered during sampling activities.*

Timing: March 2009-September 2014.

Progress: *2009:* Most fish mortalities were frozen and stored at the USGS's Twisp office. Otoliths can be removed from these samples when needed.

2010: As in 2009, most fish mortalities were frozen and stored at the USGS's Twisp office, and otoliths can be taken from these samples at any time. As part of a companion study, otoliths were gained from mountain whitefish and sculpin in the Upper Methow, Chewuch River, Twisp River, M2, and M3 reaches. Otoliths were taken from sculpin and other resident juvenile fish in the Wells Reservoir. These samples will be sent for micro-chemistry analysis in 2010/2011.

Task 1.12 (updated plan for 2011 and 2012). Collect and archive otoliths from fish mortalities encountered during fish sampling efforts associated with other tasks.
Timing: October 2011-September 2012.
Methodology: (No change from that as originally planned)

Task 1.13. *Install and maintain thermographs at key locations.*
Timing: March 2009-September 2014.
Methodology: Many key locations already have thermographs deployed by various agencies (Reclamation, WDFW, YN, and others). We will assess the adequacy of coverage, and we will install and maintain thermographs at sites identified as gaps. We anticipate that this may require up to 10 additional thermographs.
Progress: *2009:* We maintained 21 thermographs and helped Reclamation to identify and install additional sites during the 2009 field season. Thermographs were downloaded in the spring and then again in fall. Data were maintained in electronic format.
2010: We maintained 21 thermographs with help from Reclamation. Thermographs were downloaded in spring and again in fall. Data were maintained in electronic format.

Task 1.13 (updated plan for 2011 and 2012). Collaborate and assist Reclamation with their effort to maintain thermographs throughout the Methow watershed and to manage the data.
Timing: October 2011-September 2012.

Task 1.14 (new). Assess physical habitat of side channel at different flow levels.
Timing: March 2011-September 2012.
Methodology: Based on pilot work that we conducted in 2009 and 2010, we will take habitat measurements of individual side channels (e.g., length, width, and depth by habitat units such as pools, glides and riffles) every two weeks during periods of changing flow levels in spring and early summer. These surveys will be compared to mainstem flow gages to help with collaborative efforts to model flows by Reclamation, USGS, and Yakama Nation.

Task 1.15 (new). Conduct habitat surveys of stream margins and banks in the M2 and M3 reaches.
Timing: March 2011-September 2012.
Methodology: This will be highly collaborative effort with Reclamation. Key habitat measurements will be identified to characterize stream margins and banks at low water in summer. The field work is expected to be primarily conducted by Reclamation personnel. The USGS will provide technical input, training, and help with analysis.

Task 1.16 (new). Assess predation of fall Chinook eggs by other fish species.
Timing: October 2011-September 2012.
Methodology: Use underwater cameras at summer Chinook redds to record egg predation by other fish species. Catch fish by hook and line near redds to gain diet samples for assessing amount of egg predation. This will be a highly exploratory effort, with methodologies expected to mature through time. These data will be used to complement and enhance food web studies described below (see Objective 4).

B. Measuring the response to restoration

Objective 2. Assess changes in fish population metrics as a result of stream restoration actions in the treatment reach.

Task 2.1. *Assess changes in the following metrics for steelhead and spring Chinook between pre-treatment and post-treatment periods in the treatment, reference, and control reaches:*
Smolt age structure
Annual and seasonal growth of parr (length, mass)
Parr-to-parr survival
Parr-to-smolt survival
Smolt-to-adult survival
Degree of retention of fish natal to the treatment reach
Degree of retention of fish not natal to the treatment reach
Number of smolts produced (from natal fish, and from non-natal fish temporally retained)
Residualism of natal and non-natal wild steelhead
Residualism of hatchery released steelhead (which could be related to habitat availability, and also hatchery practices)

Analysis: As conceived, the sampling design conforms to an asymmetrical, before-after control-impact paired model (BACIP), as described by Smith (2002). A total of three control sites (upstream: Upper Methow, Chewuch; downstream: mainstem Methow reach "M3") will be used in an ANOVA to assess changes in the single treatment reach "M2". The difference in upstream versus downstream location of the control reaches will be assessed, which may require partitioning of the analysis in case of interaction effects among control sites, as described by Underwood (1994) and Michener (1997). Various covariates will be introduced to the model to test their effectiveness in explaining the variability in the data (e.g., stream temperature, stream width, pool metrics, riparian condition, pool:non-pool ratios). Many of these metrics are highly interrelated, and these relationships will be explored through life history modeling (see Objective 3). For example, change in growth can be density-dependent, which will much depend on the retention and survival of natal and non-natal fish. Growth in turn is expected to influence parr-to-parr survival, smolt age structure, and degree of residualism (in steelhead). And in turn, smolt age structure is expected to influence smolt-to-adult survival. Ability to detect change in some of these metrics, especially smolt-to-adult survival will much depend on the species' life history and the duration of the study, which may extend past the planned duration of the study (beyond 2014).

Based on information gathered on realized performance of the PIT tag interrogation systems in 2009, the number of recaptured PIT tagged fish, and the variability in the types of data collected for analyses, we will conduct a power analysis to assess the level of detectability of change expected from restoration actions. If level of detectability is deemed too low, we will adaptively assess if we need to enhance the detectability of interrogators, increase effort to recapture PIT tagged fish, and/or increase the number of fish to be PIT tagged. The effort by USGS to adequately meet PIT tagging and detection needs is much dependent on collaborative efforts with WDFW (see Task 5.2, Table 3).

Progress *2009-2010*: Intensive fish collection and tagging was conducted during the 2009 and 2010 field season (See Objective 1). Combined with the installation of several PIT tag interrogators, these efforts will form the backbone for this analysis. Analysis of fish behavior and survival has been initiated.

Task 2.1 (updated plan for 2011 and 2012). (No change from that as originally planned)

Task 2.2. *Assess changes in the following metrics for individual species and/or the multiple species within the fish community between pre-treatment and post-treatment periods in the treatment, reference, and control reaches:*

Fish species presence or absence
Relative abundance fish within the assemblage
Relative abundance, size, and/or age structure of competitors (e.g., mountain whitefish, brook trout, sculpin)
Relative abundance, size, and/or age structure of predators (e.g., bull trout)

Analysis: These analyses will be similar to those described in Task 2.1

Progress *2009-2010*: As largely described under tasks in Objective 1, we collected pre-treatment data on abundance, density, growth, and age structure of individual species of the fish assemblage in tributaries, side channels, and mainstem Methow River. Sampling was conducted using snorkeling, electrofishing, hook and line sampling, and snetting. We present initial presence-absence data gained from our 2009 sampling in Attachment 2: Table 2.5.

Task 2.2 (updated plan for 2011 and 2012). (No change from that as originally planned)

Task 2.3. *Determine if there was a change in nutrient production and/or nutrient retention between pre-treatment and post-treatment periods in the restoration reach.*

Analysis: This assessment is expected to be done largely by collaborative efforts of other entities, as described under Objective 4. One study already planned is to be conducted by graduate student, Ryan Bellmore, whose major professor is Dr. Colden Baxter of Idaho State University. Yakama Nation is also expected to launch a nutrient study in the near future (2009), which we believe will be a highly collaborative and compatible effort.

Progress *2009-2010*: Much collaboration occurred with Ryan Bellmore and Dr. Colden Baxter of Idaho State University, as well as with John Jorgensen of Yakama Nation to help their ongoing efforts to characterize nutrient dynamics in the Methow watershed.

Task 2.3 (updated plan for 2011 and 2012). (No change from that as originally planned)

C. Modeling the potential fish response to restoration

Objective 3. Develop a reach-based fish production model to incorporate the dynamics and capacity of anadromous salmonids in the Methow watershed, with ability to assess role of fish movement and habitat connectivity and to assess potential effectiveness of restoration actions.

Task 3.1. *Model major aspects of population dynamics (fish growth, survival), life history strategies (movement, age at smolting, age at adult return), and species interactions (competition, predation) to gage potential response of target fish species (Chinook, steelhead, bull trout) and other fish species (rainbow trout, cutthroat trout, mountain whitefish, dace, sculpin, and others) to the restoration effort.*

Timing: October 2008-September 2011.

Methodology: One underlying theme we will want to incorporate is the efficiency of response of fish to find more optimal habitat when it exists upstream or downstream. This response could range from highly efficient, i.e., conforming to tenets of ideal free distribution (Fretwell and Lucas 1972, Grand 1997) whereby fish readily move downstream or upstream to find better habitat conditions) to poorly efficient, i.e., decision to move based on immediate habitat conditions and species interactions, and this movement may or may not be met with better conditions for survival and/or growth. Another aspect that we will model is predator-prey *dynamics based on bioenergetic factors of consumption rates mediated by stream temperature and velocity. We will generally try for a high degree of compatibility with the effort described by Quantitative Consultants for the Lemhi and South Fork Salmon rivers (Chris Beasley, pers. comm.), and use the guidelines for evaluation of restoration effectiveness described by the Independent Multidisciplinary Science Team (2007). In addition to using EDT (see Allen and Connolly report in Attachment 2) and a cohort life-cycle model (under developed by P.J. Connolly) to gage potential response to restoration, we will use the program STELLA and start with Ford's (1999) Tucannon River coho salmon model, to develop a dynamic, user-friendly model that should be readily usable by managers to help understand potential fish response to the treatment. Various other theoretical approaches are likely to be modeled.*

Progress *2009-2010*: Modeling effort expended was considerable. The scope of the effort has been much enhanced and broadened by increased collaboration and funding (see Task 3.2). Combined with a companion effort separately funded by Reclamation, we have ongoing modeling efforts to combine aspects of life history, food webs, bioenergetics, and genetics. The cohort life-cycle model developed by P.J. Connolly continues to be tweaked and used to inform other models under development. While some work with STELLA was completed, we continue to explore other options such as SLAM.

Task 3.1 (updated plan for 2011 and 2012). (No substantial change from that as originally planned)

Task 3.2. *Collaborate in ongoing efforts with colleagues from agencies, universities, private entities, and Tribes to assess primary driver variables and to derive pertinent models that describe fish and habitat relationships and that estimate productivity.*

Timing: October 2008-September 2014.

Note: Our Methow work is viewed as a part of a larger need for this modeling tool in the Columbia River Basin. For example, PI Pat Connolly will be participating in existing PNAMP Fish Monitoring group, and he will be participating in a developing team that will attempt to create a multi-faceted steelhead model. This team is comprised of Chris Jordan (NMFS), Gordie Reeves (USFS), Hiram Li (OSU), Jason Dunham (USGS), Michael Newsom (Reclamation), and others.

Progress *2009-2010*: Extensive collaborative effort was expended to a large degree of fruition. Tangible success of these efforts is in the number of companion studies that were funded, which has enabled expansion and intensification of the overall task. The other projects that were funded include: 1) ―Forecasting the impacts of climate change in the Columbia River Basin: Threats to fish habitat connectivity", funded by USFWS to USGS-CRRL 2) ―Aquatic ecosystems and landscape processes in the face of climate change: An integrated analysis of physical processes and biotic responses in the Pacific Northwest USA", funded by USGS/USFS to, in part, USGS-CRRL, 3) ―Physical, biological, social, & economic impacts of climate change in the Methow River in the Columbia Basin" funded by USGS to USGS-CRRL, and 4) ―Future Runoff Scenarios for decision makers for the Methow River, Washington" funded by USGS to USGS Washington Water Science Center. Other collaborations are ongoing with USFWS and NOAA in an effort to assess change in steelhead rearing strategies at Winthrop National Fish Hatchery.

Task 3.2 (updated plan for 2011 and 2012). (No change in intent, but a change in scope and intensity)

D. Assessing food-web dynamics

Objective 4. Assess the current food web and potential for biotic resistance imparted by presence and abundance of other interacting fish (e.g., native, nonnative, hatchery releases) and other members of the aquatic community (e.g., predators, competitors) in the restoration and potentially connected reaches in the mainstem Methow and Chewuch rivers based on aquatic productivity and fish diet information.

Task 4.1. *Assess productivity and food web dynamics in the restoration reach.*

Methodology: This will involve an assessment of diet for the primary fish in the reach (e.g., steelhead, Chinook, bull trout, rainbow trout, cutthroat trout, and mountain whitefish). We will estimate the contribution of the diet from different trophic stages to the annual growth of target species, competitors, and predators. It is anticipated that Dr. Colden Baxter will have graduate student Ryan Bellmore on this task during 2009-2011 as part of his doctoral work.

Timing: October 2008-December 2014.

Progress *2009-2010*: This work is being conducted by a doctoral student at Idaho State University (J. Ryan Bellmore). The goal of this work is to construct a quantitative food web for the fish assemblage in the restoration reach of the Methow River. This analysis will help determine both the potential for food limitation in the restoration reach of the Methow and the potential for competition among species in the fish assemblage. To construct this food web, Idaho State University is estimating the total invertebrate food base available to fish, and the annual production of fish. To estimate the invertebrate food base, seasonal samples (four sampling dates) of aquatic invertebrates were taken in both the main channel and five side channels of the Methow River. In addition, at two sites (the main channel and one side channel) monthly samples were taken to quantify the growth of individual invertebrates (n = 12 samples from each site). Together these samples will be used to calculate annual aquatic invertebrate production for the restoration reach. In addition, the input of terrestrial invertebrates, which can be an important part of the diet of many salmonid fishes, was sampled three times during the summer of 2009. The portion of the food base available to fish is being determined via fish diet and isotope samples taken from the dominant fish species present in the main channel and each of the five side channel sites (n = approximately 600 samples). By November 2009, all the field data were collected for this study (including fish surveys conducted in cooperation with the USGS). Currently, the researchers at Idaho State University are in the process of finishing the laboratory processing of all invertebrate samples that will be used in the food web analysis.

Task 4.1 (updated plan for 2011 and 2012). (No change from that as originally planned)

Task 4.2. *Collaborate with and assist Yakama Nation in their effort to assess effects of added nutrients to portions of the Methow subbasin.*

Timing: It is expected that YN will launch their nutrient study in the near future (2009).

Progress *2009-2010*: We maintained close contact with Yakama Nation's John Jorgensen, the lead for the nutrient enhancement project. The project, to date, has focused on water quality sampling and completing the design of the study. Fish sampling, including PIT tagging, is planned for 2011.

Task 4.2 (updated plan for 2011 and 2012). (No change from that as originally planned)

E. Collaborating with management agencies

Objective 5. Collaborate with and participate in a multi-agency effort to develop and implement a coordinated inter-agency basin-wide research and monitoring program for the Methow River.

Use efforts underway by other agencies to supplement project activities to further tasks and objectives included in this agreement.

Task 5.1. *Collaborate with WDFW, USFS, and YN to help ensure that systematic redd surveys in the potentially connected reaches in the mainstem Methow and Chewuch rivers are conducted throughout spawning times of Chinook, steelhead, coho, and bull trout.*
Timing: October 2008-September 2014.

Task 5.2. *Collaborate with WDFW to help ensure their planned smolt trapping, PIT tagging, and deployment of PIT tag interrogation systems are conducted during March-November at the specified sites, in the Twisp River and the mainstem Methow River near McFarland Creek. (See Figure 1 for general location.)*
Timing: October 2008-September 2014.

Task 5.3. *Collaborate with and provide technical assistance to Reclamation (e.g., Multiple Pathways and Indicator [MPI] surveys), USFS, YN, and other agencies and entities to ensure appropriate habitat variables for understanding fish-habitat relationships are being taken in the restoration reach, in control and reference reaches, and in selected side channels.*
Timing: March 2009-September 2014.

Task 5.4. *Coordinate and share resources with other projects that monitor the status and trend of listed salmon, steelhead and bull trout in the basin. These agencies and entities include USFWS, BPA, NMFS, WDFW, YN, and Upper Columbia Regional Technical Team.*

Task 5.5. *Coordinate and share resources with other agencies or projects that would provide data related to relative reproductive success of hatchery and naturally produced anadromous fish in the Methow subbasin.*

Task 5.6. *Coordinate and provide expertise as needed to further scientific equipment necessary to accomplish a pre-treatment restoration reach based study. These activities would include identifying potential cost share partners and technical expertise for PIT tag detector sites that would support the experimental design for this study (activity identified as Critical Uncertainty #4 below).*

Task 5.7. *Coordinate and provide expertise as needed to further scientific data and samples necessary for genetic information related to assessing reproductive success of listed fish in the basin.*

Task 5.8. *Give technical presentations related to the project activities at Columbia Basin effectiveness monitoring meetings, interagency workgroups, watershed councils, landowner coordination meetings, and other appropriate scientific and public outreach forums.*

Progress for Tasks 5.1 - 5.8 *2009-2010*: Much collaboration was done as per described within these tasks. Multiple local watershed meetings of the Methow Restoration Council, the M2 Implementation group, Upper Columbia Salmon Recovery Board, and the Upper Columbia Regional Technical Team were attended, which included much active participation. Several informal presentations were given at these meetings. Formal presentations and posters given include:

Presentations

Connolly, Patrick J., Kyle D. Martens, Michael A. Newsom, and Dana Weigel. 2010. Assessing the influence of habitat connectivity on success of different life history strategies for production of steelhead smolts. International Congress on the Biology of Fish, July 2010, Barcelona, Spain.

Connolly, Patrick J., Kyle D. Martens and Russell Perry. 2010. Assessing complex life cycles and stream restoration needs for steelhead using PIT tag technology and mark-recapture modeling. Western Division American Fisheries Society. April 2010, Salt Lake City, Utah.

Connolly, Patrick J., Kyle D. Martens, and Michael Newsom. 2010. Use of age structure and movement pattern information to help prioritize actions for restoring steelhead. Oregon Chapter American Fisheries Society. February 2010, Eugene, Oregon.

Connolly, Patrick J., Kyle D. Martens, and Patrick J. Connolly. 2010. Deployment and anchoring methods for instream PIT tag interrogation systems. Oregon Chapter American Fisheries Society, February 2010, Eugene, Oregon.

Connolly, Patrick J., Kyle D. Martens, Dana Weigel, and Wesley Tibbits. 2010. Effectiveness of Actions in Beaver Creek. Upper Columbia Regional Technical Team Analysis Workshop January 2010, Wenatchee, Washington.

Connolly, Patrick J., Kyle D. Martens and Ian G. Jezorek. 2009. Contribution to steelhead smolt production from differing life history strategies: downstream movement as parr versus staying until time of smolting. Western Division American Fisheries Society, May 2009, Albuquerque, New Mexico.

Connolly, Patrick J. 2009. Environmental drivers of *Oncorhynchus mykiss* life history diversity. Washington-Oregon American Fisheries Society, April 2009, Shelton, Washington.

Connolly, Patrick J., Kyle D. Martens, and Wesley T. Tibbits. 2009. Following fish in the Methow River watershed. March 2009, Twisp, Washington.

Connolly, Patrick J. 2009. Response of rainbow trout populations to reconnection with adult steelhead after removal of century-old barriers. Oregon Chapter American Fisheries Society, February 2009, Bend, Oregon.

<u>Posters</u>

Connolly, Patrick J., Kyle D. Martens, and Wesley T. Tibbits. 2009. Effectiveness of rock type diversion structures for restoring upstream passage of juvenile and adult salmonids in Beaver Creek of the Methow River watershed. Western Division American Fisheries Society, May 2009, Albuquerque, New Mexico.

Task 5.1-5.8 (updated plan for 2011 and 2012). (No change from that as originally planned)

F. Managing the database

Objective 6. Create and manage an electronic database of protocols used and data collected**.**

Task 6.1. *Enter data in a standard electronic format, and ensure high quality of data (QA/QC).*

Progress *2009-2010*: Most data have been entered into an electronic format (primarily Excel spreadsheets). Upon entering data, all data were checked for quality. Most PIT tag files have been entered and proofed, and subsequently uploaded to PTAGIS. Other formats for storage of these data continue to be explored as per the project's and Reclamation's needs.

Task 6.1 (updated plan for 2011 and 2012). (No change from that as originally planned)

Task 6.2. *Provide protocol and data inputs to the Integrated Status and Effectiveness Monitoring Project (ISEMP) in the effort to test the robustness of monitoring protocols, indicator metrics, and sampling designs currently used in monitoring programs.*

Progress *2009-2010*: We attended two meetings on the ISEMP database and it appears that our data will be easily adapted when they are ready. Once ISEMP is ready to handle data and protocols for the Methow River, we will work to get all of our data and protocols entered into their database.

Task 6.2 (updated plan for 2011 and 2012). (No change from that as originally planned).

Task 6.3. *Contribute and coordinate with the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) in their effort to produce a comprehensive network of effective aquatic monitoring programs in the Pacific Northwest.*

Progress *2009-2010*: Collaboration occurred when opportunities arose. One outcome of these collaborations resulted in the following publication:

Connolly, P.J. 2010. Guidelines for calculating and enhancing detection efficiency of PIT tag interrogation systems. Pages 119-125 *in* Wolf, K.S., and O'Neal, J.S., eds., PNAMP Special Publication: Tagging, Telemetry and Marking Measures for Monitoring Fish Populations—A compendium of new and recent science for use in informing technique and decision modalities: Pacific Northwest Aquatic Monitoring Partnership Special Publication 2010-002, Chapter 7. http://www.pnamp.org/node/2871 (accessed 21 November 2010).

Task 6.3 (updated plan for 2011 and 2012). (No change from that as originally planned)

Schedule

Degree of completion as of October 2010 are noted below.

October 2008—September 2009

Initiate pre-treatment data collection (PIT tagging, snorkeling, etc.) in October 2008
Degree of completion as of October 2010: 100%
Purchase PIT tag interrogator equipment and build antennas in winter 2008/2009
Degree of completion as of October 2010: 100%
Initiate smolt trapping in July 2009
Degree of completion as of October 2010: 100%
Complete installation of two multiplexing PIT tag interrogation systems by September 2009
Degree of completion as of October 2010: 100%
Complete installation of four single-antenna PIT tag interrogation systems in side-channels by September 2009
Degree of completion as of October 2010: 100%
Initiate food web study (i.e., assisting MS student Ryan Bellmore) in April 2009
Degree of completion as of October 2010: 100%

October 2009—September 2011 (note: two years)

Complete food web study by June 2011 (To be conducted by Idaho State University's Ryan Bellmore, as a doctoral student under Dr, Colden Baxter.)
Degree of completion as of October 2010: 90%, ongoing as planned
Complete installation of one multiplexing PIT tag interrogation systems by September 2010
Degree of completion as of October 2010: 100%
Complete modeling effort by September 2011
Degree of completion as of October 2010: 30%, ongoing as planned
Continue pre-treatment data collection until time of restoration actions begin
Degree of completion as of October 2010: 70%, ongoing as planned

October 2011—September 2012

Continue pre-treatment data collection through at least May 2012
Commence post-treatment data collection once restoration actions begin

October 2012—September 2014 (note: two years)

Continue post-treatment data collection
Final report on pre-treatment findings in February 2013

Deliverables

December 15, 2009 *Progress Report stating the progress of each activity by objective and task*
With the present document, degree of completion as of November 2010: 100%
December 15, 2010 *Progress Report stating the progress of each activity by objective and task*
With the present document, degree of completion as of November 2010: 100%
December 15, 2011 *Progress Report stating the progress of each activity by objective and task*

December 15, 2012 *Interim Report in scientific format on the methods and results for data collected during the pre-treatment phase of the project*

December 15, 2013 *Progress Report stating the progress of each activity by objective and task*

December 15, 2014	*Final Report submitted in scientific format, publications, data and/or data summaries in usable electronic format*

Critical Uncertainties (CU)

CU1) Effect of hatchery fish program: limitations of response of wild fish because of past, current, and near-future hatchery management (e.g., change in release numbers, location of releases, size of releases, or stock(s) released).

CU2) Confounding effect of recent and near-future changes in water management, e.g., changes to MVID.

CU3) Confounding effect of recent and near-future restoration efforts within control reaches or in other areas of the watershed.

CU4) Commitment from PUD and WDFW for smolt trapping, PIT tagging, and installing/maintaining PIT tag interrogation systems are key elements for the success of this project.

CU5) Extent and nature of the restoration actions that will be implemented in the restoration reach.

Permitting and logistical needs (PL)

PL1) Permitting will need to be completed for siting PTISs and the smolt trap (JARPA, fish sampling). Status as of this writing: JARPAs are in review. Fish permits are already largely secured.

PL2) Restoration project activities and schedule need to be highly coordinated with the sampling effort. Status as of this writing: Continuing to work closely with a USBOR team that is modeling river flow in the treatment reach.

Budget for FY2011

See Attachment 3 (included in separate electronic file).

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Table 1. Pre- and post-treatment data collection and analysis in 2009-2014.

Assessment / Methods	Sampling design	Analysis
Fish assemblage/abundance/density		
Snorkeling	Fish > 150 mm: Mar, Jul-Nov (n=9)	Fish use; seasonal relative abundance
Smolt trapping	Daily trapping; marked fish for efficiency	Annual out-migration; timing of movement
Electrofishing	Tributaries (4), side channels (2-3); mainstem (restoration reach, 3 controls)	Fish use; seasonal abundance (#/m^2, g/m^2)
Juvenile growth/survival		
Electrofishing	Capture-recapture	Change in length and weight; condition
Smolt trapping	Capture-recapture	Change in length and weight; condition
PIT tagging	Capture-recapture	Individual growth; survival; condition
Juvenile age structure		
Smolt trapping	Daily trapping; marked fish for efficiency;	Length-frequency; age analysis
PIT tagging	Capture-recapture	Individual age at size; survival; habitat use
PIT tag readers	Detection of PIT-tagged fish	Individual age at moving and/or smolting
Juvenile movement		
Electrofishing	Capture-recapture	Natal area; time in reach; survival
Smolt trapping	Capture-recapture	Time in reach; survival; young-of-year movement
PIT tagging	Capture-recapture	Time in reach; survival
PIT tag readers	Detection of PIT-tagged fish at key locations (mainstem, tributaries, and side channels)	Time in reach; survival
Adult return		
Redd surveys	Continuous, nearly 100%	Abundance, smolt-to-adult survival
Wells Dam counts	PUD methods at dams	Abundance, smolt-to-adult survival

Table 2. List of fish assessment activities and their timing in the Methow watershed in 2009-2014.

Activity/Site or action	Who	Timing	Fish monitoring and handling activities
Smolt trapping			
Methow or Chewuch R.			
-ab treatment reach	USGS	Mar-Nov+	Assemblage, abundance, length, weight, PIT tag/detection
Twisp R.	WDFW	Mar-Nov+	Assemblage, abundance, length, weight, PIT tag/detection
Methow-at McFarland	WDFW	Mar-Nov+	Assemblage, abundance, length, weight, PIT tag/detection
PIT tag interrogation systems			
Beaver Cr. (Stokes)	USGS	Jan-Dec	Movement data
Gold Cr. (lower, upper)	USGS	Jan-Dec	Movement data
Libby Cr. (lower)	USGS	Jan-Dec	Movement data
Chewuch R. (mouth)	USGS	Jan-Dec	Movement data
Methow -ab Chewuch R.	USGS	Jan-Dec	Movement data
Side-channels (n=2)			
within reference reach(es)	USGS	Jan-Dec	Movement data
Side-channels (n=2)			
within treatment reach	USGS	Jan-Dec	Movement data
Methow "M2" -ab Twisp R.	USGS	Jan-Dec	Movement data
Twisp R.	WDFW	Jan-Dec	Movement data
Methow mouth	WDFW[1]	Jan-Dec	Movement data
Instream fish assessment			
Snorkel-mainstem	USGS	Mar-Nov	Assemblage, abundance
Electrofish-4 mainstem areas	USGS	Mar-April; Jul-Oct	Assemblage, abundance, length, weight, PIT tag; movement
Electrofish-4 tributaries	USGS	Mar-April; Jul-Oct	Assemblage, abundance, length, weight, PIT tag; movement
Electrofish-4 side channels	USGS	Mar-April; Jul-Oct	Assemblage, abundance, length, weight, PIT tag; movement
Hook and line	WDFW, USGS	Jan-Dec	Assemblage, abundance, length, weight, PIT tag; movement
Redd surveys	WDFW, YN	Jan-Dec	Spawner abundance and distribution, timing of spawning
PIT tagging	USGS, WDFW	Jan-Dec	Movement, growth, survival

[1]Partially installed in October 2008; planned to operational in spring 2009.

Table 3. Level of PIT-tagging efforts for Chinook salmon and steelhead in the Methow watershed during each year of the project, 2009-2014.

Site	Group	PIT tags	USGS effort of total
Smolt traps (n=2, existing))	WDFW	2,000	0
Smolt traps (n=1, new)	USGS	1,000	1,000
Methow R.-upper	USGS and WDFW	1,500	1,000
Methow R.-treatment	USGS and WDFW	1,000	500
Methow R.-middle	USGS and WDFW	1,000	500
Chewuch River	USGS and WDFW	1,500	1,000
Twisp River	WDFW	500	0
Wolf Creek.	USGS	500	500
Eightmile Creek	USGS	500	500
Beaver Creek	USGS	500	500
Gold and Libby creeks	USGS	500	500
Hatchery(s)	WDFW	5,000	0
	Totals	15,500	6,000

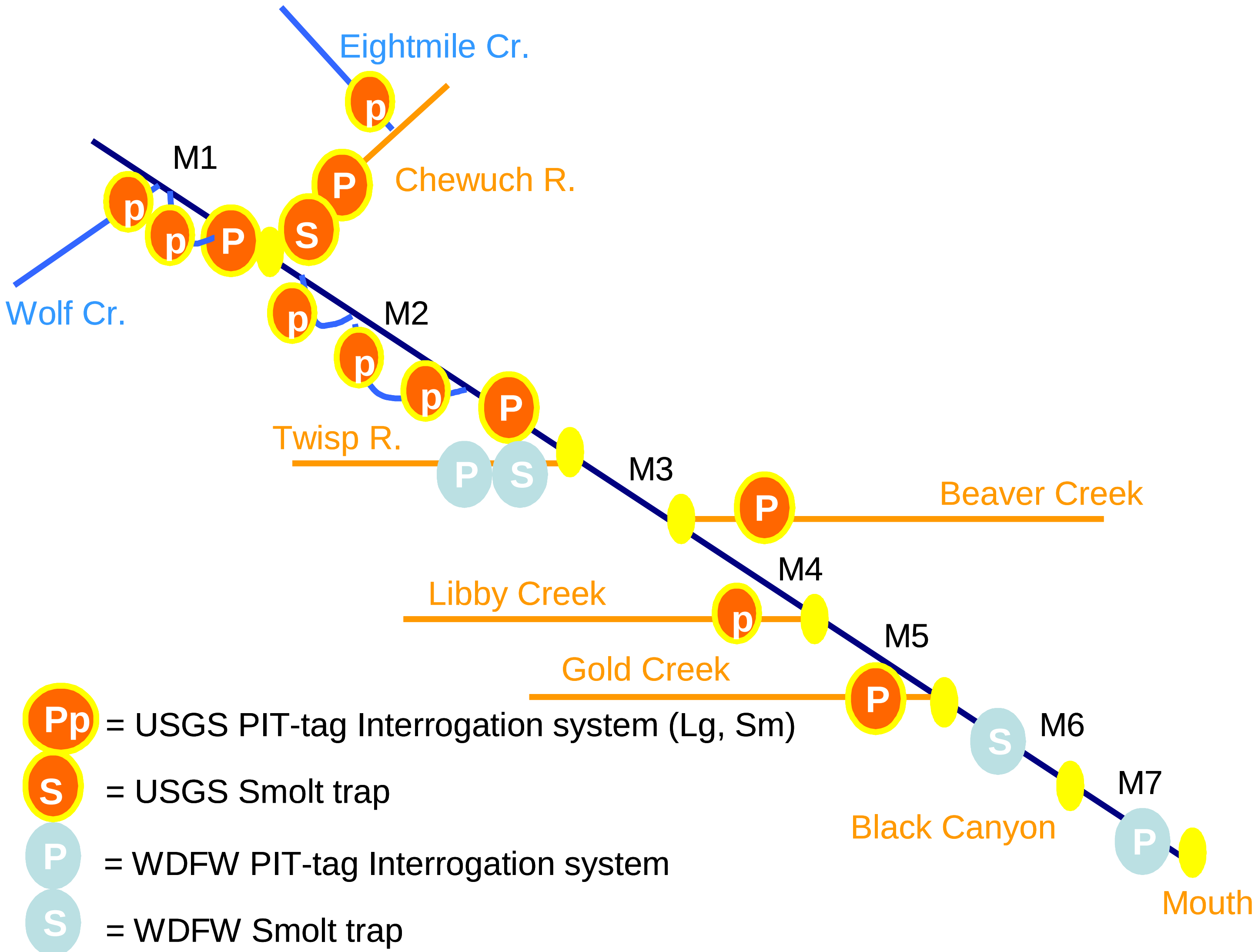


Figure 1. Location of fish monitoring gear already in place or planned in the Methow River watershed by Washington Department of Fisheries and Wildlife (WDFW) or U.S. Geological Survey (USGS). New installs are planned for completion in 2009. The restoration reach is denoted as —M2”, P or p = large or small PIT-tag interrogation system (PTIS), and S=smolt trap.

Attachment 1. Likelihood of detecting PIT tagged fish.

Attachment Table 1.1. Number of PIT-tagged juvenile steelhead and spring Chinook estimated to survive and to be detected, based on 1,000 and 250 tags, at various end points based on site where PIT tagged and age at tagging and age at smolting. These estimates are derived from estimated survival and PIT tag detection efficiency at various sites in the Methow and Columbia rivers (see Attachment Table 1.2 for these estimates by site). See map in Figure 1 for location of sites.

		Steelhead (n = 1,000) (Age-1 parr to age-3 smolt)			Spring Chinook (n = 1,000) (Age-1 parr to age-2 smolt)		
PIT tagging site	End point	Number surviving	Number detected	Percent detected	Number surviving	Number detected	Percent detected
Chewuch	M2-downstream end	503	636	64%	670	770	77%
	Methow mouth	419	705	70%	558	826	83%
	Columbia mouth	76	742	74%	155	863	86%
Upper Methow	M2-downstream end	513	618	62%	684	761	76%
	Methow mouth	427	692	69%	570	820	82%
	Columbia mouth	78	731	73%	158	859	86%
M2-within	M2-downstream end	540	360	36%	720	480	48%
	Methow mouth	450	489	49%	600	616	62%
	Columbia mouth	82	558	56%	167	702	70%
M3-within	M2-downstream end	600	0	0%	800	0	0%
	Methow mouth	500	224	22%	666	290	29%
	Columbia mouth	91	340	34%	185	465	47%

		Steelhead (n = 250) (Age-1 parr to age-3 smolt)			Spring Chinook (n = 250) (Age-1 parr to age-2 smolt)		
PIT tagging site	End point	Number surviving	Number detected	Percent detected	Number surviving	Number detected	Percent detected
Chewuch	M2-downstream end	126	159	64%	168	192	77%
	Methow mouth	105	176	70%	140	206	83%
	Columbia mouth	19	186	74%	39	216	86%
Upper Methow	M2-downstream end	128	155	62%	171	190	76%
	Methow mouth	107	173	69%	142	205	82%
	Columbia mouth	19	183	73%	40	215	86%
M2-within	M2-downstream end	135	90	36%	180	120	48%
	Methow mouth	112	122	49%	150	154	62%
	Columbia mouth	20	140	56%	42	176	70%
M3-within	M2-downstream end	150	0	0%	200	0	0%
	Methow mouth	125	56	22%	167	73	29%
	Columbia mouth	23	85	34%	46	116	47%

Attachment Table 1.2. Estimated survival and PIT tag detection efficiency at various sites in the Methow and Columbia rivers. Those values in **bold** are the ones that differ between juvenile steelhead and spring Chinook. Values for survival and detection efficiency are based on available literature and best professional judgment.

			Steelhead (Age-1 parr to age-3 smolt)				Spring Chinook (Age-1 parr to age-2 smolt)			
Reach	Site		Between survival	Site survival	PIT tag detection efficiency	Steelhead Notes	Between survival	Site survival	PIT tag detection efficiency	Chinook Notes
Chewuch	Chewuch									
	[rearing to smolt phase]	Between	**0.60**			a	**0.80**			a
Chewuch	PTIS-1 (USGS)	At		1.00	0.70	a		1.00	0.70	a
		Between	0.95			a	0.95			a
Chewuch	Smolt Trap-1 (USGS)	At		0.98	**0.10**	b		0.98	**0.07**	b
		Between	1.00			a	1.00			a
M2	PTIS-2 (USGS)	At		1.00	0.60	a		1.00	0.60	a
		Between	0.90			a	0.90			a
McFarland	Smolt Trap-2 (WDFW)	At		0.98	**0.05**	c		0.98	**0.04**	c
		Between	0.85			a	0.85			a
Methow mouth	PTIS-3 (USGS)	At		1.00	0.40	a		1.00	0.40	a
		Between	0.90			a	0.90			a
Columbia Rive	Wells Dam	At		1.00	0.00			1.00	0.00	
		Between	0.90			a	0.90			a
Columbia Rive	Rocky Reach Dam	At		1.00	0.02	d		1.00	0.02	d
		Between	0.90			a	0.90			a
Columbia Rive	Rock Island Dam	At		1.00	0.05	d		1.00	0.05	d
		Between	**0.82**			e	**0.88**			h
Columbia Rive	Wanapum Dam	At		1.00	0.00			1.00	0.00	
		Between	**0.82**			e	**0.88**			h
Columbia Rive	Priest Rapids Dam	At		1.00	0.00			1.00	0.00	
		Between	**0.82**			e	**0.88**			h
Columbia Rive	McNary Dam	At		1.00	0.25	f		1.00	0.25	f
		Between	**0.81**			g	**0.87**			i
Columbia Rive	John Day Dam	At		1.00	0.25	d		1.00	0.25	d
		Between	**0.81**			g	**0.87**			i
Columbia Rive	The Dalles Dam	At		1.00	0.00			1.00	0.00	
		Between	**0.81**			g	**0.87**			i
Columbia Rive	Bonneville Dam	At		1.00	0.36	d		1.00	0.36	d
		Between	0.85				0.85			
Columbia Rive	Estuary	At		1.00	0.03	d		1.00	0.03	d

Notes for Attachment Table 1.2:

a Estimate based on professional opinion.

b Data from WDFW's Twisp smolt trap for 2005. Reference: Snow, C. and A. Fowler. 2006. Methow River Basin Spring Chinook and Steelhead Smolt Monitoring in 2005. Washington Department of Fish and Wildlife, Olympia WA.

c WDFW 2005 Methow trap with increased estimate based on professional opinion. Reference: Snow, C., and A. Fowler. 2006. Methow River Basin Spring Chinook and Steelhead Smolt Monitoring in 2005. Washington Department of Fish and Wildlife, Olympia WA.

d USGS CRRL data: (Beaver creek weir - 2006).

e Average survival for 1998-2002 from RIS to McN: 0.55 (0.82*0.82*0.82 =0.55), includes passage over dam and its pool. Reference: FPC (Fish Passage Center). 2008. http://www.fpc.org/survival/juvenile_queries.html (January 2008).

f DE=0.2499 Reference: Columbia River DART (Data Access in Real Time). 2008 http://www.cbr.washington.edu/dart/ (5 January 2008).

g Average survival from McN-BON: 0.54 (0.81*0.81*0.81=0.53), includes passage over dam and its pool Reference: Williams, J.G., S.G. Smith, W.D. Muir, B.P. Sandford, S. Achord, R. McNatt, D.M. Marsh, R.W. Zabel, and M.D. Scheuerell. 2004. Effects of the Federal Columbia River Power System on Salmon Populations. National Oceanographic and Atmospheric Administration, Fisheries Ecology Division, Seattle, WA.

h Average survival for 1998-2002 from RIS to McN: 0.69 (0.88*0.88*0.88= 0.68), includes passage over dam and its pool. Reference: FPC (Fish Passage Center). 2008. http://www.fpc.org/survival/juvenile_queries.html (January 2008).

i Average survival from McN-BON: 0.67 (0.88*0.88*0.88=0.68), includes passage over dam and its pool Reference: Williams, J.G., S.G. Smith, W.D. Muir, B.P. Sandford, S. Achord, R. McNatt, D.M. Marsh, R.W. Zabel, and M.D. Scheuerell. 2004. Effects of the Federal Columbia River Power System on Salmon Populations. National Oceanographic and Atmospheric Administration, Fisheries Ecology Division, Seattle, WA.

Attachment 2. Tables and a figure describing sampling sites and selected background information gathered in 2008-2010.

Attachment Table 2.1. Streams snorkel-surveyed for fish population during the 2009 field season. Stream reaches are listed in an upstream to downstream pattern within a watershed.

Watershed Stream reach or section	Starting rkm	Ending rkm	Total rkm	Number of snorkelers	Number of times sampled	Estimated time taken to complete survey (hrs)
Methow River						
UMR – Big Valley to cable car	92	89	3	4 (3 once)	4[a]	2.5
MMR – MVID east to Twisp	72	65	7	4	7[b]	3.5
LMR – Twisp to Golden Doe	61	54	7	4	4[c]	3.5
Chewuch River						
CHE – rkm12 to rkm 8	12	8.6	3.5	3 (4 once)	4[d]	2.5

[a] Snorkel dates: 07/15/2009, 08/04/2009, 10/21/2009, and 11/09/2009
[b] Snorkel dates: 03/04/2009, 07/13/2009, 08/05/2009, 09/01/2009, 09/29/2009, 10/20/2009, and 11/10/2009
[c] Snorkel dates: 07/16/2009, 09/03/2009, 10/22/2009, and 11/23/2009
[d] Snorkel dates: 07/15/2009, 09/02/2009, 10/6/2009, and 11/24/2009

Attachment Table 2.2. PIT tag interrogation sites and total number of detections by fish species for 2008 and 2009. Fish codes are: RBT/STH = rainbow trout/steelhead, BRK = brook trout, CTT = cutthroat trout, CHN = Chinook, COH = coho, BLT = bull trout.

Watershed Site	Distance upstream from mouth (km)	Install date	Site ID	Unit type	Total number of 134.2 kHz PIT tagged fish interrogated						
					Total	RBT/STH	BRK	CTT	CHN	COH	BLT
Gold Creek Watershed											
Gold Creek	35	9 Nov 2005	GLC	Mux	56	50	0	2	0	1	0
SF Gold Creek	35	3 Dec 2004	GL2	2001f	27	23	0	0	0	0	0
Libby Creek Watershed											
Libby Creek	42	14 Nov 2004	LBC	2001f	65	58	0	0	0	0	0
Beaver Creek Watershed											
Beaver Creek	57	28 Sep 2004	BVC	Mux	163	137	7	0	0	0	0
Methow Watershed											
Middle Methow	65.2	28 Sep 2009	MRT	Mux	NA[a]						
Side Channel 2	70	20 Apr 2009	MSC	2001f	21[b]	1	0	0	0	16	0
Side Channel 2	70.5	20 Apr 2009	MSC	2001f	19[b]	3	0	0	0	8	0
Side Channel 3	76	17 Sep 2009	MSC	Allflex	NO[b]						
Upper Methow Watershed											
Upper Methow	81.2	21 Sep 2009	UMR	Mux	NA						
Wolf Creek	85	1 Dec 2008	WFC	2001f	65	16	0	0	37	0	1
Side Channel 4	86	4 Oct 2009	UMS	2001f	NA						
Side Channel 5	93	5 Oct 2009	UMS	2001f	NA						
Chewuch Watershed											
Eightmile Creek	99	1 Dec 2008	EMC	2001f	32	20	0	1	9	0	0

[a] Data not available
[b] Sites only operate when water is flowing in the spring.

Attachment Table 2.3. Streams surveyed or sampled for fish and where a total of 3,599 PIT tags deployed in the Methow watershed during the 2009 field season. Watersheds and streams are listed in a downstream to upstream pattern within a watershed. SC = Side channel. Fish codes are: RBT = rainbow trout/juvenile steelhead, STH = adult steelhead, BRK = brook trout, CTT = cutthroat trout, CHN = Chinook, COH = coho, BLT = bull trout, SCP = sculpin, BLS= bridgelip sucker, WHT= mountain whitefish and LND= longnose dace.

Watershed / Stream reach or section	Distance upstream from mouth (km)	Method	Total number of 134.2 kHz PIT tags deployed										
			RBT	STH	BRK	CTT	CHN	COH	BLT	SCP	BLS	WHT	LND
Gold Creek													
S. Fork Gold Creek – Reach 1	4.2	PS, FSNP	82	0	0	0	0	0	0	1	0	0	0
Libby Creek													
Libby Creek – Reach 1	2.6	FSNP	26	0	0	0	0	0	0	0	0	0	0
Beaver Creek													
Beaver Creek – Ott	1.3	FSNP	78	0	3	0	0	0	0	2	0	0	0
Beaver Creek – Stokes	4.6	FSNP	110	1	8	0	0	0	0	0	0	0	0
South Fork Beaver – Reach 2	8.7	FSNP	26	0	0	0	0	0	0	0	0	0	0
Beaver Creek – Reach 2	12.8	PS, FSNP	229	0	11	0	0	0	0	0	0	0	0
Beaver Creek – Reach 4	14.0	FSNP	24	0	1	0	0	0	0	0	0	0	0
Lower Methow River													
Methow River - lower	54.0	FSNP	13	0	0	0	12	1	0	0	0	0	0
LMS1 -Golden Doe	54.0	H/L	6	0	0	0	13	0	0	0	0	6	0
Methow River - Halderman Hole	61.0	Snetting	0	0	0	2	0	0	1	0	0	81	0
Twisp River													
Poorman Creek	3.2	FSNP	47	0	12	0	0	0	0	0	0	0	0
Methow River – M2													
Methow River	64.0	FSNP	113	0	0	0	146	6	1	5	3	70	0
	64.0-81.0	H/L	25	1	0	47	9	0	2	0	0	14	0
	64.0-78.8	Snetting	5	1	0	42	0	0	13	0	0	233	0
SC1-Sugar dyke	67.1	PS	79	0	0	0	192	19	0	0	0	0	0
SC2-Habermehle	71.3	PS, FSNP, M/R	35	0	0	0	168	95	0	6	22	4	1
SC3-Bird	78.8	PS, FSNP, H/L, M/R	171	0	1	0	119	11	1	0	9	0	0
Upper Methow													
Methow River - upper	80.3	FSNP	97	0	13	0	73	2	1	0	4	0	0
Wolf Creek – Reach 1	0.0	PS, FSNP	73	0	0	0	12	0	2	3	0	0	0
SC4-Heath	86.8	PS, FSNP	35	0	9	2	35	0	0	1	0	2	5
SC5-Stansberry	94.5	PS, FSNP	143	0	3	0	82	0	1	10	1	0	0

Attachment Table 2.3 Continued.

Watershed Stream reach or section	Distance upstream from mouth (km)	Method	Total number of 134.2 kHz PIT tags deployed										
			RBT	STH	BRK	CTT	CHN	COH	BLT	SCP	BLS	WHT	LND
Chewuch River													
Chewuch River - Reach 1	1.0	Screw	13	0	0	7	75	0	0	0	4	0	84
Chewuch River – Reach 2	10.0	FSNP	24	0	0	0	25	0	0	0	0	0	0
Eightmile Cr. – Reach 1	0.0	PS, FSNP	148	0	2	2	8	0	6	0	0	0	0
Eightmile Cr. - Flats Campground	4.0	FSNP	18	0	11	0	0	0	0	0	0	0	0
Eightmile Cr. - Ab. Flats Camp.	5.0	FSNP	2	0	0	0	0	0	0	0	0	0	0
Chewuch River – Reach 3	19.0	FSNP	16	0	0	0	21	0	0	0	0	0	0
Chewuch River – Reach 4	30.0	FSNP	48	0	0	0	1	0	1	0	0	0	0
		Grand Total	1,686	3	74	102	991	136	29	29	43	416	90

[a]FSNP = Fish sampled by electrofishing, not a population survey, PS= 500 m reach population survey, M/R = Mark-Recapture, H/L = Hook and Line, Screw = Rotary screw trap.

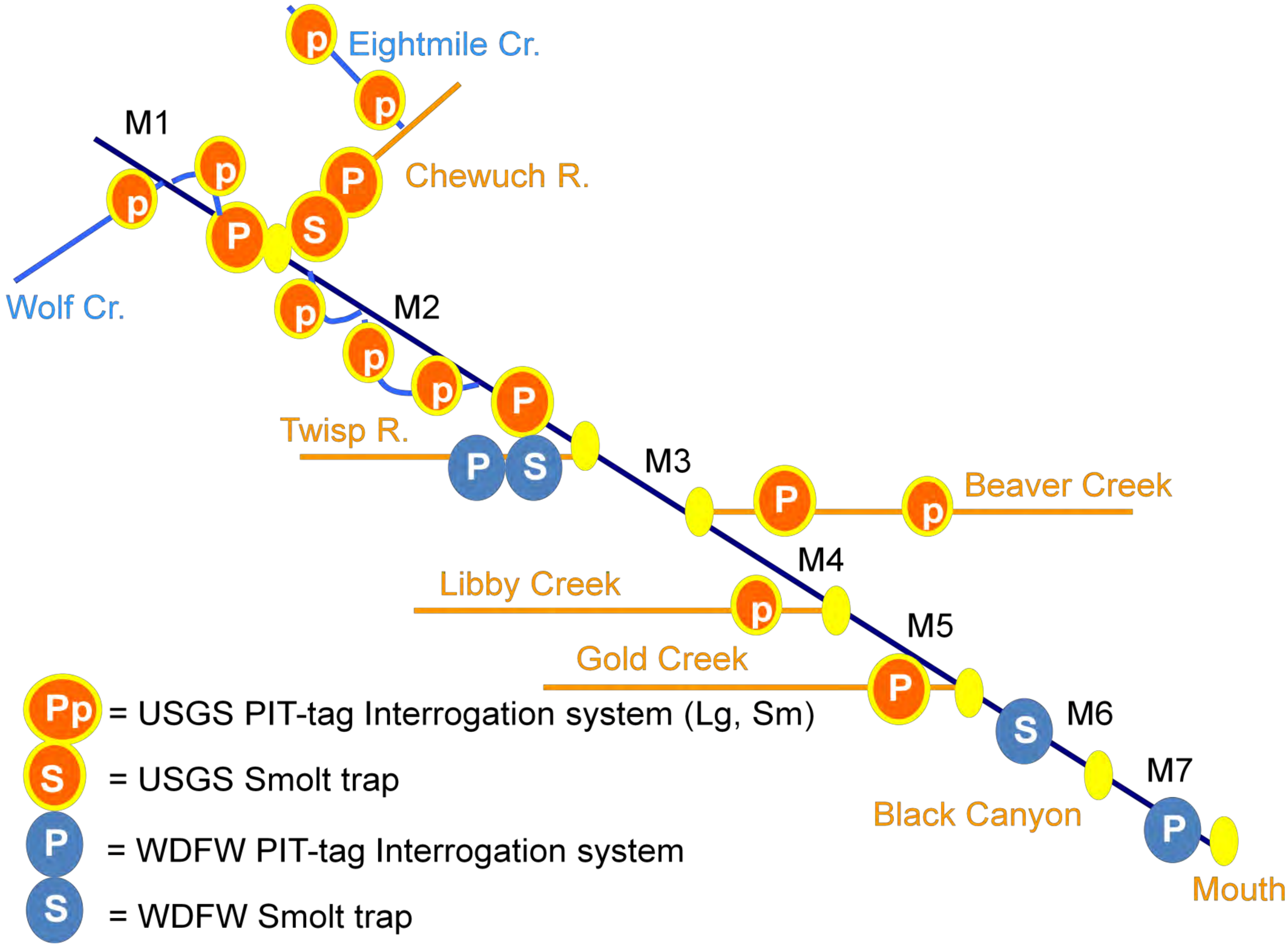
Attachment Table 2.4. Streams surveyed or sampled for fish and where a total of 918 genetic samples collected in the Methow watershed during the 2009 field season. Watersheds and streams are listed in a downstream to upstream pattern within a watershed. Fish codes are: RBT = rainbow trout/juvenile steelhead, STH = adult steelhead, CTT = cutthroat trout, CHN = Chinook, COH = coho, BLT = bull trout.

Watershed Stream reach or section	Distance upstream from mouth (km)		Genetic samples collected					
			RBT	STH	CTT	CHN	COH	BLT
Gold Creek								
Crater Creek	10.0		10	0	0	0	0	0
Foggy Dew – Ab. trailhead	11.2		0	0	14	0	0	0
Libby Creek								
North Fork Libby	13.0		0	0	15	0	0	0
Beaver Creek								
Beaver Creek - Reach 1	1.3		60	1	0	0	0	0
Beaver Creek - Reach 2	12.8		49	0	0	0	0	0
Beaver Creek - Reach 4	15.6		29	0	0	0	0	0
Beaver Creek – South Fork	14.0		26	0	0	0	0	0
Lower Methow								
Methow River - lower	54.0		8	0	0	0	0	1
SC0-Golden Doe	54.0		4	0	0	13	1	0
Methow River – M2								
Methow River – M2	64.0		60	1	45	49	0	16
SC1-Sugar dyke	67.1		24	0	0	19	5	0
SC2-Habermehle	71.3		5	0	0	25	25	0
SC3-Bird	78.8		16	0	0	26	8	1
Chewuch River								
Chewuch River - Reach 1	1.0		9	0	6	73	0	0
Chewuch River – Reach 2	14.0		25	0	0	25	0	0
Eightmile Cr	18.0		3	0	0	0	0	5
Chewuch River – Reach 3	19.0		0	0	0	0	0	0
Chewuch River – Reach 4	30.0		23	0	0	0	0	0
Upper Methow								
Methow River - upper	80.3		21	0	0	52	1	1
Wolf Cr	85.0		20	0	0	2	0	1
SC4-Heath	86.8		10	0	1	34	0	0
SC5-Stansberry	94.5		23	0	0	26	0	1
		Grand Total	**425**	**2**	**81**	**344**	**40**	**26**

Attachment Table 2.5. Presence and absence of fish species sampled in the Methow watershed by the U. S. Geological Survey during the 2009 field season. Watersheds and streams are listed in a downstream to upstream pattern within a watershed. P = present, A = absent.

Watershed Reach or section	Distance upstream from mouth (km)	**Rainbow trout/ steelhead** *Oncorhynchus mykiss*	**Brook trout** *Salvelinus fontinalis*	**Cutthroat trout** *Oncorhynchus clarkii*	**Chinook salmon** *Oncorhynchus tschawytscha*	**Coho salmon** *Oncorhynchus kisutch*	**Bull trout** *Salvelinus confluentus*	**Sculpin** *Cottus spp.*	Other species observed
Gold Creek									
Gold Creek - Reach 2	4.1	P	A	A[a]	P	A	P[b]	P	A
S. Fork Gold Creek - Reach 1	4.2	P	A	A	A	A	A	P	A
Libby Creek									
Libby Creek - Reach 1	2.6	P	A	P	Pc	A	A	A	A
Beaver Creek									
Beaver Creek - Ott	1.3	P[c]	P	A	A	A	A[a]	P	A[ag]
Beaver Creek - Stokes	4.6	P	P[b]	A	A	A	A	A	A
Beaver Creek - Reach 2	12.8	P	P	A	A	A	A	A	A
Beaver Creek - Reach 4	14.0	P	P	P[b]	A	A	A[a]	A	A
Lower Methow									
Methow River - lower	54.0	P[c]	A	P	P[c]	P[c]	A[a]	P	P[degaf]
SC0-Golden Doe	54.0	P[c]	A	A[a]	P[c]	P[c]	A[a]	P	P[g]
Methow River - Halderman Hole	61.0	P[c]	A	P	P[c]	P[c]	P[c]	P	P[g]
Twisp River									
Poorman Creek	3.2	P	P	A	A	A	A	P	A
Methow River - M2									
Methow River	64.0	P	A	P	P	P	P	P	P[defg]
SC1-Sugar dyke	67.1	P	A	A	P	P	A	P	P[defg]
SC2-Habermehle	71.3	P	A	A	P	P	A	P	P[defg]
SC3-Bird	78.8	P	A	A	P	P	A	P	P[de]
Chewuch River									
Chewuch River - Reach 1	1.0	P	A	P	P	A	A	P	P[def]
Chewuch River – Reach 2	14.0	P	A	P	P[c]	P[c]	P	P	P[d]
Eightmile Cr. – Reach 1	0.0	P	P	P	P	A	P[bc]	P	A
Eightmile Cr. - Flats campground	4.0	P	P	A	A	A	A	P	A
Eightmile Cr. - Ab. Flats camp.	5.0	P	P	A	A	A	A	P	A
Chewuch River – Reach 3	19.0	P	A	P	P[c]	A	P	P	P[def]
Chewuch River – Reach 4	30.0	P	A	P	A	A	P	P	A
Upper Methow									
Methow River	80.3	P	P	A	P	P[c]	P[c]	P	P[deg]
Wolf Cr. – Reach 1	0.0	P	A	A	P	A	P[bc]	P	P[d]
SC4-Heath	86.8	P	P	A	P	P	A	P	P[dg]
SC5-Stansberry	94.5	P	A	P	P	A	P	P	P[eg]

[a] Species was detected during previous years of sampling, but was not observed during 2009 sampling.
[b] Only 1 individual was observed during surveys at this site.
[c] Adult and juvenile of the same species were observed in this reach.
[d] Longnose dace *Rhinichthys cataractae.*
[e] bridgelip sucker *Catostomus columbianus*
[f] pacific lamprey *Lampetra tridentata*
[g] mountain whitefish *Prosopium williamsoni*



Attachment Figure 2.1. Location of fish monitoring gear already in place or planned in the Methow River watershed by Washington Department of Fisheries and Wildlife (WDFW) or U.S. Geological Survey (USGS). Depicted as existed by the end of FY2010. The restoration reach is denoted as ―M2", P or p = large or small PIT-tag interrogation system (PTIS), and S=smolt trap.

Attachment 3: Budget for FY2011

(included as separate electronic file)