DEPARTMENT OF ECOLOGY
State of Washington

Quality Assurance Project Plan

Nason Creek (Chelan County) Oxbow Reconnection Monitoring

March 2010

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SEA - Shorelands and Environmental Assistance Program.
EAP - Environmental Assessment Program.
CRO - Central Regional Office.
ERO - Eastern Regional Office.
EIM - Environmental Information Management database.

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Abstract

During 2010, the Washington State Department of Ecology (Ecology) will continue conducting snorkel surveys in the reconnected Nason Creek oxbow[1] and two reference sites (Chiwawa River off-channel and mainstem Nason Creek). The first two years of surveys were completed in 2007 (pre-reconnection) and 2008 (post-reconnection) by the Yakama Nation on contract with the Chelan County Natural Resources Department.

The surveys will show if chinook and steelhead counts increased in the reconnected oxbow relative to the reference sites. Data will be used to assess whether oxbow reconnection projects help restore salmonid use of reconnected habitat.

Each study conducted by Ecology must have an approved Quality Assurance (QA) Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completion of the study, a final report describing the study results will be posted to the Internet.

[1] Oxbow: A u-shaped low-flow habitat or lake formed when a meander of a stream is separated from the main flow by the cutting of a new stream channel.

Introduction

In September 2007, the Chelan County Natural Resource Department (CCNRD) installed two fish-passable culverts to reconnect an oxbow to the mainstem of Nason Creek. The oxbow is a low-flow habitat formed when a meander of Nason Creek was cut off by the construction of Washington State Route 207 (WA-207). The purpose of the reconnection was to restore habitat for Endangered Species Act (ESA) listed Upper Columbia spring chinook (*Oncorhynchus tshawytscha)* and Upper Columbia steelhead (rainbow trout; *Oncorhynchus mykiss)*. The project provided a chance to observe salmonid recolonization of historic habitat.

Before and after reconnection, the Yakama Nation Fisheries Resource Management Program (Yakama Nation) conducted snorkel fish counts for CCNRD. Pre-construction surveys were completed in the summer of 2007. Post-construction surveys were completed in the winter, spring, and summer of 2008. The sample sites included an oxbow on Nason Creek and two reference sites: one on the mainstem of Nason Creek and one on a Chiwawa River off-channel habitat.

The Yakama Nation reported survey results to the CCNRD. Initial trends point to increased counts of juvenile chinook in both the oxbow and reference reaches. However, after the 2008 post-construction surveys, further funding was unavailable. In their final report to the CCNRD, the Yakama Nation recommended further monitoring to understand whether the reconnection has increased salmonid abundance in the oxbow. (Murdoch and Collins, 2009)

To test whether the oxbow reconnection has helped improve habitat for ESA listed salmonids, the Washington State Department of Ecology (Ecology) intends to continue the monitoring program in 2010. Ecology will follow the survey procedures outlined by the Yakama Nation (Murdoch and Collins, 2009) to estimate salmonid abundance and will evaluate fish abundance trends in the oxbow and two reference reaches.

Study area and surroundings

Nason Creek drains about 69,000 acres from the Cascade Crest near Stevens Pass and joins the Wenatchee River just below Lake Wenatchee at river mile 53.6. Precipitation in the Wenatchee River basin ranges from 40 to 80 inches per year. About 96% of the Nason Creek subwatershed is forest, primarily fir and hemlock species. Land use includes timber harvest, rural residential, and recreation. The US Forest Service manages about 78% of the watershed. (Ecology, 1995, 2009; USFS, 1996; WWPU, 2006)

History of study area

The Wenatchee River basin is known for historically large salmon runs. Since the early 1900s, overfishing, the construction of dams on the Columbia River, hatchery mitigation programs, irrigation diversions, and habitat degradation from mining, grazing, and logging have all contributed to severely reduced salmon stocks.

The Wenatchee basin is currently home to ESA listed spring chinook, summer steelhead, and bull trout. Indigenous coho were extirpated from the basin, but hatchery-introduced coho runs are beginning to establish. Sockeye spawn in Lake Wenatchee. Other salmonids in the system include summer chinook, whitefish, and introduced brook trout (Andonaegui, 2001).

Nason Creek is one of the more productive streams in the Wenatchee basin, providing habitat for all resident salmonids. However, between 1890 and 1943, construction of United States Highway 2 (US-2), WA-207, and the Great Northern railroad fragmented side-channel habitat and degraded water quality for the lower nine river miles (USFS, 1996; WWPU, 2006).

Many factors pose risks for salmonid populations in the Nason Creek subwatershed. Road construction and channel straightening changed the flow structure in Nason Creek. Pool habitat was lost. Instream flow velocity, channel erosion, and water temperature all increased. Lack of adequate culverts contributed to the habitat loss and limited fish access to the floodplain (Nason Creek Watershed Analysis, 1994). Nason Creek has failed to meet (exceeded) state and federal water quality standards for temperature (WWPU, 2006).

To help restore salmonid populations, the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB, 2007) recommended the reconnection of historic off-channel habitat. The expected benefits to salmon include:

- Increased habitat diversity.
- Improved natural channel stability.
- Restored riparian habitat.
- Reduced instream sediment.
- Lower water temperatures.

Nason Creek Oxbow Reconnection

CCNRD sponsored work on the initial surveys and construction for the Nason Creek oxbow reconnection project. Pre-construction monitoring for the project occurred between June and September 2007. Monitoring included surveys by snorkel fish counts conducted by the Yakama Nation (Murdoch and Collins, 2009).

Between September 10 and 13, 2007, WA-207 was shut down to permit the installation of two fish passable culverts to reconnect an oxbow on Nason Creek located between mileposts 0.83 and 1.33. Prior to construction, the Yakama Nation removed all fish from the oxbow by seining and herding. Fish were transplanted to the Nason Creek mainstem across the road (M. Collins, personal communication, 2009).

Two 12-foot diameter corrugated metal culverts were installed at the upstream and downstream ends of the oxbow. The lower portion of each culvert was buried in stream substrate to simulate a natural stream surface (Figures 1 and 2). The construction opened up 21.7 acres of off-channel refuge, rearing, and over-wintering habitat for juvenile salmonids (UCSRB, 2007).

Figure 1. Outlet of oxbow before reconnection.

Figure 2. Outlet of oxbow after reconnection.

(Photo credits: CCNRD.)

Post-construction surveys by snorkel fish count were conducted by Yakama Nation in the winter, spring, and summer of 2008. Results from the first year of pre- and post-construction sampling are available in Murdoch and Collins (2009).

Results of previous studies

Oxbow reconnection

Oxbows are important for salmonids because oxbows provide low-flow habitats in which adult spawners can rest and juveniles can rear and overwinter (Swales and Levings, 1989; Nickelson et al., 1992; Bonneau and Scarnecchia, 1998; Andonaegui, 2001).

Oxbow reconnection shows promise in reestablishing salmonid habitat and was recommended for improving salmon populations in the Upper Columbia (UCSRB, 2007). Juvenile coho, chinook, and cutthroat seek refuge from fall and winter high flows in the off-channel habitats created by reconnection (Roni et al., 2002).

Snorkel fish counts

The Yakama Nation used snorkel fish counts[2] to estimate salmonid abundance in the sample sites. Snorkel counts are less disturbing to fish than other methods of estimating abundance (e.g.; electrofishing, mark-and-recapture). Also recent studies have found snorkel counts comparable to these methods (Thurow and Schill, 1996; Roni and Fayram, 2000; Thurow et al., 2006; Pink et al., 2007). Snorkel fish counts are currently employed by Washington State, federal, and tribal agencies.

All 2007-2008 surveys, except for winter, occurred during the day. Winter surveys were held at night. Previous studies showed little difference between night and day snorkel fish counts in warm water (Thurow and Schill, 1996; Thurow et al., 2006). However, night surveys were more effective in icy (winter) water because of daytime concealment by salmonids at low water temperatures (Roni and Fayram, 2000; Bradford and Higgins, 2001; Thurow et al., 2006).

Summary of the 2007-2008 fish count results

Results reported below and listed in Table 1 are from the 2007-2008 Yakama Nation fish counts and were previously described in Murdoch and Collins (2009). Survey seasons in Table 1 are defined by the time of year and flow regime.

Pre-construction surveys found chinook and steelhead in all sites including the oxbow. However, fish were found only in the vicinity of the single outlet culvert. Juvenile salmonids could enter the oxbow from the downstream outlet culvert during high streamflows, but were stranded in the oxbow during low-flow periods. Counts of juvenile salmonids in the oxbow declined between the spring high-flow and the summer low-flow surveys in 2007. The two reference sites were not sampled in the spring of 2007.

Following reconnection of the oxbow, surveys were conducted in the winter, spring, and summer of 2008. Yakama Nation crews documented juvenile chinook and steelhead occupying new habitat areas as well as rearing and spawning within the reconnected oxbow.

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[2] Underwater fish counts or underwater visual distance sampling.

2008 winter and spring fish counts in the oxbow showed little difference from the pre-construction surveys. However, the 2008 summer surveys showed an increase in salmonid counts.

From 2007 to 2008, counts of salmonids at the two reference sites were relatively consistent through all seasons. The Nason Creek mainstem site appeared to be a good reference reach for steelhead; however, few chinook were found. In contrast, the Chiwawa site proved to be a good reference reach for chinook, but no steelhead were found there.

Initial samples from the 2007-2008 surveys indicate an increase in salmonid abundance in the oxbow relative to the reference sites. This 2010 project will continue the sampling to evaluate whether the increase is consistent in subsequent years.

Table 1. Chinook and steelhead counts for the Nason Creek oxbow site and two reference sites, 2007-2008 (from Murdoch and Collins, 2009).

Survey		Date	Flow[1] (cfs)	Avg. Temp[2] (C)	Fish Counts					
					Oxbow		Mainstem		Chiwawa	
					CHK[3]	STL[3]	CHK	STL	CHK	STL
Pre-Construction 2007	Spring	6/29	469	8.0	20	8				
	Summer	8/16	56	14.5			3	115		
		8/21	65	13.8	0	3	2	11		
		8/29	45	10.3			7	18	90	0
		9/4	39	10.5	0	5			111	0
		9/12	33	10.0					74	0
Post-Construction 2008	Winter (night survey)	2/20	82	2.0	0	1	0	49		
		2/27	91	4.3	0	3	0	119		
		3/7	123	4.0	7	19	0	152		
	Spring	6/18	910	7.8	0	0			1	0
		6/24	879	7.3	1	0			125	0
		6/25	864	6.8	0	0			220	0
	Summer	8/6	94	9.5					175	0
		8/7	91	14.3	246	43	5	145		
		8/13	83	13.1			0	151		
		8/14	80	13.8	57	91				
		8/19	74	8.6					360	0
		8/20	88	10.9	3	36			150	0
		8/21	111	14.3			2	79		

[1] Nason Creek mainstem flow near the confluence with the Wenatchee River (Ecology, 2009). This flow represents the general flow regime in the vicinity of the survey sites, but is not an indicator of specific site flows.
[2] Average water temperature between sampled sites during the surveys.
[3] CHK = chinook salmon; STL = steelhead / rainbow trout.

Project Description

The project goal for the 2010 Nason Creek monitoring is to determine if the restored connection to the Nason oxbow will produce an increase in reach-level abundance of salmonids by season and species within the first three years following construction relative to two reference sites.

The project objectives are to:

1. Compare pre- and post-construction summer fish abundance in the oxbow relative to the reference sites.
2. Compare seasonal post-construction fish abundance between 2008 and 2010 in the oxbow relative to the reference sites.

Station description

The oxbow is located on (1) lower Nason Creek, in WRIA[3] 45, at about river kilometer (RK) 5.5 and (2) WA-207 between mileposts 0.83 and 1.33, about one mile northbound of the US-2 intersection (Figure 3). The oxbow is about 3150 feet long.

The oxbow consists of sequential beaver ponds with deeply sedimented substrate. Instream vegetation is dominated by spatterdock (*Nuphar polysepala*). Cattails, willow, red osier dogwood, and hawthorn line the banks. Trees include black cottonwood and mixed conifers.

After the September 2007 reconnection, the Yakama Nation noted a cobble channel forming at points of constriction and near the culverts, although spatterdock and sediment still dominate (Murdoch and Collins, 2009).

Chinook, steelhead, coho, brook trout, and whitefish have all been observed in the oxbow. Ecology staff observed spawning adult coho in the oxbow in November 2009.

Reference sites

Two reference reaches were selected for surveys. The reference reaches provide comparison fish counts to estimate the non-construction related changes in fish abundance in the mainstem Nason Creek and in a natural off-channel habitat (Chiwawa River).

The first reference site is located on the mainstem of Nason Creek and is an Integrated Status and Effectiveness Monitoring Program (ISEMP) annual panel site. The Nason Creek reference site was chosen to reduce duplication of monitoring efforts and provide a source of data to compare changes over time. The mainstem site is located upstream of the oxbow at RK 12.2 and next to milepost 82.7 on US-2 (Figure 4).

[3] Water Resource Inventory Area.

The Nason Creek mainstem reference reach is about 1600 feet long. The reach substrate consists of boulder, cobble, gravel, and sand. The banks are steep and cut for most of the sample reach. Discharge ranges from <50 cfs at low flow to >3000 cfs in the spring (Ecology, 2009). Bank vegetation includes red osier dogwood, willow, hawthorn, and conifer trees.

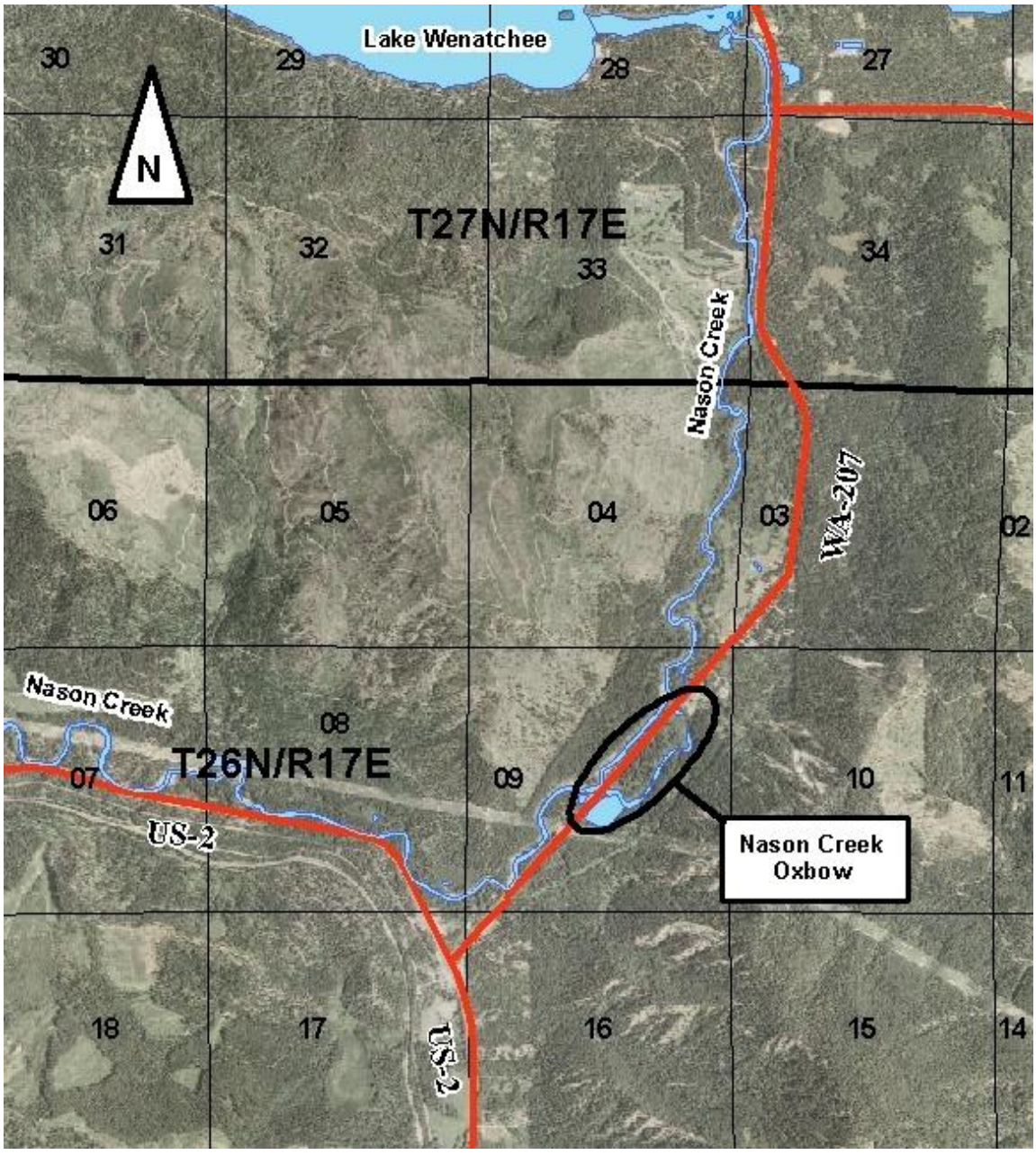

Figure 3. Location of the reconnected oxbow on Nason Creek.

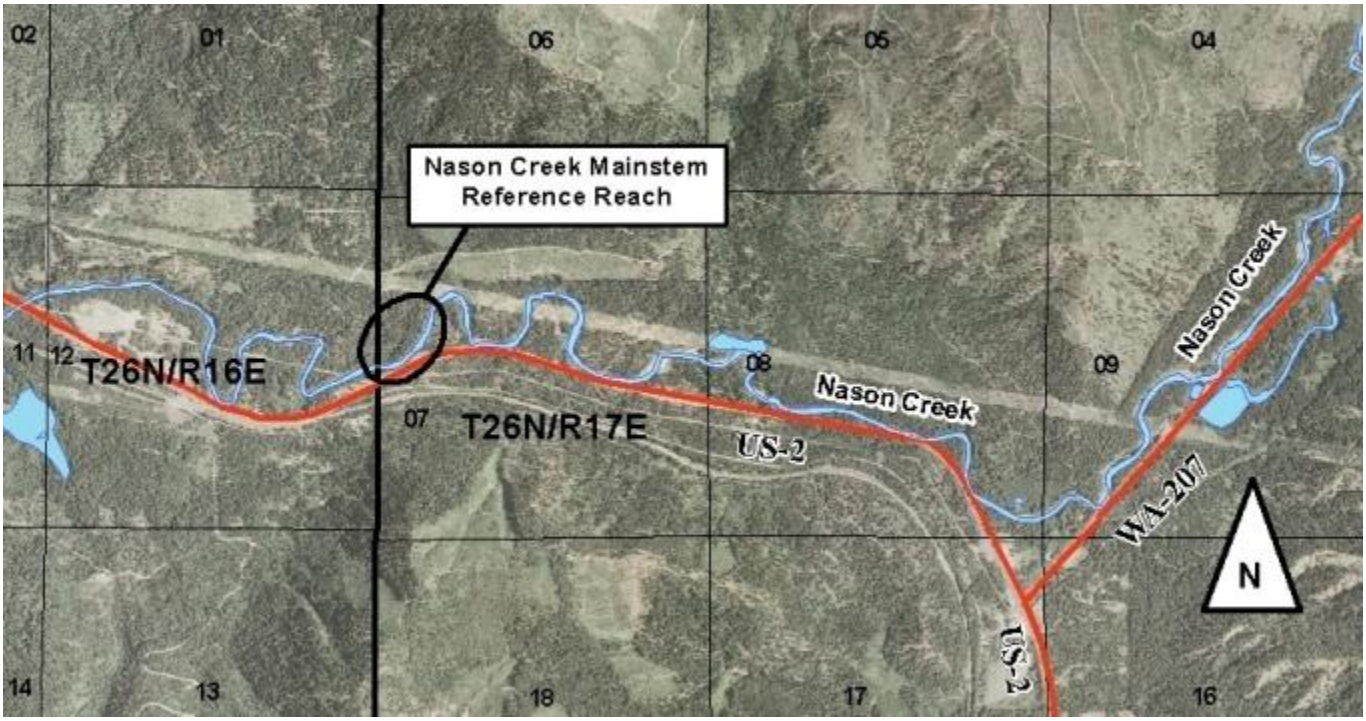

Figure 4. Location of the Nason Creek main-channel reference site.

The second reference reach was a natural off-channel habitat. Due to the lack of off-channel habitat on Nason Creek, a site on the Chiwawa River was chosen. In addition to meeting the off-channel habitat criteria, the site was chosen for accessibility during high water events. The off-channel reference site is located at RK 38.3 on the Chiwawa River (Figure 5).

The Chiwawa off-channel reference site receives flow through an upstream wetland on the edge of the Chiwawa River. The dry-season flow is low, < 2 cfs, and primarily from groundwater. During high flows (typically May-June) surface flow enters the site through the wetland. Deep (>1 meter) pools below the wetland have sedimented substrate. The shallow outflow substrate is a mix of gravels and sediment. The vegetation on site is a mix of conifers and black cottonwood, and an understory of willow, spirea, and other emergent shrubs.

Small fish are able to access the off-channel site year-round through the outflow. Also, the site is a rearing area for juvenile chinook (Murdoch and Collins, 2009).

The length of the surveyable reach on the Chiwawa site is about 500 feet during the dry season.

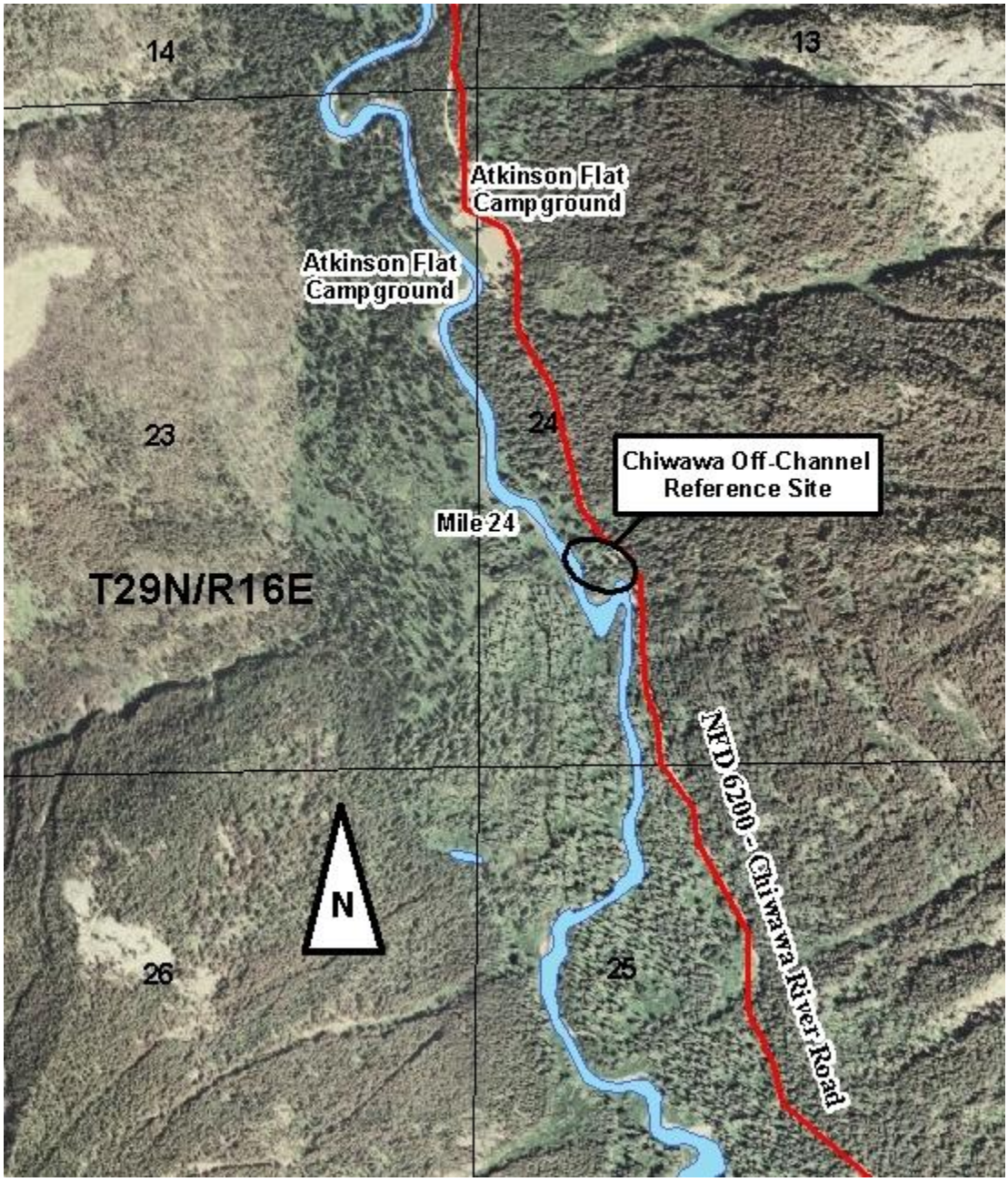

Figure 5. Location of the Chiwawa River off-channel reference site.

Organization and Schedule

The following people are involved in this project. All are employees of the Washington State Department of Ecology.

Table 2. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Dave Holland Shorelines and Environmental Assistance Program CRO Phone: (509) 457-7112	EAP Client	Clarifies scopes of the project, provides internal review of the QAPP, and approves the final QAPP.
Daniel Dugger Eastern Operations Section EAP-CRO Phone: (509) 454-4183	Co-Author/ Project Manager	Manages the project. Writes the QAPP, oversees field surveys and data collection, conducts QA review of data, and analyzes and interprets data. Writes the draft report and final report.
Jenna Durkee Eastern Operations Section EAP-CRO Phone: (509) 454-7865	Co-Author/ EIM Data Engineer	Writes the QAPP, assists in field surveys and data collection. Enters data into EIM, and analyzes and interprets data. Writes the draft report and final report.
Gary Arnold Eastern Operations Section EAP-CRO/ERO Phone: (509) 454-4244	Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
William R. Kammin EAP-HQ Phone: (360) 407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

EAP – Environmental Assessment Program.
QAPP – Quality Assurance Project Plan.
CRO –Ecology's Central Regional Office, Yakima, WA.
ERO –Ecology's Eastern Regional Office, Spokane, WA.
HQ –Ecology's Headquarters, Lacey, WA.

Table 3. Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.

Field and laboratory work	Due date	Lead staff
Field work completed	September 2010	Dan Dugger
Environmental Information System (EIM) database		
EIM user study ID	ddug0001	
Product	Due date	Lead staff
EIM data loaded	January 2011	Jenna Durkee
EIM quality assurance	February 2011	Jenna Durkee
EIM complete	March 2011	Jenna Durkee
Final report		
Author lead / support staff	Dan Dugger / Jenna Durkee	
Schedule		
Draft due to supervisor	December 2010	
Draft due to client/peer reviewer	January 2011	
Draft due to external reviewer(s)	January 2011	
Final (all reviews done) due to publications coordinator (Joan)	March 2011	
Final report due on web	April 2011	

Performance and Acceptance Criteria

Data collected in 2010 will be compared with fish count data obtained from Nason Creek oxbow snorkel surveys conducted by the Yakama Nation Fisheries in 2007 and 2008 (Murdoch and Collins, 2009). Ecology will consult with Yakama Nation staff regarding prior year data quality and design to ensure measurement quality objectives (MQOs) were met.

Our target population for the snorkel fish count surveys will include the fish present in the Nason Creek oxbow, Nason Creek mainstem, and Chiwawa River off-channel reaches during the surveys. We will attempt to count fish during the same seasonal migration movements represented by the 2007 and 2008 surveys.

Sample dates will be set to coincide with season and streamflow conditions that match the 2007-2008 surveys, with the intent of capturing the same salmonid migratory movements. In 2010, planned sample events will be set for the winter low flow, spring high flow, and summer low flow. The Nason Creek mainstem site will not be sampled during the spring due to high flows that impede sampling. The Chiwawa reference site will not be sampled in the winter due to seasonal road closures.

Data collected in 2010 will be compared with data from the 2007-2008 surveys to evaluate whether salmonid abundance has increased in the oxbow. Details on the sample protocols employed in 2007-2008 are available in Murdoch and Collins (2009). This 2010 project will seek to repeat the Murdoch and Collins (2009) sample protocols to allow comparison between years.

Measurement quality objectives (MQOs)

Data that are collected following the sampling, measurement, and quality control procedures outlined below will satisfy this project's MQOs.

Sampling Process Design (Experimental Design)

For project consistency, we will repeat the first two years of sample protocols used by the Yakama Nation in Murdoch and Collins (2009).

This 2010 study follows a Before-After/Control-Impact (BACI) design to evaluate changes in fish counts and densities pre- and post- construction. Ecology data will be analyzed together with Yakama Nation data from the 2007-2008 surveys.

We will conduct three more seasons of replicate snorkel surveys in the oxbow and two reference reaches. Three replicate snorkel surveys will be conducted per sample season. Sample seasons will include winter (roughly January to March), spring (roughly April to June), and summer (roughly July to August) of 2010 (Table 4).

As in 2008, we will survey at night in the winter, and during the day in the spring and summer.

We expect some sample sites to be inaccessible in some seasons. In the winter, the Chiwawa reference site cannot be reached due to its remote location and seasonal road closures. In the spring, the Nason Creek reference site cannot be snorkeled due to high flows. During the summer, all sites will be sampled (Table 3).

Data from 2010 summer surveys will be compared to the 2007 pre-construction and the 2008 post-construction summer samples. Data from the 2010 winter and spring surveys will be compared to the 2008 winter and spring samples

Table 4. Number of surveys to be compared by season and site.

Site:		Oxbow Nason Creek			Mainstem Nason Creek		Off-Channel Chiwawa River	
Season:		Winter	Spring high-flow	Summer low-flow	Winter	Summer low-flow	Spring high-flow	Summer low-flow
Pre-construction	2007	-	1	2	-	3	-	3
Post-construction	2008	3	3	3	3	3	3	3
	2010	3	3	3	3	3	3	3

Sampling Procedures

Site visits will usually include four to five surveyors. At least one surveyor will work from the shore as bank tender. The bank tender will help direct the snorkeling effort and act as safety coordinator for the group. The bank tender will carry the vehicle keys, cell phone or radio, whistle, throw rope, first aid kit, spare dive lights, and data sheets.

We will follow Ecology's Environmental Assessment Program (EAP) Standard Operating Procedures (SOP) for minimizing the spread of invasive species. We will prefer non-felt (e.g., vibram) wading boots that can be visually inspected and cleaned between sites. If felt wading boots are used, they will be changed to a decontaminated pair between sites.

Details on the EAP SOP for minimizing the spread of invasive species can be found at: http://aww.ecology.ecy.wa.gov/programs/eap/InvasiveSpecies/invspec.html

Measurement Procedures

We will use snorkel protocols based on:

1. Murdoch and Collins (2009), and
2. The Yakama Nation and Bonneville Power Administration's (BPA) Integrated Status and Effectiveness Monitoring Program (ISEMP) (Murdoch and Nelle, 2008).

At the start and end of each site visit, we will measure water temperature to the nearest degree (°C) using a hand-held thermometer. We will measure underwater visibility to the nearest meter with a 4-inch Castaic Catch 22 Rainbow Trout lure with hooks removed. We will measure length and width of the area snorkeled with a tape measure.

Where possible, surveyors will enter the river about five meters downstream of the reach start and position themselves across the channel so that all fish can be seen. Whenever possible, snorkeling will proceed from downstream to upstream. Surveyors will count fish that pass downstream and to their left while coordinating with adjacent snorkelers to ensure fish are counted only once. The snorkeler on the right side of the survey line will count fish passing to the left and right.

Fish will be identified and counted by species and length increments of 2 cm in odd numbers (e.g., 3, 5, 7). Fish categorized as 1 cm will be from 0.1 cm to 2 cm, 3 cm size class will be from 2.1 cm to 4 cm, and so on. Unidentified species will be noted with estimated size. Information will be written on a wrist cuff then transcribed to the field data sheets. (Murdoch and Nelle, 2008.)

We will record a site sketch of each survey showing the area surveyed, flag points, and other features of interest.

Field Quality Control Procedures

Prior to sampling, field staff will train in all sample techniques until proficient. We will use taxonomic keys to identify fish to species and to observe live fish in hand. We will practice underwater size estimation with pre-measured dowels. We will conduct dry sampling runs to practice field identification and size estimation.

We will flag each sample site along the reach to measure the survey length. We will estimate the average width of the surveyed area.

Training

Training will be conducted as needed to ensure all field staff are familiar with sample protocols. We will work on fish identification, size estimation, and sampling coordination.

Staff from the Yakama Nation who conducted the first two years of surveys have offered to assist in training to ensure sampling consistency.

Species identification

Our target species are chinook, coho, and steelhead (rainbow trout). Other species of interest include whitefish, bull trout, and brook trout (salmonids), suckers (catostomids), redside shiners, chubs, minnows, and dace (cyprinids).

The snorkelers will be trained with out-of-water and in-water visual examples and explanations of fish identification features. We will use an underwater camera to check the accuracy of fish identification during training and sample events.

Fish size

Training on fish size estimation will take place in the water with the use of a metric length scale on the PVC cuff or by comparison with a previously measured object. Surveyors will memorize their body metrics as a backup estimate. Body metrics include:

- Thumb to pinky finger tip span (Y-measure).
- Thumb to index finger tip span (L-measure).
- Thumb tip to thumb-hand joint length (T-measure).

Vocal coordination

At least one surveyor will work from the bank, as bank tender, to coordinate the sampling effort. The bank tender will direct the sampling effort to prevent duplicate fish counts and to ensure coverage of the sample area.

The bank tender will use a whistle to attract the attention of the snorkel team.

Reach measurement

To measure reach length, each site will be flagged at regular intervals.

After the survey season is complete, the field crew will ensure that all flagging is removed from the site.

Underwater visibility

Visibility will be measured at each site snorkeled using a 4-inch Castaic Catch 22 Rainbow Trout lure with hooks removed.

The lure will be fastened to a line and placed in the mid-water column. A snorkeler will enter the water, move away from the lure perpendicular to the bank until the lure is not identifiable as a fish, then move back towards the lure until it is visible. At this point the distance from the snorkeler to the lure is measured using a tape. This is repeated for a total of three snorkelers, and the distance is recorded on the datasheet.

For streams narrower than the maximum visibility, we will use the average wetted width (measured at the start and end of the reach) as the maximum visibility for that site (Murdoch and Nelle, 2008).

If underwater visibility is less than one meter, we will postpone the survey until visibility improves.

Day/night surveys

Dive lights will be used in both night and day surveys to help view fish. The dive light will be attached to the snorkeler's arm with a lanyard. The bank tender will carry a flashlight, batteries, and spare dive lights for snorkelers on night surveys.

Survey preparation

Prior to scheduled surveys, we will check the streamflow at Nason Creek using the Ecology flow network, located at https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=45J070.

We will also check expected fish presence by consulting with the Yakama Nation who collect daily fish counts at a rotary screw trap on Nason Creek.

Measurements

Water temperature will be measured with a hand-held thermometer calibrated to a NIST[4]-certified thermometer in the lab.

[4] National Institute of Science and Technology.

Safety and access

High flows

At times, streamflow will be too high for the snorkel crew to safely move and count fish. The crew will decide if flow levels are safe based on consensus. If anyone feels flow is unsafe, the survey will be postponed.

If the product of stream depth (ft) and flow velocity (ft/sec) is greater than 10 ft^2/sec, we will not enter the water. Because snorkeling requires greater submersion and exposure than wading, we will not attempt to snorkel if the product is greater than 8 ft^2/sec.

Entanglement

Large woody debris (LWD) and other instream objects are a drowning hazard for snorkelers. Flow can pin a snorkeler under LWD. But LWD also provides cover for fish and should be surveyed.

To reduce the risk, we will evaluate all instream objects for danger and safe approach before surveying. We will work in teams. The bank tender will direct snorkeling activity around LWD.

Ice

During winter surveys, ice may cover the stream and make access difficult. If snorkeling is too dangerous or if the visibility to the bank is compromised due to ice, the survey will be postponed until the ice does not hinder safety or visibility.

In some cases we may need to survey through areas with thin ice cover. We will never enter any part of a stream with greater than ½ inch thick surface ice.

Data Management Procedures

Each snorkeler will carry a PVC wrist-cuff marked with metric units for recording fish counts and estimating fish length. The wrist-cuff counts will be transcribed to data sheets following the survey.

Data sheets will include a site sketch and fish counts per species.

We will enter data into an Excel spreadsheet (Microsoft, 2007). The spreadsheet will be backed up on Ecology's shared hard drive. Fish count data by species will also be entered into Ecology's Environmental Information Management (EIM) database.

Audits and Reports

The data collected during this project will be used to assess changes in fish species and abundance at the Nason Creek oxbow relative to the two reference sites. No specific decision is anticipated based on the study results. Thus, assuming the project MQOs are ultimately met, the data will be deemed acceptable for use (except as qualified during the data review process).

A draft data report will be prepared and forwarded to the client within four months of the final survey. The report will include the following:

- Description of the project purpose, goals, and objectives.
- Map(s) of the study area and sampling sites.
- Descriptions of field and analysis methods.
- Discussion of data quality and the significance of any problems encountered in the surveys.
- Summary tables of fish species and count data.
- Comparison with pre-project data
- Observations regarding significant or potentially significant findings.
- Recommendations based on project goals.

The final data report should be ready for publication within two months of receiving review comments on the draft data report.

Data Verification

All data will be reviewed by project staff who did not perform the data entry and then compared to the field sheets. If substantive errors are identified, an independent review of the data will be conducted. Fish count and water temperature data will be published in an appendix of the final report.

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Appendices

Appendix A. Glossary, Acronyms, and Abbreviations

Glossary

Char: Char (genus *Salvelinus*) are distinguished from trout and salmon by the absence of teeth in the roof of the mouth, presence of light colored spots on a dark background, absence of spots on the dorsal fin, small scales, and differences in the structure of their skeleton. (Trout and salmon have dark spots on a lighter background.)

Oxbow: A u-shaped low-flow habitat or lake formed when a meander of a stream is separated from the main flow by the cutting of a new stream channel.

Salmonid: Any fish that belong to the family *Salmonidae*. Basically, any species of salmon, trout, or char. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm.

Snorkel fish counts: Underwater fish counts or underwater visual distance sampling.

Acronyms and Abbreviations

CCNRD	Chelan County Natural Resource Department
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
ESA	Endangered Species Act
LWD	Large woody debris
MQO	Measurement quality objective
PVC	Polyvinyl chloride
QA	Quality assurance
QAPP	Quality assurance project plan
RK	River kilometer
SOP	Standard operating procedure
US-2	U.S. Highway 2
USGS	U.S. Geological Survey
WA-207	Washington State Route 207
WRIA	Water Resources Inventory Area
Yakama Nation	Yakama Nation Fisheries Management Program, Yakima, WA.

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
ft	feet
m	meter
s	second

Appendix B. Datasheets

Fish Count Survey – Page 1

Nason Creek Oxbow Reconnection Surveys 2010						
Site Name:			**Date:**		**Page: 1 of ____**	
Bank Tender:		**Divers:**				
Weather: **(R) (O) (PC) (S)**		**Wetted Width:** Down: (m) Up: (m)				
Start Time:	Start Temp: (C)		End Time:		End Temp: (C)	
Percent of Site Sampled:		Lure visibility:	(m)		(m)	(m)
Reason % Unsampled:						

Species	Size	B.tender	Diver1	Diver2	Diver3	Diver4

Fish Count Survey – Additional Pages

Nason Creek Oxbow Reconnection Surveys 2010						
Site Name:			**Date:**		**Page: ____ of ____**	
Species	Size	B.tender	Diver1	Diver2	Diver3	Diver4

Fish Count Survey – Site Sketch

Nason Creek Oxbow Reconnection Surveys 2010		
Site Name	**Date:**	**Page: ____ of ____**
Sketch By:	**Include: Scale, Flags, Habitat, LWD, Survey Area**	
Sketch (include comments):		

Appendix C. Equipment Lists

General Equipment

Item	Comments
Data sheets	Example snorkel and electrofishing data sheets are provided in Appendix B. Data sheets will be printed on waterproof "rite-in-the-rain" paper. Extra data sheets will be prepared prior to heading into the field.
Binder	A clipboard, tatum, or waterproof "rite-in-the-rain" binder should be used to organize and protect data sheets while in the field.
Pencils	Wood and/or mechanical pencils for the field kit.
Pencil sharpener	
Erasers	
Thermometer	Digital or alcohol-based thermometer accurate to 1°C. Calibrated in the lab to a NIST-certified thermometer.
Fishing lure	4-inch Castaic Catch 22 Rainbow Trout lure with hooks removed. For measuring underwater visibility.
First aid kits	
Glow sticks	Night snorkel: to mark the start and end of each site. To flag measurement points along the reach.
Extra ruler	
Dry suit repair kit	Waterproof sealant for minor dry suit repairs in the field.
Dry suit maintenance kit	Talc powder and wax for maintaining dry suits in the field.
Mask defogger	
Extra batteries	Extra batteries for flashlights.
Dive light	A minimum of one spare dive light should be carried with each crew.
Flagging	All non-essential flagging will be removed when it is no longer needed.
Measuring tape	
Permanent marker	
Fish field guides	
Waterproof camera	
Site maps	
Cell phone or radio	
Whistle	Waterproof, ice-resistant safety whistle for all surveyors.
Duct tape	
Multi-purpose tool	Such as a "Leatherman" or "Swiss Army Knife"

Personal Equipment

Item	Comments
Dry suits	All dry suits will be checked for leaks prior to and at the end of each field season. Dry suits will be maintained leak free throughout the field season. Dry suits and wetsuits will have cryptic coloration (brown or black). Bright colors will be avoided. Dry suits function as personal flotation devices (PFD) for the snorkel crew.
Thermal undergarments	All dry suit sets are equipped with thermal undergarments, including thermal gloves and booties. Additional layers of warm-when-wet undergarments are recommended for winter surveys.
Mask and snorkel	Mask and snorkels will be properly fitted to each snorkeler. An extra mask and snorkel will be available. Masks and snorkels will either be clear or black in color.
Boots	Wading boots will be worn over the latex feet of the dry suits.
Neoprene gloves/dry gloves	Summer: neoprene gloves. Winter: dry gloves.
Neoprene hood	Properly fitted.
Anti-fog solution for masks	
Data cuff and pencils	Data cuffs for recording fish count data made from PVC pipe and rubber tubing. Marked with metric length measurements to assist in fish size estimation.
Ruler/or dowel	Small rulers or dowels will be carried by each observer to aid in fish size estimation .
Knee Pads	For protection of knees and dry suits while crawling through shallow reaches.
Dive lights	Night sites: one per person plus a spare. Day sites: one spare per crew.
Dive beacon	Each snorkeler will wear a dive beacon for night surveys.
Hand and foot warmers	
Ear plugs and ear drops	
Food and water	
Spare clothing and towel	

Bank Tender Equipment

Item	Comments
Waders or dry suit	In summer, quick-dry shorts and neoprene socks can be substituted for waders. A dry suit may be necessary for bank tending at the oxbow site due to deep water and mud.
Wading boots	Vibram-soled. If felt-soled, one dedicated pair per site.
Personal flotation device	Flotation devices are required for all Ecology employees working in and near water.
Backpack or dry bag	
Flashlight	Night snorkels: A flashlight in addition to the spare dive light listed under "General Equipment."
Throw bag	Throwable bag containing a rescue rope with handles.
Head lamp	
Sunglasses	
Food and water	

Additional equipment required for winter snorkel surveys

Item	Comments
Thermos with hot water	
Blankets or sleeping bag	
Propane heater	