Rocky Reach Project Resident Fish Study

Completion Report

Submitted by:

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I. Introduction

The Rocky Reach Hydroelectric Project, FERC Project No. 2145, which is owned by Public Utility District No.1 of Chelan County (Chelan PUD), was started in 1956 and completed in 1961. In 1969, additional generating units were added and the Rocky Reach Project (Project) reached its present size and configuration in 1971. The Rocky Reach Dam created a 43-mile long reservoir referred to as Lake Entiat. To meet the natural resource requirements, a Natural Resources Working Group was organized to develop a Comprehensive Resident Fish Management Plan (RFMP) for the Project. An outline of this Resident Fish Study Plan was recently released and it has three clear goals to implement within the Project boundary, which are to: 1) protect and enhance resident fish; 2) protect their habitat; and 3) enhance recreational fishing opportunities. In addition, Chelan PUD agreed to implement several resident fish Protection, Mitigation, and Enhancement measures (PMEs). One PME was to conduct "resident fish monitoring to measure relative abundance and species composition in the Reservoir," which is section 4.2 of the RFMP. A second PME is to "evaluate the creation of an additional recreational fishing opportunity in the Reservoir that is compatible with existing fish resources," which is section 4.1.3 of the RFMP.

In 2010 the Chelan PUD contacted the Washington Department of Fish and Wildlife (WDFW) Large Lakes Research Team (LLRT) to develop a study plan to catalogue the resident fishes within the Project. The LLRT has conducted similar studies of resident fishes in a number of eastern Washington lakes and reservoirs and recently collaborated with the U.S. Geological Survey (USGS) on a Grant County Public Utility District (Grant PUD) funded study in the Priest Rapids Project. Although smaller in scope, the Chelan PUD funded Rocky Reach Project Resident Fish Study was completed in a manner that will allow comparisons to portions of the Grant PUD funded study.

The initial study was designed to satisfy the requirement to evaluate the creation of an additional recreational fishing opportunity, section 4.1.3, and determine next steps for resident fish monitoring, section 4.2: either conducting 2 additional one-year surveys for determining the efficacy of predator control measures; or conducting 3 additional one-year monitoring surveys to monitor any changes in abundance or species composition in the resident fish populations in the Reservoir.

II. Study Area

The Rocky Reach Project extends from the tailrace of the Rocky Reach Dam approximately 69 km upstream to the Wells Dam tailrace (Chelan PUD 1999). The dam itself is located in north central Washington approximately seven miles from the city of Wenatchee (Figure 1). Due to the large spatial scope of the sampling area the Project was divided into 3 areas, upper, middle and lower which contained 37 sections (separate maps). Furthermore, each section contained multiple sites which were randomly selected for sampling (Figure 2). Along with the visual description of individual sites coordinates in UTM's were used to navigate during sampling efforts.

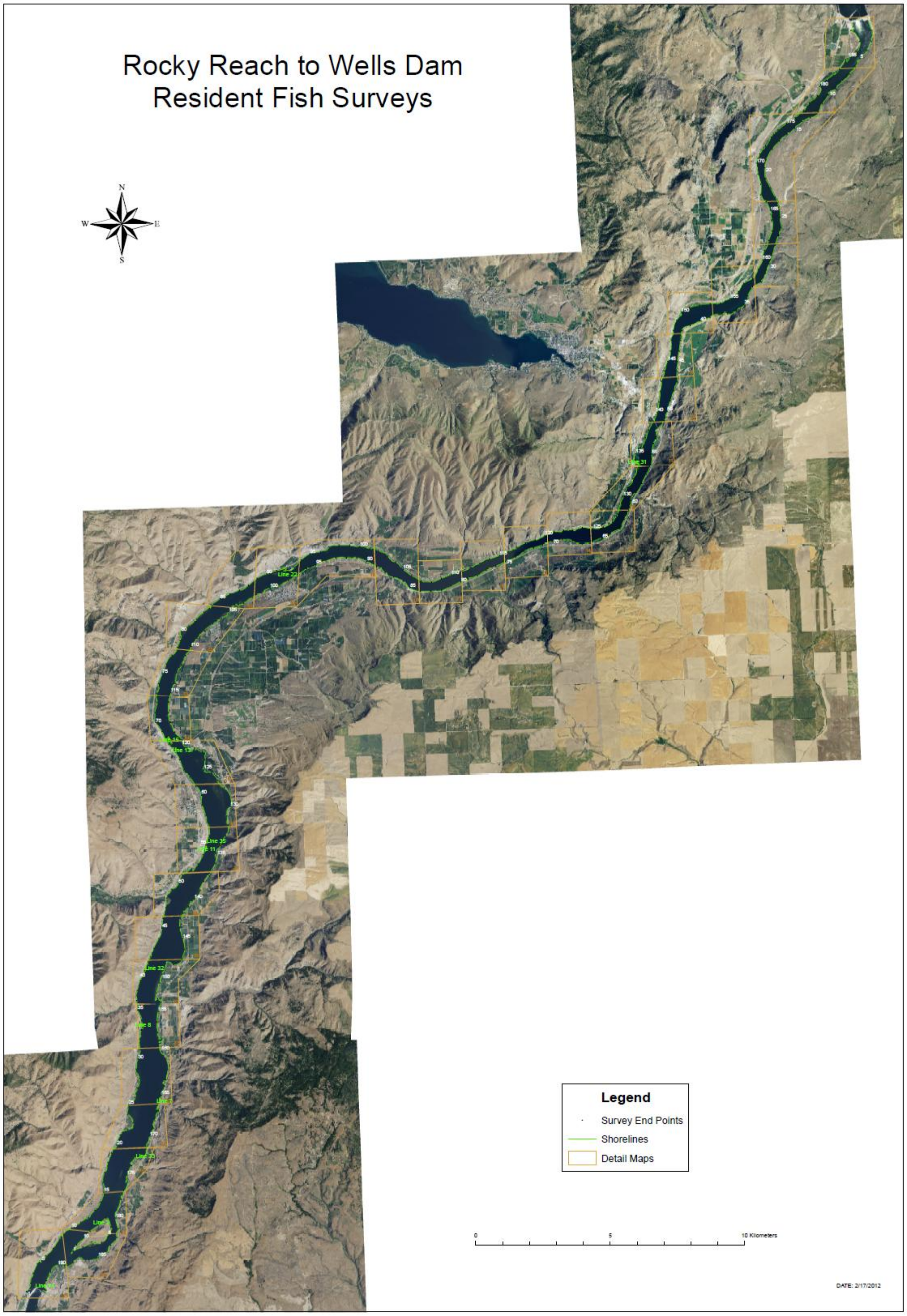

Figure 1. GIS representation of Rocky Reach Project from Rocky Reach Dam upstream to Wells Dam with individual sections throughout the Project.

Figure 2. One of the 37 sections and associated sites including the Rocky Reach Hydroelectric Project.

III. Study Goal

The primary goal of this study was to conduct a scientifically sound resident fish survey and collect relevant data within the Priest Rapids Project. This study was designed to be repeatable and used for future index sampling throughout the duration of the current FERC license to detect potential changes within the fish assemblage of the Project. Although the current design precluded hypothesis testing with respect to interactions such as predation, we were able to assess the resident fish assemblage within the Project.

There are three primary objectives associated with the Rocky Reach Project Resident Fish Survey.

1. To support the goal of the Rocky Reach RFMP, which is "to protect and enhance resident fish and their habitat within the Project boundary and to enhance recreational fishing opportunities." Tasks within this study were developed to meet the requirements in sections 4.1.3 and 4.2 of the RFMP. One objective of this plan, in accordance with the Settlement Agreement, was to "conduct resident fish monitoring to measure relative abundance and species composition in the [Rocky Reach] Reservoir." The size and the open nature of the Project make abundance estimates difficult to accomplish accurately with reasonable minimum and maximum bounds. Consequently, this objective was modified to monitor and assesses ***changes*** in the resident fish community.

2. Evaluate fish habitat in areas of heavy aquatic vegetation growth, including water quality, the types of vegetation in these areas (emphasizing native vs. non-native), and the relative abundance of resident predators such as northern pikeminnow (*Ptychocheilus oregonensis*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), walleye (*Sander vitreus*), and channel catfish (*Ictalurus punctatus*).

3. To "…evaluate the creation of an additional recreational fishing opportunity in the Reservoir that is compatible with existing fish resources."

IV. Methods and Analysis

Prior to the 2012 sampling season the LLRT requested a permit renewal from NOAA in 2011. On June 11, 2012 NOAA issued a Scientific Research Permit 16433 to the LLRT for sampling within the Columbia Basin. Because the LLRT was operating in a system that could potentially contain several Endangered Species Act (ESA) listed species, LLRT staff maintained a high level of safety and operational standards and treated every salmonid as a listed species. In addition, salmonids were not purposely netted so as not to exceed the take in our permit. Capturing and handling salmonids can be a significant stressor to sensitive species and this can be further exacerbated during the summer months when water temperatures are at their highest. NOAA recognized the potential impacts from handling salmonids during this period and has a stipulation with our permit 16433 stating the following:

> *Each researcher must stop capturing and handling listed fish if the water temperature exceeds 70 degrees Fahrenheit at the capture site. Under these conditions, listed fish may only be identified and counted. Additionally, electrofishing is not permitted if the water temperatures exceed 64 degrees Fahrenheit.*

Consequently, the water temperature was used as an indicator when sampling within the Rocky Reach Project could be conducted.

a. Boat electrofishing

Boat electrofishing was conducted along the shoreline at the preselected random sites using two, 5.5 m (18 ft) Smith Root 5.0 Generator Powered Pulsator (GPP) electrofishing boats (Figure 3). Individual electrofishing boats operated downstream and parallel to the shoreline at a rate of 1–1.4 m/h, maintained a distance from shore that allowed the inshore boom to fish entirely in the water, and avoided areas that exceeded 3 m in depth. To initiate fish galvanotaxis, we operated the GPP unit at approximately 1–2 amperes (amps) using a low power setting (50–500 volts) with a frequency between 30–120 Hz DC. Each crew consisted of one boat operator and two dip netters stationed at the front of the vessel. The target effort for each individual site was 600 seconds but varied on occasion due to environmental factors and in–river hazards that resulted in aborting the remainder of the site.

Boat electrofishing began thirty minutes after official sunset. However, boats were launched earlier each night in order to enter all site coordinates and test electrofishing units before transiting to designated sites in the dark. Once at a designated site, boat crews recorded the following information: water temperature, specific conductance, time when sampling began, coordinates in UTM, initials of crew, assigned coordinates, date, and site designation. Upon completion of site data collections, the boat operator verified the crew’s readiness, started the onboard generator, oriented the boat downstream, and began electrofishing. Two crew members located at the bow of the boat used 8’ long dipnets to capture stunned fish that were immediately placed into one of the two onboard livewells equipped with a pump that continually added fresh water into the tank. It was also the job of the netters to make the boat operator aware of approaching hazards while electrofishing at which point maneuvers could be initiated to prevent injury to staff or damage to equipment. After 600 seconds of electrofishing, the boat operator pressed the man overboard button on the GPS to identify the end of the actual electrofishing site. This information was then recorded on the data sheet along with the power settings used to electrofish. Following site data collection, the boat crew secured all items and traveled to the next selected sample site where the methods were repeated. After the completion of two–600 second electrofishing sites, the boat operator moored the electrofishing boat and worked up all captured fish. Work up consisted of identifying all fish, recording their lengths and weights and releasing them back into the river. In the event transit time between sites was extended as a result of distance or environmental conditions, crews collected the pertinent data from the captured fish immediately after the completion of the first site.

Figure 3: LLRT electrofishing boat preparing to commence shocking run at a prescribed site during the 2012 survey. Whisker-like booms in the foreground are lowered into the water prior to starting the on board generator.

b. Fyke Nets

Unlike boat electrofishing which is an active form of sampling, fyke nets are passive and used to intercept fishes moving parallel to the littoral zone during the night. Fyke nets were set with the lead line on shore, and the first hoop closest to shore just under the water with the wings in a 45-degree angle towards the shore (Figure 4). The lead line on the shore was either held in place with a large weight or tied to a stationary object on shore. The cod end which was located furthest from shore was held in place with a large pancake weight to assure the fyke net remained open and did not collapse while fishing. After a night of soaking, a boat crew picked up the fyke net from the cod end side and placed fish immediately in the live well. Data including length, weight and species identification were recorded from captured fish. In addition total fishing time and exact location were recorded.

Figure 4: LLRT staff deploying a fyke net within the Rocky Reach Reservoir during the 2012 summer survey.

c. Popnetting

In areas of thick macrophytes and appropriate depths, we sampled resident fish using popnets similar to those used by Morgan et al (1988). Areas of concern were identified by PUD staff and then confirmed for heavy vegetation growth by LLRT staff. A popnet consists of a 3.05 x 3.05 m (10 x 10 ft) frame of polyvinyl chloride (PVC) filled with float material and a frame of equal dimensions filled with weights. Each popn et sampled a 9.29 m^2 (100 ft^2) area per net set (Figure 5). The frames are connected by a 1.83 m (6 ft) net with 6.35 mm (0.25 in) knotless mesh. Upper and lower frames were pinned together and the nets set flush with the substrate. Contact between the substrate and the bottom frame was accomplished by placing sandbags over the bottom frame and a net skirt to ensure that fish cannot escape the sample area. To trigger the popnet, 100’ cords were attached to each pin so they could be pulled without approaching the net and skewing results. The cords that were attached to the pins ran parallel to shore and held in place far away from the trap with a small weight and buoy.

Approximately 24 h after setting a net LLRT staff approached a popnet and simultaneously pulled the pins causing the top frame to rapidly float to the surface and enclose the fish within the area of the net. Once a popnet was deployed, a specialized seine was pulled through the popnet enclosure to capture all the fish following a depletion method (Everhart and Youngs 1981). We made no less than three passes with the seine to collect fish. Seining continued until we collected less than half the number of fish as were collected from the previous pass. As with electrofishing and fyke netting lengths, weights, species identification and specific location were recorded. Using a YSI 6600 V2 Multiparameter Water Quality Sonde (YSI sonde) unit we also collected water quality parameters in the areas where we set popnets.

Figure 5. A typical popnet deployment by Large Lakes Research Team personnel.

Analysis

Catch per unit effort for electrofishing and fyke netting will be calculated separately using the following formulas:

$$CPUE = N / T$$

Where CPUE is catch per unit effort, N is the number of individuals, and T is time (seconds for electrofishing and net-night for fyke netting. This analysis can be completed for the entire data set of like methods or can be partitioned in a number of ways to detect temporal and spatial variation.

Species composition will be calculated based on number and weight for each of the different sampling methods, as an absolute abundance estimate is not reasonable to calculate. Species composition by weight (biomass) is calculated using the following formula:

$$\text{Species comp.} = (\Sigma Spp_{wt} / \Sigma\ T_{wt})*100$$

Where Spp_{wt} is the weight of an individual species and T_{wt} is the total weight of all the species collected. Species composition by number is calculated using the same formula by substituting the sum of the number of a species and the total number of individuals for all species, respectively.

Due to the small number of predators captured during this project there was no need to calculate relative weights for predators within the Rocky Reach Project.

Additional data analysis will include developing a length frequency histogram for the three primary methods of fish capture.

From each individual popnet deployment, a population estimate will be conducted using a multiple removal-depletion method. For each popnet, we will perform a linear regression for each species where catch is a function of the sum of catch. Using these data, we will estimate the number of individuals of each species for ages 0, 1, and 2 in each popnet haul by:

$$N = \frac{a}{b}$$

Where N is the number of individuals of each species in each popnet haul, a is the intercept of the straight-line equation, and b is the slope of the straight-line equation.

V. Results

The Rocky Reach Resident Fish Survey was broken into two sampling seasons; summer and fall. During the summer survey we sampled using electrofishing boats, fyke nets, popnets and YSI portable water quality sampler. During the fall sampling period we used electrofishing boats and fyke nets. However, along with the prescribed standard sampling we also completed a targeted electrofishing survey around docks identified by the Chelan PUD. During the course of the project over 100 sites were sampled using all the methods we employee (Figure 6).

Species composition and biomass was dominated by *Cyprinidae* (minnows) and *Catostomidae* (suckers) during the summer boat electrofishing and fyke netting efforts (Tables 1&2). Electrofishing was more effective at catching all species of fish compared to fyke netting and in general larger fish as well (Table 3). Catch per unit effort data corroborated the abundance of sucker and minnow at the top 4 most prolific species were within these families (Table 4). Interestingly, the species composition of fish captured in our popnets was dominated by the family Gasterostedae, specifically the three-spine stickleback (Table 5). As expected fish captured in the popnets were smaller in length and were most likely comprised of young of year and 1 year olds (Table 6). The abundance of fish captured within the dense macrophytes by popnets suggested water quality parameters were adequate to support a fish assemblage. Water quality data collected at these sites further indicates appropriate conditions existed for multiple life stages of fish (Table 7).

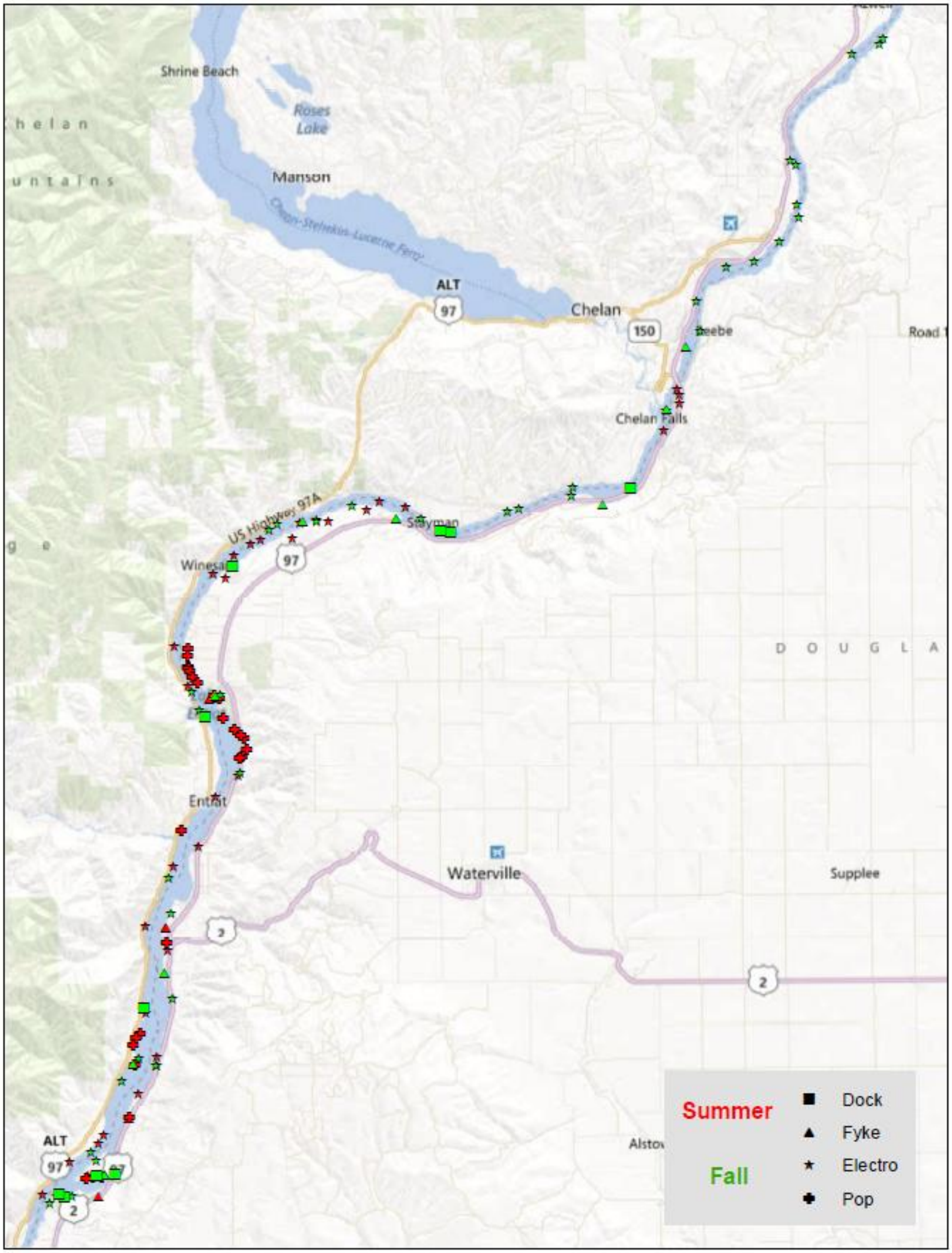

Figure 6. GIS visual of temporal and spatial distribution of all sampling techniques utilized throughout the Rocky Reach Resident Fish Survey.

Table 1: Species composition by number during summer 2012 Rocky Reach survey.

	Electrofishing %	Fyke Netting %	Electrofishing #	Fyke Netting #
Bluegill	0.21	0.00	5	
Bridgelip Sucker	0.46	0.00	11	
Chinook Salmon	0.04	0.71	1	1
Chiselmouth	8.52	5.71	205	8
Sculpin	6.94	2.14	167	3
Carp	0.33	0.00	8	
Minnow Spp.	0.42	0.00	10	
Longnose Sucker	0.25	0.00	6	
Largescale Sucker	22.10	9.29	532	13
Northern Pikeminnow	30.83	60.00	742	84
Peamouth	3.32	0.71	80	1
Pumkinseed	0.04	0.00	1	
Redside Shiner	22.35	0.71	538	1
Sucker Spp	2.29	0.00	55	
Smallmouth Bass	0.50	0.00	12	
Tench	0.46	2.86	11	4
Threespine Stickleback	0.37	17.86	9	25
Walleye	0.04	0.00	1	
Whitefish spp.	0.46	0.00	11	
Yellow Perch	0.08	0.00	2	

Table 2: Biomass of individual species for both electrofishing and fyke net sampling during 2012 summer survey.

	Electrofishing	Fyke Netting
Bluegill	0.07	0.00
Bridgelip Sucker	0.43	0.00
Chinook Salmon	0.01	0.02
Chiselmouth	3.38	0.72
Sculpin	2.81	0.98
Carp	5.89	0.00
Minnow Spp.	0.00	0.00
Longnose Sucker	0.61	0.00
Largescale Sucker	54.07	11.91
Northern Pikeminnow	17.50	34.68
Peamouth	2.76	1.27
Pumkinseed	0.02	0.00
Redside Shiner	2.62	0.05
Sucker Spp	2.57	0.00
Smallmouth Bass	0.70	0.00
Tench	6.30	50.05
Threespine Stickleback	0.00	0.33
Walleye	0.02	0.00
Whitefish spp.	0.07	0.00
Yellow Perch	0.16	0.00

Table 3: Mean length and 95% C.I. of fish captured electrofishing and fyke netting during summer 2012 resident fish survey.

	Electrofishing		Fyke Netting	
Species	**Mean Length**	**95% C.I.**	**Mean Length**	**95% C.I.**
Bluegill	114.8	31.0		
Bridgelip Sucker	196.9	75.1		
Chinook Salmon	112.0		64.0	
Chiselmouth	152.3	72.4	105.8	28.3
Sculpin	130.0	92.0	143.3	36.7
Carp	699.8	201.1		
Minnow Spp.	43.8	10.2		
Longnose Sucker	259.3	156.6		
Largescale Sucker	244.2	205.1	211.8	88.3
Northern Pikeminnow	164.0	121.5	142.3	144.6
Peamouth	201.3	131.1	263.0	
Pumkinseed	124.0			
Redside Shiner	101.5	48.8	79.0	
Sucker Spp.	184.3	163.0		
Smallmouth Bass	200.2	145.3		
Tench	407.7	277.4	464.5	58.8
Threespine Stickleback	48.9	7.2	49.8	8.5
Walleye	189.0			
Whitefish Spp.	107.8	67.7		
Yellow Perch	233.0	82.0		

Table 4. Catch per unit effort (CPUE) for boat electrofishing (EB) and fyke netting (FN) during the 2012 summer Rocky Reach survey.

	EB	FN
Species	CPUE (fish/hr)	CPUE (fish/net night)
Bluegill	0.86	0.00
Bridgelip Sucker	1.89	0.00
Chinook Salmon	0.17	0.14
Chiselmouth	35.14	1.14
Sculpin	28.63	0.43
Carp	1.37	0.00
Minnow Spp.	1.71	0.00
Longnose Sucker	1.03	0.00
Largescale Sucker	91.20	1.86
Northern Pikeminnow	127.20	12.00
Peamouth	13.71	0.14
Pumkinseed	0.17	0.00
Redside Shiner	92.23	0.14
Sucker Spp	9.43	0.00
Smallmouth Bass	2.06	0.00
Tench	1.89	0.57
Threespine Stickleback	1.54	3.57
Walleye	0.17	0.00
Whitefish spp.	1.89	0.00
Yellow Perch	0.34	0.00

Table 5. Species composition using expanded population estimates of fish captured in summer popnets within dense macrophyte mats at specific locations of the Rocky Reach Pool.

Species	**Number**	**%**
Chiselmouth	7	0.9
Sculpin Spp.	22	2.7
Minnow Spp.	1	0.1
Northern Pikeminnow	99	12.3
Peamouth	9	1.1
Redside Shiner	37	4.6
Smallmouth Bass	1	0.1
Sucker Spp.	60	7.4
Threespine Stickleback	568	70.5
Unknown	2	0.2

Table 6. Range in length (mm) of fish captured in 27 popnets located within areas of high macrophyte densities within the Rocky Reach Project.

Species	Min. Total Length (mm)	Mean Total Length (mm)	Max. Total Length (mm)
Chiselmouth	31	70	110
Northern Pikeminnow	12	31	98
Peamouth	13	19	23
Redside Shiner	19	63	82
Sculpin spp.	24	33	44
Smallmouth Bass	81	81	81
Sucker spp.	14	29	53
Threespine Stickleback	16	30	59
Unidentified Fish	10	10	10

Table 7. Mean standard water quality parameters collected from locations where popnets were deployed during the summer of 2012 Rocky Reach Resident Fish Survey.

Location	Temperature	Specific Conductance	Dissolved Oxygen	pH	Turbidity	Secchi Depth
	C	us/cm	mg/L	pH	NTU	meters
24-2	17.84	152.00	10.14	8.13	0.05	0.20
24-3	17.94	150.50	11.53	8.58	0.78	0.70
24-4	18.00	150.75	11.32	8.53	0.35	0.55
24-5	17.89	151.00	10.43	8.27	-0.55	1.00
25-2	17.87	152.00	10.86	8.30	0.70	0.40
25-3	18.03	152.00	10.76	8.17	2.80	0.30
25-6	17.95	152.00	10.29	8.11	0.73	1.50
25-7	17.81	151.00	10.13	8.03	3.25	0.50
26-1	17.97	156.00	10.54	8.38	0.90	1.00
26-2	17.83	152.00	10.71	8.41	-0.10	2.00
26-3	17.70	152.00	10.71	8.41	2.45	0.70
26-4	17.61	150.50	10.53	8.25	0.25	0.80
26-5	17.09	153.00	10.79	8.26	0.65	1.00
28-9	17.71	151.00	10.86	8.31	0.35	0.50
30-8	17.40	150.67	10.88	8.27	-0.63	1.20
32-13	17.46	150.50	10.61	8.35	-1.00	0.90
32-14	17.46	150.00	10.95	8.45	-0.60	1.30
33-6	17.90	151.00	10.17	8.08	-0.80	0.80
33-8	17.66	150.00	11.00	8.48	-1.05	1.00
34-5	17.38	151.00	10.35	8.13	-0.90	0.70
36-13	17.99	151.00	10.61	8.12	-0.45	0.70
36-14	17.47	151.00	10.30	8.06	2.67	1.20
36-15	16.60	151.50	11.00	8.37	5.55	0.94

During the fall sampling period minnows dominated the species composition of fish captured in our boat electrofishing and fyke netting efforts (Table 8). Although not as abundant relative to other species sampled, large scale sucker still represented 56% of the biomass captured during our efforts (Table 9). Fyke nets captured 12 different species during the fall sampling including bluegill and a tagged adult steelhead that were not captured with boat electrofishing. Boat electrofishing yielded 18 different species, the majority of which had a mean length longer than the same species captured in the fyke nets (Table 10). The CPUE data indicated the most abundant families of fish contacted were minnows and suckers with as 198 redside shiners collected in a typical hour of electrofishing. Three-spine sticklebacks were caught at a rate of 43 per night in the fyke nets deployed during the fall sampling period (Table 11). Minnows dominated the composition of the assemblage during our electrofishing efforts in the dock areas (Table 12). Generally the length of individual fish within a species was static. However, some species of minnows occupy the same habitat throughout their life histories which was indicated by the 95% confidence interval around the mean in some species such as carp and tench (Figure 7).

Table 8. Species composition of fishes captured during the fall 2012 Rocky Reach survey.

	Electrofish%	Fyke Net %	Electrofish #	Fyke Net #
Bluegill	0.00	0.72		2
Bridgelip Sucker	0.57	0.00	14	
Chiselmouth	18.34	11.23	452	31
Sculpin	4.55	0.00	112	
Carp	0.08	0.00	2	
Minnow Spp.	0.20	0.00	5	
Largemouth Bass	0.24	0.00	6	
Longnose Sucker	0.37	0.72	9	2
Largescale Sucker	12.13	3.26	299	9
Northern Pikeminnow	16.92	17.39	417	48
Peamouth	5.48	2.17	135	6
Redside Shiner	47.00	20.65	1158	57
Steelhead	0.00	0.36		1
Sucker Spp.	0.81	1.45	20	4
Smallmouth Bass	0.16	0.72	4	2
Tench	0.04	0.00	1	
Threespine Stickleback	1.34	140.58	33	388
Walleye	0.12	0.00	3	
Whitefish	0.89	0.00	22	
Yellow Perch	0.16	0.36	4	1

Table 9. Biomass of fish captured during the fall 2012 Rocky Reach Survey.

Species	Electrofish %	Wt. in Grams	Fyke Net %	Wt. in Grams
Bluegill	0.00		2.57	170
Bridgelip Sucker	1.07	2357	0.00	
Chiselmouth	9.86	21702	7.06	467
Sculpin	1.18	2602	0.00	
Carp	0.79	1749	0.00	
Minnow Spp.	0.08	172	0.00	
Largemouth Bass	0.03	61	0.00	
Longnose Sucker	2.04	4482	14.16	937
Largescale Sucker	56.92	125247	51.70	3422
Northern Pikeminnow	13.90	30594	9.84	651
Peamouth	7.11	15642	10.70	708
Redside Shiner	4.36	9605	3.14	208
Steelhead	0.00		0.00	
Sucker Spp.	0.01	22	0.12	8
Smallmouth Bass	0.08	182	0.15	10
Tench	0.67	1474	0.00	
Threespine Stickleback	0.01	15	0.54	36
Walleye	0.60	1323	0.00	
Whitefish	1.19	2614	0.00	
Yellow Perch	0.09	207	0.03	2

Table 10. Mean length and 95% confidence interval of fish captured during the fall 2012 Rocky Reach Resident fish survey.

	Electrofishing		Fyke Netting	
SPECIES	**Mean Length**	**95% C.I.**	**Mean Length**	**95% C.I.**
Bluegill			146.5	41.0
Bridgelip Sucker	245.9	90.0		
Chiselmouth	169.7	89.1	95.5	92.5
Sculpin	114.7	53.5		
Carp	584.5	340.8		
Minnow Spp.	109.0	206.7		
Largemouth Bass	88.0	36.3		
Longnose Sucker	361.7	145.1	362.5	137.2
Largescale Sucker	303.3	274.3	216.9	387.7
Northern Pikeminnow	178.6	146.8	108.4	81.0
Peamouth	216.3	169.7	243.3	111.3
Redside Shiner	97.1	54.7	77.9	42.3
Steelhead			561.0	
Sucker Spp.	53.3	22.6	61.8	8.5
Smallmouth Bass	109.0	171.5	69.5	41.0
Tench	531.0			
Threespine Stickleback	38.3	22.6	47.0	13.8
Walleye	244.0	455.9		
Whitefish	218.5	115.2		
Yellow Perch	117.5	165.7	56.0	

Table 11. Catch per unit effort (CPUE) for boat electrofishing (EB) and fyke netting (FN) during the 2012 fall Rocky Reach survey.

	EB	FN
	CPUE (fish/hr)	CPUE (fish/net night)
Bluegill	0.00	0.22
Bridgelip Sucker	2.40	0.00
Chiselmouth	77.49	3.44
Sculpin	19.20	0.00
Carp	0.34	0.00
Minnow Spp.	0.86	0.00
Largemouth Bass	1.03	0.00
Longnose Sucker	1.54	0.22
Largescale Sucker	51.26	1.00
Northern Pikeminnow	71.49	5.33
Peamouth	23.14	0.67
Redside Shiner	198.53	6.33
Steelhead	0.00	0.11
Sucker Spp.	3.43	0.44
Smallmouth Bass	0.69	0.22
Tench	0.17	0.00
Threespine Stickleback	5.66	43.11
Walleye	0.51	0.00
Whitefish	3.77	0.00
Yellow Perch	0.69	0.11

Table 12. Species composition of fish captured during dock specific sampling during the fall of 2012.

	%	#
Bluegill	0.06	1
Bridgelip sucker	0.12	2
Chinook Salmon	0.53	9
Chiselmouth	25.31	427
Sculpin	1.72	29
Carp	0.12	2
Minnow Spp.	0.18	3
Largemouth Bass	0.24	4
Longnose Sucker	0.41	7
Largescale Sucker	7.17	121
Northern Pikeminnow	21.75	367
Peamouth	10.49	177
Redside Shiner	28.99	489
Sucker Spp.	1.66	28
Tench	0.24	4
Threespine Stickleback	0.83	14
Walleye	0.06	1
Whitefish	0.06	1
Yellow Perch	0.06	1

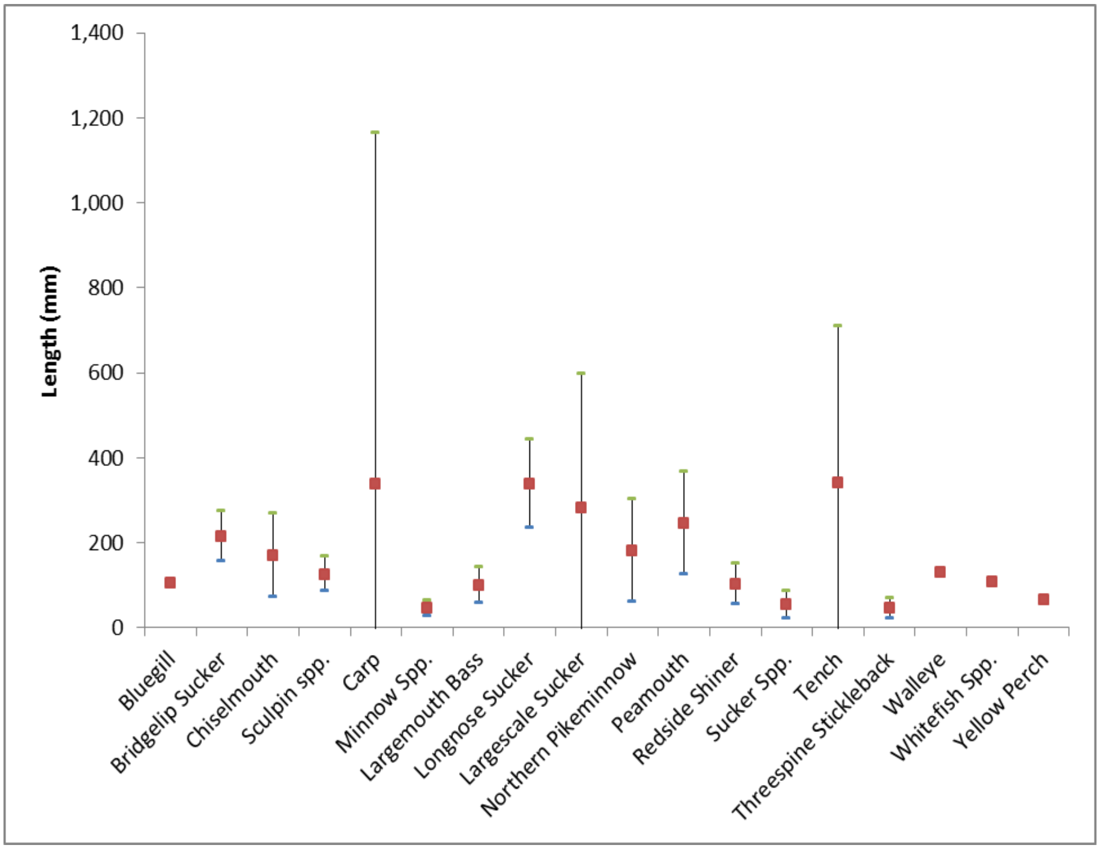

Figure 7. Mean size and 95% interval of fish captured during dock specific sampling in the fall 2012 survey.

VI. Discussion

Three primary goals were listed within section III that we set out to achieve at the beginning of the Rocky Reach Resident Fish Project. The first of which was simply a compliance task to accurately assess the resident fishery with the Rocky Reach Project. There were several environmental factors that greatly impacted the progress of this task. During the late winter of 2012 record snowfalls were delivered to regions within the Columbia Basin. Consequently, spring runoff was substantial in volume and duration and extended into summer. As in many areas within the east slopes of the Cascades high winds are often experienced. On several occasions our sampling periods were aborted due to winds that generated large waves and chop that would have greatly impacted our CPUE by refracting our lights and reducing our netters ability to recognize and capture stunned fish. Another environmental phenomenon we dealt with during the fall sampling period was the inundation of the region with smoke as a result of several large forest and range fires and a lack of wind. Department of Ecology air monitoring data indicated hazardous conditions with respect to air quality on a regular basis in the areas sampling was required and recommended people remain indoors. Fire personnel could not predict when the region’s fires would be extinguished and no changes in the weather were forecasted during our sampling times. Consequently, LLRT staff were fitted and issued full facemask respirators with dual carbon and organic filters to reduce the likelihood of negative impacts from smoke inhalation.

Despite the environmental conditions quality data was collected and the project completed. Data generally followed the typical fisheries regime between summer and fall sample periods. For example, species that were collected in large numbers were longer in length during the fall survey compared to the summer survey. In addition the distribution of fish throughout the Project between summer and fall sample period was variable as indicated by the CPUE data. Variations in distribution between seasons are often attributed to life history traits such as temporal spawning movements. Due to seasonal variability it is not appropriate to compare between the summer and fall sample periods. The collected data should be used for future resident fisheries surveys to detect possible changes.

We had expected to capture a large number of minnows and suckers in Rocky Reach similar to the assemblages we have sampled above and below the Project. However, unlike other systems below and above the Project, the Rocky Reach Pool lacked comparative numbers of non-native predators such as smallmouth bass. Initially the Chelan PUD was concerned with the presence of docks within the Rocky Reach Pool potentially attracting non-native predators such as bass and creating an environment where predators and Chinook salmon overlaps. However, during the additionally designed fall dock survey project we only contacted 4 largemouth bass and 1 walleye in over 3.3 hours of electrofishing. Currently, we do not know why non-native predators are less abundant in the Rocky Reach Pool compared to other systems. We did capture 367 northern pikeminnow at a rate of 110 per hour or approximately 40 northern pikeminnow per hour of electrofishing greater than our standardized sampling regime. Therefore it does appear that structures can increase the number of pikeminnow within the littoral zone of the Rocky Reach Pool.

One of the concerns the Chelan PUD has with the Rocky Reach pool are the large number of macrophyte mats and what their impacts may be on water quality in the vicinity of the mats. There have been recorded instances of submerged vegetation impacting dissolved oxygen and pH parameters (Clayton and Edwards 2006; Frodge et al. 1990). However in a system such as the Rocky Reach pool where there is a constant flow of water a retention time of as little as 1 day (Hemstrom Pers Comm. 2012) the likelihood of sustained poor water quality standards persisting is minimal. That being said, fish in the egg stage could be impacted by poor D.O. and pH conditions as they lack the ability to simply move to habitat that is more suitable. Such conditions would be a concern if we did not detect young of year fish but that was not the case. Therefore, any water quality impacts are most likely negligible and localized mortality can be simply attributed to natural mortality.

Regarding the evaluation of a potential recreational fishery within the reservoir is not as simplistic as we had originally anticipated. Prior to the commencement of the Rocky Reach surveys we had expected to capture an abundance of non-native gamefish such as bass species and walleye similar to the assemblage in impoundments above and below the Rocky Reach Project. We had developed a generic plan of action that would have permitted us to us our collected data and pinpoint congregations of such fish and developed an angler friendly GIS product used to target said populations. Not only would this strategy have been desirable to many anglers but could potentially relieve deleterious interactions between native and non-native fishes within the system had they existed. However, our sampling methods during both seasons yielded very few desirable game fish.

Some of the original ideas for resident fisheries within the Rocky Reach pool were to develop a supplementation program within the reservoir with such species as kokanee or rainbow. However, we feel that such a program would not be beneficial to the sensitive and listed species that utilize and pass through the project. Kokanee for example, have been used extensively throughout the Northwest with some degrees of success in various systems. However, several have found that kokanee can be susceptible to entrainment and the likelihood of kokanee remaining in the Rocky Reach system is minimal (Maiolie et al. 1992; Stober et al. 1983). Kokanee rely heavily only zooplankton as a food source and without a comprehensive zooplankton study we do not know if an adequate food source even exists. Rainbow trout are the most stocked fish in the northwest primarily as a put and take fishery. In Washington State the annual trout opener attracts upwards of 300,000 anglers opening day weekend and is appropriate in closed systems. However, in open systems with listed salmonids the supplementation of rainbow trout is not recommended or for several reasons. Within the Mid-Columbia the stocking of hatchery steelhead or anadromous rainbow trout has been greatly reduced and there is an effort to extirpate the remaining stocks via recreational fisheries (Bartlett and Tweit 2006). The primary concern with rainbow of hatchery origin within the Rocky Reach Project is the potential to hybridize with native wild stocks and dilute the genetic composition of the native populations. Increased negative interactions such as competition and predation is also a concern whenever adding more fish to a system. During the net pen rearing program on Moses Lake we discovered that rainbow trout were top end predators of fish as indicated by stable isotope analysis. Consequently, the supplementation of any fish species that could potentially impact native protected stocks is not recommended.

The question still remains regarding the creation of a resident fishery that is appropriate with the current assemblage within the Rocky Reach pool. In order to do so we explored some of the socioeconomics of fisheries within the Mid-West. Carp were introduced to the Great Lake Region in the late 1800's but have only recently been targeted as a formidable game fish primarily by specialized anglers (Baldwin et al. 1962; Bogue 2000). The carp angling trend has also been picking up in the northwest and there are several companies that guide for carp on Banks Lake. In an ever changing and unpredictable fishing environment, anglers are generally pretty resourceful and are willing to change focus and tactics to target other potential fisheries. The fish assemblage within the Rocky Reach Pool is dominated by minnows and suckers. The former of the two groups are sought after in other parts of the world such as Europe. However, suckers are commonly targeted and consumed in the mid-west. Therefore, we pose the question, is it feasible to develop a sucker fishery within the Rocky Reach Pool? With the data collected during our surveys we can develop maps that would outline areas of concentrations anglers could target. A number of the suckers we captured during our survey were quite large and would be sporting to catch on a rod and reel. In the Mid-West suckers are not only targeted for sport but also consumption. Consequently, if the suckers within the Rocky Reach pool are considered desirable to consume, promoting such a fishery would be relatively simple. As there are no primary literature sources on the preparation and consumption of suckers, we have turned to the internet to locate a myriad of sources explaining the capture, which is generally gigging and cooking of suckers (Associated Press 2013; Manitoba Conservation Fisheries 2013; Philips 2013).

Along with promoting a fishery that has a potentially desirable consumption component the Chelan County PUD may consider promoting a northern pikeminnow fishing derby. Rather than promoting a fishery for sport or consumptive purposes it may be feasible to offer cash rewards for the capture and kill of northern pikeminnow within the Rocky Reach pool. The BPA funded program below Priest Rapids Dam removes thousands of NPM every year and pays anglers upwards of $8.00 a fish. Rather than allocating a season to removing NPM the Chelan PUD could sponsor a weekend tournament(s) for recreational anglers NPM and be paid on a per fish basis. The Grant County PUD has sponsored such a tournament in the past and worked with local Chambers and businesses to promote their tournament with some success.

Due to the unique situation of the Rocky Reach Reservoir regarding the absent of currently desirable game fish and the presence of listed native stocks the promotion of any recreational fishery must be closely monitored so as not to impact protected stocks.

VII. Conclusion

The completion of this project will provide managers with baseline data in a manner that is repeatable for future monitoring and evaluation surveys necessary to detect changes. The potential for the Columbia River fish assemblage to change does exist. Future supplementation programs including salmon, steelhead, and white sturgeon could change the resident fish composition via interspecific interactions. Other changes within the reservoir could be attributed to additions via entrainment, angler introductions, or changes in the physical parameters associated with regional and/or global climate changes. Recent WDFW studies have indicated an increase in the presence of northern pike in the Pend Oreille within a one year period. In fact an LLRT creel clerk recently contacted an angler that captured a 26" northern pike that was caught at North Port, Washington. Should an apex predator become abundant within the Project, a change within the resident and anadromous fish assemblage will occur. As well as the potential for fish to be entrained into the Project, fish can also be relocated by anglers. In 2008 we received a call regarding a Moses Lake tagged walleye that was captured just below Wells Dam and it is believed this fish was moved by an angler.

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IX. Appendices

Appendix 1. Comment s from Art Viola regarding the direction of the study submitted to the Chelan PUD.

One of the goals of the Resident Fish Study is:

Goal: Recommend future actions needed to increase angling opportunity for resident fish in the Rocky Reach Reservoir.

Objective 1. Identify current resident fish species composition and relative abundance to one another.

Tasks: These need to be filled in, but are basically the field sampling already detailed in the draft study.

Objective 2. Describe the present habitats preferred by each resident fish species and if these are different or change with age class, time of year, water temperatures, and water flows, D.O. levels, etc.

Task 1. A literature search.

Task 2. Compare and describe preferred habitats of resident fish sampled in the field with literature derived information.

Objective 3. Describe current forage resources and resource abundance in the reservoir including, phytoplankton, zooplankton, macro-invertebrates.

Tasks: These need to be filled in, but are basically the field sampling already detailed in the draft study.

Task. Compared and describe preferred forage of resident fish sampled in the field with literature derived information.

Objective 4. Describe competition in time and location for forage among current resident fish species, potential future resident fish (stocked) and anadromous species.

Task 1. Compare and describe preferred forage of resident fish sampled in the field with literature derived information.

Objective 5. Describe predation in time and location among present resident fish species, potential future resident (stocked) and anadromous species.

Task 1. A comparison of field survey results with literature derived information.

Objective 6. Based on data collected in the field and literature derive information evaluate if an ecological niche exits capable of supporting the addition (by stocking) of a new resident fish species e.g. (cutthroat, kokanee or some other species) and whether this niche can be occupied without adding excessive competition for forage or predation to the present day assemblage of resident and anadromous fishes.

Task 1. A comparison of field survey results with literature derived information.

Objective 7. Provide a summary of your recommendations of future actions needed to increase angling opportunity for resident fish in the Rocky Reach Reservoir.

Appendix 2. Standard Operating Procedures for Boat/Towing Operations, Safety, and Gear Types Used for Fish Collections.

Boat Operations and Towing

All permanent LLRT personnel are required to complete both the U.S. Department of the Interior's Motorboat Operators Certification Course (MOCC) as well as the Smith-Root, Inc. Principles of Electrofishing class. Operators and crew are required to wear U.S. Coast Guard approved PFD's (type I, II, III, IV) at all times. All LLRT vessels are equipped with mapping GPS; however, operators should not rely on these systems during operations and always be on the lookout for hazards. While operating a vessel with the LLRT it is important that you adhere to the MOCC student manual as well as the Washington State Parks Adventures in Boating Washington Handbook. Prior to trailering a boat, it is the responsibility of the crew to conduct a thorough safety check of both the tow vehicle and trailer.

Safety checklist

Tow Vehicle

- Tire pressure
- Oil
- Coolant
- Lights and indicators

Trailer and Boat

- Safety chain properly secured
- Lights hooked up and operational
- Everything inside vessel is secured
- Boat is secured to trailer
- Tire pressure
- Greased bearing buddies
- Motor up and locked
- Batteries turned off
- Plug is out during trailering

Towing

- Maintain longer distances between yourself and car in front
- Frequently check mirrors and status of boat

Launching Boat

- Do not unstrap and unchain boat until down the ramp
- Make sure plug is in
- Batteries turned on
- Motor lifted and unlocked
- Trailer lights unplugged
- When stopped on ramp leave truck in gear or park and engage parking brake

- When making final launching approach take off seatbelt and open windows for communications between yourself and crew members outside of vehicle

<u>Gear Types used for Fish Collections</u>

GPS coordinates (UTM) for all sampling gears are collected at each location

Adapted from Bonar et al. (2000)

Fyke Nets

4' high, 3/8" diameter aluminum or stainless steel circular hoops with two 25' wings and up to a 100' lead. Mesh size is 0.25".

- Fyke nets should be set perpendicular to shore.
- Nets should be set in the evening/late afternoon before electrofishing starts and retrieved the next morning.
- Record set time and pick up time.
- Try to set the net so the top of the first hoop is no more than about 1 foot under the water's surface.

Electrofishing

18 ft Smith Root 5.0 Generator Powered Pulsator (GPP) electrofishing boat.

- Electrofishing should be conducted with pulsed DC, high range 100-1000 volts, 120 cycles per second.
- Standardize power output of the electrofishing unit based on the specific conductivity of each lake.
- Electrofish starting at each randomly chosen sampling point for 600 seconds as measured by the timer on the electrofishing unit12. Always record on data sheets the actual number of seconds electrofished (e.g., 578 sec, 600 sec, 605 sec, etc.).
- Electrofish in the same direction from the sampling point for all samples.
- Electrofish pedal operations (continuous or intermittent) are at the discretion of the operator, and should be designed to capture the highest number of fish. Use intermittent electrofishing when approaching structure such as beaver lodges, downed trees, docks, and weed patches.
- Stay off the pedal until close to structure, and then hit the pedal.
- A minimum of two dippers and one driver should be in each electrofishing boat.
- Dippers should attempt to net everything, even young-of-year (YOY).
- We have found that catch rates go down if you electrofish the same section over again.
- Make sure that when fish are worked up, they are released back at the start of the section, and not near the end where they can stray into the next section to be electrofished again. Electrofish at night to have the highest catch rates.

LLRT Amendment to Boat Electrofishing Operations

- Low power, 100-500 volts, and 42-48% range at 30 Hz DC. We have found that fishes respond better to and exhibit galvanotaxis more frequently at lower power settings. In addition, the probability of injury is lessened when fish exhibit taxis compared to tetany.

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Appendix 3. Standard Operating Procedures for Boat Electrofishing (specific methods used for Grant PUD funded Priest Rapids Project Study).

Purpose
To provide guidelines for physical capture of predatory fish using an electrofishing boat.

Area of Applicability
For USGS and WDFW LLRT personnel collecting fish using an electrofishing boat for the investigation of predator-prey interactions within the Mid-Columbia River.

Materials Needed
- Electrofishing boat with live wells and depth finder
- GPS receiver
- Fiberglass handled nets, rubber gloves, rubber boots, and PFDs
- Data sheets, pens, field notebook
- Timepiece
- Specific conductivity meter
- Back-up headlamps
- Marine radio and or cell phone

Procedures
1. Prior to electrofishing boat deployment, alert KitCom and Grant Co. dispatch and inform them WDFW LLRT / USGS boats will be conducting research on the Columbia River.
2. Make sure all personnel onboard the electrofishing boat wear rubber boots and PFDs. In addition, netters should wear rubber gloves and use fiberglass handled nets to capture fish.
3. Navigate to selected transect using a GPS receiver and a laptop equipped with GIS software or a paper map with a list of transect coordinates.
    a. Verify that the GPS start point is within the correct reservoir, site strata (i.e. forebay, tailrace, tailrace BRZ, etc.) and depth strata (less than 3 m depth).
    b. If sample point is not in correct reservoir or site strata, randomly select a different site from the provided list of alternate sample points.
    c. If GPS point is onshore or too shallow for electrofishing, move outwards from the GPS start point perpendicular to shore until a depth is reached that can be sampled.
    d. If GPS point is too deep for electrofishing, from GPS start point move perpendicular towards shore until a depth is reached that can be sampled.
    e. Estimate whether the entire electrofishing transect will be within the specified depth strata (less than 3 m). If the entire transect will likely not fit within the specified depth strata, randomly select a different site from the provided list of alternate sample points, such that the entire transect will be within the less than 3 m depth strata. Repeat steps 2a-2d if necessary.
    f. If a GPS site is located such that the crew determines the site is not safe to sample, then the safety issue will be recorded, and a different site from the provided list of alternate sample points will be chosen randomly. Repeat as necessary.

4. Record the following information on the data sheet before electrofishing begins: Outing Start Date (MM/DD/YYYY), Reach & Location (e.g. WM1; Character (C) 1 is reach/Project (R=Rock Island, W=Wanapum or P=Priest Rapids), C2 is location within reach (F=forebay, M=mid, T=tailrace), C3 is 0=BRZ or 1=non-BRZ)), Net #, Start Date/Time (HH:MM in military time), Assigned UTM coordinates, Assigned Depth Strata, Boat Operator, Netters, Temperature (°Celsius [°C]), and Specific conductivity (in microsiemens per cm).
5. At the start of sampling, using the GPS receiver, record the Actual UTM Start (in UTM zone 10N WGS84) on the data sheet.
6. Moving in an upstream direction in waters between 0.5-3 m, perform low-power electrofishing using 50-500 volts and 42-48% range at 30 Hz DC, to produce 1-2 amps. Standardize power output of the electrofishing unit based on the specific conductivity of the water. If fish display severe tetanus, adjust settings to induce taxis and minimize tetanus.
7. Electrofish pedal operations (continuous or intermittent) are at the discretion of the operator, and should be designed to capture the highest number of fish. Use intermittent electrofishing when approaching structures such as beaver lodges, downed trees, docks, and weed patches. Stay off the pedal until close to structure, and then hit the pedal.
8. Never cover the same section that you have electrofished over again, as catch rates decrease.
9. Electrofishing is discontinued in any transect where excessive numbers of salmonid juveniles or adults are incidentally shocked. When adult salmon are encountered, temporarily turn off the electric power allowing the adult to swim free and escape. Non-target species should be counted but not netted.
10. Place netted fish in circulating live wells until they can be processed.
11. At the end of the transect (600 electrofishing seconds) record Actual UTM End, End Date/Time, Effort (the actual number of seconds electrofished - from the boat's counter), Power (high or low, Hz and % Range), Minimum (Min) Actual Depth (in meters), and Maximum (Max) Actual Depth (in meters).
12. Make sure that after fish are worked up, they are released back at the start of the section, and not near the end where they can stray into the next section to be electrofished again.

Appendix 4. Standard Operating Procedures for Water Quality Data Collection.

Purpose
To provide guidelines for conducting water quality surveys.

Area of Applicability
For WDFW LLRT personnel conducting water quality surveys.

Materials needed
- YSI 6600 V2 Multiparameter Water Quality Sonde, handheld YSI computer and cord
- Secchi disk and line
- Anchor and line
- Bucket
- Static sites
- Data sheets and pencils

Procedures
1. Arrive at specific site using GPS coordinates. Throw anchor and make sure the boat is not moving. Fill bucket 2/3 full of water from the body of water to be sampled. Use the YSI sonde to measure the water quality parameters.
2. Before sampling begins, hold the YSI sonde just below the surface of the water for 40 seconds prior to recording any data to acclimate the YSI sonde and allow it to clean the optic ports. The first reading can then be taken at the surface and then at each meter until the bottom is reached (try not to touch the bottom).
3. Parameters are logged on the handheld YSI computer and recorded on the water quality data sheets (Figure 1). The parameters include depth (m), temperature (°C), specific conductivity (s/cm), dissolved oxygen (mg/L), pH, turbidity (NTU) and chlorophyll (µg/L). Also, record the barometric pressure at the first site.
4. After the last reading is recorded at the bottom of the water column, slowly pull the YSI sonde up and out of the water. Place the YSI sonde in the bucket of water that was previously filled. The bucket should be dumped and refilled periodically throughout the day.
5. Secchi depths are taken at each site. Sunglasses and hats should be removed when taking readings. The Secchi disk is lowered into the water on the shaded side of the boat. Once the disk disappears, pull it back up until it reappears again. Raise the disk up and down until the exact vanishing point is found and record the depth (m) on the data sheet.
6. After all data is recorded and equipment is secured, pull anchor and proceed to the next site.

W.Q. Data Sheet

Page: ______ Project: ______ Field data check ______

Office data check ______

Date: ______ B.P. ______ Initials: ______ Bio data check

Location	Depth (m)	Temp.	SpC	D.O. mg/L	pH	Turbidity NTU	Chl (µg/L)	Secchi (m)	Zoop. Pull Depth (m)

Calibration date: ______

Comments ______

Appendix 5. Calibration Instructions for the YSI 6600 V2 Multiparameter Water Quality Sonde.

Purpose
To provide guidelines for calibration methods to ensure the YSI 6600 V2 Multiparameter Water Quality Sonde is accurate for specific bodies of water.

Area of Applicability
For WDFW LLRT personnel calibrating the YSI 6600 V2 Multiparameter Water Quality Sonde.

Materials needed
- YSI 6600 V2 Multiparameter Water Quality Sonde, YSI computer and cord
- Distilled water
- Known turbidity standard (<0.1, 10, 20, and 40 NTU)
- 4, 7, and 10 pH standards
- Known conductivity solution
- KimWipes®
- Paper towels
- Calibration data sheet

Procedures
1. Fill out a calibration data sheet for the specific body of water to be sampled and gather the proper standards for the calibration.
2. Connect the YSI sonde to the handheld YSI computer with its field cord. Turn on the handheld YSI computer and bring up the calibration menu. Remove the black cap from the calibration cup on the YSI sonde and fill 1/3 of the calibration cup with distilled water. Replace the cap and swish gently to rinse. Empty the distilled water and repeat the rinse step. For the calibration of conductivity and pH, the calibration cup will be attached to the YSI sonde and the probes are pointing up when standards are poured. For the calibrations turbidity, chlorophyll, and dissolved oxygen, the calibration cup is removed from the YSI sonde and inserted so that the probes are now pointing down.
3. On the calibration menu, scroll to the conductivity option and press enter. Choose the SpCond option for specific conductivity and press enter. Enter the value of standard used in this calibration (for most of our water quality surveys we calibrate at 0.5 µm/s). Fill the calibration cup to cover the sensor. Pay close attention that air bubbles are removed from the sensor for an accurate reading. On the handheld YSI computer, press enter to start the calibration and allow some time for the sensor to give an accurate reading. Record this reading in the in the "actual" box on the calibration data sheet and then press the enter key again to calibrate the sensor. A new number should read on the screen. Record this number in the "after calibration" box. The standard should then be transferred into a clean, labeled bottle for benchmarking after the survey is completed. Rinse the calibration cup and sensors with distilled water for the next calibration.
4. Select pH from the calibration menu on the handheld YSI computer. Choose the 3-point calibration option from the menu. Start with the pH 7 standard (press 7 on the numeral keypad). Pour a small amount of the pH 7 standard over the sensor and then swish to

rinse out any existing distilled water and empty. Fill the calibration cup with pH 7 standard to cover the sensor. On the handheld YSI computer, press the enter key and allow some time for the sensor to give an accurate reading. Record the actual reading along with pH MV Buffer reading on the data sheet in the appropriate boxes. Press enter to accept calibration, and record the next readings in the "after calibration" boxes. Once calibration is successful, pour the pH 7 standard into a clean, labeled bottle for benchmarking after the survey is completed. Rinse out the calibration cup with distilled water for the next standard. Repeat step 4 for using pH standards 4 and 10.

5. Next, choose turbidity 3-point calibration on the handheld YSI computer. The calibration will start with a 0 value. To begin, rinse the sensors and calibration cup with distilled water and dry with KimWipes®. Pay close attention to dry between the sensors. The calibration cup should be removed and completely disassembled to dry all parts. Reassemble the calibration cup and pour in a small amount of the <0.1 NTU standard to rinse the calibration cup and the YSI sonde sensors. The calibration cup and instruments must be dried again. Reassemble the calibration cup with the black lid attached to the bottom. Pour <0.1 NTU standard into the calibration cup until it is about 1/3 full. Immerse the sensors carefully into the standard (make sure no bubbles are on the sensor); if the standard does not completely cover the bottom of the sensor add a small amount of <0.1 NTU standard to the calibration cup. Press the enter key to give the actual reading. There will be an option to clean optics; select this for the best calibration results. Once the cleaning is through, record the reading in the in the "actual" box on the calibration data sheet, accept the calibration, and record the reading again in the "after calibration" box on the calibration data sheet. Repeat this process for the next two turbidity calibrations.
6. Rinse the calibration cup and the YSI sonde sensors with distilled water. Choose the chlorophyll option from the calibration menu and then the 1-point calibration from the next menu. Fill the calibration cup 1/3 full with distilled water and immerse the YSI sonde into the calibration cup. Run the optic cleaner to remove any bubbles or debris. Record the actual reading and accept the calibration. Record the next reading also. Empty the distilled water from the calibration cup.
7. Return to the calibration menu and select dissolved oxygen and then %Saturated. Fill the calibration cup 1/3 full with distilled water and set the sensors into the calibration cup. Make sure no water droplets are on the dissolved oxygen membrane and the water level is not touching the membrane. Enter the barometric pressure on the handheld YSI computer located at the bottom of the screen and select enter. Let the meter sit up to ten minutes and then record the actual and calibrated values.
8. Empty the water, replace the wet sponge in the calibration cup, and screw it back onto the YSI sonde. Pack all the components back into the travel bag.
9. Upon return from the water quality sample period, benchmark each standard. Test each standard with the YSI sonde to document the values after the survey. Use distilled water to rinse between each standard. The turbidity samples must be benchmarked with the same procedures as in step 5. The calibration cup and the YSI sonde must be cleaned and dried before each turbidity standard. Each benchmark value should be recoded in the proper space on the calibration data sheet.

Appendix 6: Break down

Site	CMO	COT spp.	CYP spp.	NPM	PMO	RS	SMB	SK spp.	TSS	UNK
24-2		1		37	2			2	116	1
24-3		1		6				1	72	
24-3A.2	1			12		36		6	18	1
24-3B		1			2			1		
24-4A					1	1		1	11	
24-4B		2							5	
24-5		1						8	20	
25-2				12					1	
25-3				1			1			
25-6		4							1	
25-7		2							1	
26-1A	4			10					16	
26-1B	1	4		1				6	1	
26-2				4				1	54	
26-3				1				10	1	
26-4									1	
26-5										
28-9				2				4	67	
30-8		3		2				1	3	
32-13				1	2				52	
32-14			1					2	1	
33-6		2						7		
33-8		1		4	2			1	4	
34-5				1					45	
36-13								2	77	
36-14	1			5					1	
36-15								7		
#per site	7	22	1	99	9	37	1	60	568	2
%N	0.9	2.7	0.1	12.3	1.1	4.6	0.1	7.4	70.5	0.2