From:	Tracy Hillman
To:	"Aaron Jackson"; "Andrew Gingerich"; "Bob Rose"; "Brad James"; "Bryan Nordlund"; "Chad Jackson"; "Corey Wright"; "Dave Burgess"; Bitterman, Deborah; "Donella Miller"; "Jason McLellan"; "Jeff Korth"; Osborn, Jeff; "Joe Miller"; "Josh Murauskas"; "Justin Yeager"; "Katrina Simmons"; Truscott, Keith; "Keith Vradenburg"; "Ken Finicle"; "Kirk Truscott"; Keller, Lance; "Matthew Kerec"; Smith, Michelle; "Mike Clement"; "Pat Irle"; "Patrick Verhey"; "Paul Anders"; "Ralph Lampman"; "RD Nelle"; "Reed Glesne"; Hays, Steve; Hemstrom, Steven; "Steve Lewis"; "Steve Rainey"; "Susan Rosebrough"; Hodgson, Suzanne; "Tom Skiles"; "Travis Maitland"; Frantz, Waikele M.
Subject:	RRFF: Chelan PUD"s Submittal of the Rocky Reach Pacific Lamprey 5-Year Status Report to FERC
Date:	Wednesday, February 19, 2014 8:28:16 PM
Attachments:	Final RR Pacific Lamprey 5Y Status Report.pdf

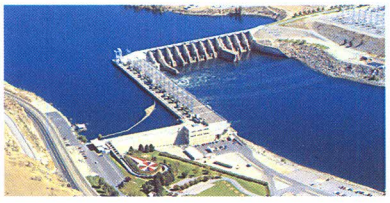
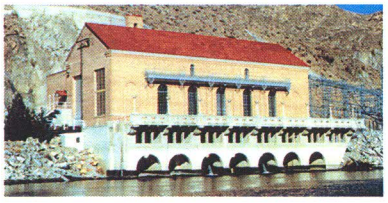
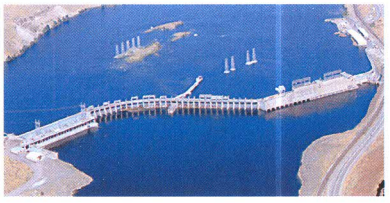
Hello RRFF,

Attached please find Chelan PUD's Five-Year Report on Adaptive Management to achieve NNI for Pacific Lamprey at Rocky Reach. This report is a FERC requirement and was due today (19 February 2014). We will include time during the March meeting to discuss the report.

Please let me or Steve Hemstrom know if you have questions.

Thanks,
Tracy

Tracy W. Hillman, Ph.D.
Senior Ecologist
BioAnalysts, Inc.
4725 N. Cloverdale Rd, Suite 102
Boise, ID 83713 USA
Tel: 208-321-0363
Cell: 208-867-2889
Fax: 208-321-0364
tracy.hillman@bioanalysts.net
www.bioanalysts.net

PUBLIC UTILITY DISTRICT NO. 1 of CHELAN COUNTY
P.O. Box 1231, Wenatchee, WA 98807-1231 • 327 N. Wenatchee Ave., Wenatchee, WA 98801
(509) 663-8121 • Toll free 1-888-663-8121 • www.chelanpud.org

February 19, 2014

VIA ELECTRONIC FILING

Honorable Kimberly D. Bose, Secretary, and
Nathaniel J. Davis, Sr., Deputy Secretary
FEDERAL ENERGY REGULATORY COMMISSION
888 First Street, NE
Washington, DC 20426

Re: **Rocky Reach Hydroelectric Project No. 2145**
Ordering Paragraph E, Appendix B, Article 5(c) of the New License
Rocky Reach Adaptive Management for Addressing Unavoidable Impacts to Pacific Lamprey 5-Year Status Report

Dear Secretary Bose and Deputy Davis:

The Public Utility District No. 1 of Chelan County, Washington (Chelan PUD), licensee for the Rocky Reach Hydroelectric Project (Project), respectfully files the Rocky Reach Adaptive Management for Addressing Unavoidable Impacts to Pacific Lamprey 5-Year Status Report in accordance with Article 5(c) of Appendix B of the *Order on Offer of Settlement and Issuing New License* (License) issued on February 19, 2009.[1]

As specified in the License, this first 5-year status report contains the measures that Chelan PUD, in consultation with the Rocky Reach Fish Forum (RRFF), identified and implemented to address unavoidable impacts in order to achieve No Net Impact (NNI). Along with a copy of this letter, Chelan PUD is providing the status report to the RRFF.

Please contact me or Steve Hemstrom at (509)661-4281 if you would like to discuss this work or if additional information would be helpful.

Sincerely,

Michelle Smith
License and Compliance Manager
michelle.smith@chelanpud.org
(509) 661-4180

Attachment

cc: Rocky Reach Fish Forum

[1] 126 FERC ¶ 61,138 (2009).

ROCKY REACH ADAPTIVE MANAGEMENT FOR ADDRESSING UNAVOIDABLE IMPACTS TO PACIFIC LAMPREY 5-YEAR STATUS REPORT

LICENSE ORDERING PARAGRAPH E, APPENDIX B, Article 5(c)

Final

ROCKY REACH HYDROELECTRIC PROJECT
FERC Project No. 2145

February 19, 2014

Public Utility District No. 1 of Chelan County
Wenatchee, Washington

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SECTION 1: INTRODUCTION

The Rocky Reach Hydroelectric Project (Project) is owned and operated by the Public Utility District No. 1 of Chelan County (Chelan PUD). The Federal Energy Regulatory Commission (FERC) license for operation of this Project (License) was issued on February 19, 2009. The License authorizes Chelan PUD to operate the Rocky Reach Dam and its reservoir for a period of 43 years. Through the Pacific Lamprey Management Plan (PLMP 2006), the License incorporated conditions for achieving No Net Impact (NNI) on Pacific Lamprey in the Project using an Adaptive Management Process.[1] This Process is structured to collect relevant biological information on lamprey at the Project for the purpose of eliminating impacts (Ordering Paragraph E, Appendix B, Article 5(c)).

In year five of the New License, and every five years thereafter, for the term of the New License, Chelan PUD will provide a report to the Rocky Reach Fish Forum[2] (RRFF) and FERC on the status of the Adaptive Management process regarding unavoidable Project impacts to Pacific lamprey.

Parties to Rocky Reach License Settlement Agreement who developed the PLMP envisioned that an Adaptive Management Process would be needed because so little information on Pacific lamprey in the Project Area (and Columbia River Basin) was known at the time of License Settlement. The Settlement Parties anticipated that new information to achieve NNI would be developed through time. Chelan PUD meets monthly with members of the RRFF. The RRFF is responsible to implements measures to identify and address unavoidable Project impacts on Pacific lamprey.

The goal of Chelan PUD's Pacific Lamprey Management Plan (PLMP) is to provide safe, timely, and effective passage for adult and juvenile Pacific lamprey, and where *unavoidable* Project effects are measured, then provide appropriate and reasonable Protection, Mitigation, and Enhancement measures to achieve an overall No Net Impact (NNI) on the population (Chelan PUD 2006).

Together with studies that Chelan PUD conducted on Pacific Lamprey during relicensing, and current studies and activities conducted within the first five years of the New License (2009-2013), Chelan PUD has identified and implemented measures to address known Project effects to begin achieving No Net Impact (NNI) on Pacific lamprey. These efforts are ongoing and include collecting and compiling information regarding Pacific lamprey distribution, population status and trends, juvenile downstream migration timing and adult upstream migration timing including

[1] Adaptive Management Process intended to generate and use new information, as it is developed, on Pacific lamprey biology, ecology and fresh-water life history in the Rocky Reach Project and other locations in the Columbia River to meet License objectives.

[2] RRFF - Rocky Reach Fish Forum includes representatives from: Washington Department of Fish, Washington Department of Ecology, US Fish and Wildlife Service, Confederated Tribes of the Colville Indian Reservation, Confederated Tribes and Bands of the Yakama Nation, Alcoa, Inc., Chelan PUD, and many other public and private representatives.

potential fishway impacts on adult passage, and juvenile rearing in the reservoir and potential effects of reservoir operations on fluctuation-zone rearing.

In years five through ten, additional information and studies will be necessary to identify and adequately describe unavoidable impacts so that appropriate and reasonable measures can be implemented to achieve NNI. This report summarizes Chelan PUD's progress in years one through five to identify impacts and achieve NNI for Pacific Lamprey through the following measures:

1) Progress on studies and efforts to collect and compile information regarding Pacific lamprey distribution, population status and trends, and juvenile downstream migration timing;

2) Progress and efforts to develop sampling and collection protocols and collect tissue samples and other relevant biological information from adult and juvenile lampreys passing through the Project;

3) Progress and efforts to identify and resolve upstream passage issues for adult lamprey moving through the adult fishway at Rocky Reach;

4) Progress on development of active tag technologies and study methods to measure Project effects on downstream passage of juvenile lamprey;

5) Progress and efforts to identify, consider, and implement appropriate and reasonable measures to address unavoidable losses at the Project in order to achieve NNI, in consultation with the RRFF.

SECTION 2: MEASURES TO ADDRESS IMPACTS AND ACHIEVE NNI

Chelan PUD began studies to develop baseline information on Pacific lamprey in the Rocky Reach Project Area during the FERC relicensing of the Project. That information combined with new evaluations contained in the PLMP continue to be useful as part of the Adaptive Management Process to identify Project effects on lamprey that are avoidable, and those that may be unavoidable. Table 2-1 summarizes the actions Chelan PUD has implemented to identify, and remove where possible, Project impacts on Pacific lamprey.

Table 2-1. Actions conducted by Chelan PUD and the RRFF and progress made to identify and eliminate Project impacts on Pacific lamprey to achieve NNI at the Rocky Reach Project.

Adaptive Management Measures	Year(s)	Purpose of Action	Progress on Action	Results of Action
Adult Pacific lamprey upstream passage, radio-telemetry study	2004	Assess adult passage rates, success, and fallback at Rocky Reach.	Report 2005 Completed	Identified and recommended modifications and improvements to fishway
Pacific lamprey adult and juvenile passage review at Rocky Reach	2006	Literature review of potential Project effects, movements of juvenile and adult lamprey	Report 2006 Completed	Identify possible issues and potential opportunities for improvement and juvenile and adult passage
In consultation with RRFF, Chelan PUD performed structural modifications and enhancements to adult fishway based on 2004-2006 passage studies to improve adult lamprey passage	2011-2012	Increase adult upstream passage efficiency	Modifications completed; monitoring of improvements ongoing	Improvements to passage to achieve similar or better passage as other mainstem Hydro Projects;
In consultation with RRFF, Chelan PUD installed half-duplex (HD) PIT tag detection system at RR fishway with detection at entrances and within adult fishway (7 total detection locations)	2011-2012	Evaluate of upstream passage improvements after fishway modifications for adult Pacific lamprey	PIT system running April-November with two years of operation and monitoring completed	Enables monitoring and evaluation of fishway modifications, lamprey passage timing and passage success at RR

Adaptive Management Measures	Year(s)	Purpose of Action	Progress on Action	Results of Action
In consultation with RRFF, Chelan PUD coordinated with US Army Corps and University of Idaho researchers to utilize pre-PIT tagged adult lamprey (from lower Columbia) to evaluate adult passage at RR	2012-2013	Evaluate adult passage success post-fishway modifications and improvements	Two years of adult passage monitoring at RR completed using PIT tagged adult lamprey	2012 passage rate: 46.2%; 2013 passage rate: 72.7% Passage improved, additional year(s) passage monitoring warranted
In consultation with RRFF, Chelan PUD operated upstream fishways within anadromous criteria and maintained annual passage counts of Pacific lamprey	2009-2013	Maintain anadromous fish passage and monitor adult lamprey passage counts to identify passage trends	Action Completed in years 1-5 of the new License; Ongoing next five years	Annual, running trends in adult passage and abundance for adult lamprey and anadromous salmon and steelhead
In consultation with RRFF, Chelan PUD to develop sampling and collection protocols and collect tissue samples and other relevant biological information from adult and juvenile lampreys passing through the Project	2009-2013	Collect information from lampreys encountered in the Project area to aid in determining abundance, biology, life histories, and genetics of lamprey	Protocols for sampling juvenile lamprey in the RR Bypass Completed; no genetic samples taken as research[3,4,] indicates little genetic differentiation in Columbia River lamprey[5]	Low genetic variability in Pacific lamprey populations has decreased importance of genetic sampling
In consultation with RRFF, evaluate relationships between adult lamprey returns to the Columbia River and their common parasitic hosts in the Pacific Marine environment[6]	2013	Explore potential marine-phase causes of declining Pacific lamprey returns to Columbia River	Report completed and published in AFS 2013	RRFF reviewing study and in consideration

[3] Goodman et al. 2006

[4] Docker, M. 2010

[5] Ward et al. 2012

[6] Murauskas et al. 2012

Adaptive Management Measures	Year(s)	Purpose of Action	Progress on Action	Results of Action
In Consultation with RRFF, operated RR downstream passage facilities in accordance with criteria for anadromous salmonids	2009-2013	Maintain safe downstream passage routes	Completed in years 1-5; juvenile Bypass operated continuously from 1-April to 31-August	Non-turbine routes maintained for juvenile lamprey through Bypass System and summer spill
In consultation with RRFF, evaluated juvenile lamprey presence and rearing in shallow water locations within Rocky Reach Reservoir	2011	Assess distribution, composition, and abundance of juvenile lamprey within observed operating range of reservoir	Report 2012 Completed	Low probability of stranding or reservoir operational effects
In consultation with RRFF, evaluated Rocky Reach Reservoir water storage, flow and hydraulic characteristics	2012	Evaluative reservoir hydraulic characteristics to determine reservoir effects on juvenile lamprey rearing and migration	Completed evaluation to RRFF 2012	RR Reservoir is riverine-like; RRFF expressed low concern with effects of reservoir operations on juvenile lamprey
In consultation with RRFF, monitored RR turbine Units 1 and 2 Intake Screens for Impingement of juvenile lamprey	2006; 2010; 2013	Monitor for impingement of juvenile lamprey on vertical barrier screens.	Completed summary Report to RRFF 2012	Very low rates of juvenile impingement on intake screens; bi-annual monitoring ongoing
In consultation with RRFF, conducted Pacific Lamprey artificial propagation and rearing evaluation	2012	Investigate feasibility and methods to artificially propagate juvenile lamprey	Report 2012 Completed	Ten recommendations for successful captive spawning and rearing of Pacific lamprey
In consultation with RRFF, measure type and magnitude of Project impacts on downstream passage of juvenile lamprey	Not yet conducted	Measure RR Project effects on downstream migrating juvenile lamprey	Not yet possible; study methodology and active tag technologies are not available	Waiting active tag and study methodologies

2.1 Pacific Lamprey Adult Upstream Passage

The goal of upstream passage for adult Pacific lamprey through fishways at Rocky Reach Dam is to achieve a passage rate that is similar to the best experience at other similar hydroelectric projects on the Snake and Columbia rivers. Two years of monitoring tagged lamprey has occurred, and at least one additional year of passage monitoring remains to complete this Biological Objective. Additionally, passage monitoring at other mainstem hydroelectric projects must be completed to compare passage rates at Rocky Reach before this objective can be completed.

In 2005, Chelan PUD conducted a relicensing study to evaluate adult Pacific Lamprey passage at Rocky Reach Dam using radio tagged adults (Stevenson et al. 2005). This analysis provided the basis to identify passage issues for adult lamprey in the fishway, and guide the scope of future work and improvements necessary to improve passage.

In 2010, Chelan PUD conducted a literature review, *Pacific Lamprey Upstream Passage modifications Literature Review and Analysis and Recommendations for Passage Improvements in the Rocky Reach Fishway* (Le and Nass 2010) to determine what modifications should be made within the fishway to improve lamprey passage. On October 28, 2010 Chelan PUD presented the RRFF with engineering plans and proposal to construct modifications to components of the adult fishway (RRFF 2010a). On December 6, 2010, Chelan PUD filed the design drawings for approval with FERC to make these modifications to adult fishway to improve adult lamprey passage.

After review and approval from FERC and the RRFF in October 2010-11 (RRFF 2010b), Chelan PUD began extensive work, completed in two phases, in the Rocky Reach adult fishway in 2011 and 2012. Work included rounding and smoothing of edges on fishway entrance structures, and fabrication and installation of aluminum ramps and plates to aid passage over gratings and through orifices. Ramps placed at perched orifices in the upper fishway. Plating was installed along fishway walls and over the diffusion grating in the bifurcation pool and left powerhouse fishway entrance to reduce fallback and increase overall passage. Phase 2 was completed early in 2012 which installed plating at all weir orifices in the lower fishway. The total cost of these improvements was $102,000.

In 2011, Chelan PUD in consultation with the RRFF installed a half-duplex (HD) PIT tag detection system within the fishway at Rocky Reach at a cost of $176,000 to monitor improvements in lamprey passage as a result of fishway modifications. The HD system is composed of HD antennas installed at seven different locations (Table 2-2) within the fishway and at fishway entrances (Chelan PUD 2013a; Anders and Lee 2011).

Adult lampreys were tagged with HD PIT tags by researchers at the US Army Corps of Engineers (USACE) and University of Idaho (UofI) at Bonneville Dam in 2012 and 2013 for evaluation through the federal hydro projects. Lampreys migrating upstream from that location were monitored in the same years (Chelan PUD 2013a). These fish moved upstream through

multiple projects in the mid-Columbia. Chelan PUD monitored tagged lamprey continuously at Rocky Reach, conducted bi-weekly checks of all HD detection equipment at the Project, and downloaded tag data from adult fish from the seven antenna detection sites a total of 142 times each year (Table 2-2).

From July through October 2012, 11 adult lampreys were detected and monitored in the fishway at Rocky Reach. Eight of 11 fish passed upstream (72.7%) by the time monitoring ended in December (Table 2-3). In 2013, from July-October, 13 PIT tagged adult lampreys were detected (Table 2-4) at Rocky Reach Dam; six of the 13 lamprey exited the fishway to the forebay by end of monitoring in December. In 2013, the first and earliest detection occurred on 30 July, while the last fish of the season was first detected on October 3. Six of the 13 fish (46.2%) passed Rocky Reach as these fish were last detected at the furthest upstream fishway antenna (RRH 07) with no subsequent detections afterward. None of the fish detected at Rocky Reach in 2012 were detected in 2013.

Table 2-2. HD Antenna sites, location descriptions, and number of downloads at each site in the adult fishway at Rocky Reach Dam.

HD Detection Site	Antenna Site Description	Number of Antennas	Number of Downloads April-Dec
RRH(01)	Entrance, Left Powerhouse (LPE)	1	20
RRH(02)	Entrance, Main Spillway (MSE)	2	20
RRH(05)	Entrance, Right Powerhouse (RPE)	2	20
RRH(03)	Internal, trifurcation pool	2	20
RRH(04)	Internal, transportation channel	2	20
RRH(06)	Internal, beginning of pool and weir ladder	2	21
RRH(07)	Most upstream antenna before fishway exit to forebay	2	21

Table 2-3. PIT tag detections of adult Pacific lamprey at Rocky Reach in 2012.

HD Tag Code	Year	Count	Exit Date	Passed?
8FC08C8	2012	1	9/10/12	YES
9E9065B	2012	2	9/17/12	YES
A306F3C	2012	3	10/15 RR(06)	No
A306F44	2012	4	9/16/12	YES
A326DE5	2012	5	7/28/12	YES
AB79DCA	2012	6	9/5/12	YES
AB79E47	2012	7	8/25/12	YES
AB79F0D	2012	8	9/18/12	YES
AB79F41	2012	9	10/15 RR(06)	No
AB7A02B	2012	10	10/1 RR(06)	No
AB7A03F	2012	11	9/15/12	YES

Table 2-4. PIT tag detections of adult Pacific lamprey at Rocky Reach Dam in 2013.

HD Tag Code	First Detect Date	First Detect Location	First Detect Time	Last Detect Date	Last Detect Location	Last Detect Time	Date Passed
A326D65	30 July	RRH(07)	3:23:25	30 July	RRH(07)	3:55:37	30 July
AECBEFC	6 Aug	RRH(03)	20:37:00	7 Aug	RRH(07)	0:43:08	7 Aug
AECC5BB	15 Aug	RRH(03)	4:12:43	15 Aug	RRH(07)	4:12:56	15 Aug
AECC355	19 Aug	RRH(02)	23:02:46	20 Aug	RRH(07)	4:50:30	20 Aug
AECC36F	20 Aug	RRH(03)	2:40:32	20 Aug	RRH(07)	7:17:22	20 Aug
AEBB9B5	31 Aug	RRH(06)	21:35:20	1 Sept	RRH(07)	1:01:08	1 Sept
AEBB952	7 Sept	RRH(01)	23:22:30	7 Sept	RRH(01)	23:22:30	-
AEBB9E1	15 Sept	RRH(01)	21:41:29	12 Dec	RRH(03)	20:37:35	-
AECBEC0	11 Sept	RRH(01)	1:53:46	11 Sept	RRH(01)	1:53:46	-
AEBB942	22 Sept	RRH(02)	23:19:47	9-Nov	RRH(06)	0:33:16	-
AECBF0A	22 Sept	RRH(06)	23:16:00	23 Sept	RRH(03)	0:44:36	-
ABAC50E	25 Sept	RRH(06)	22:04:49	26 Sept	RRH(04)	3:08:05	-
AECC3AF	3 Oct	RRH(07)	5:29:03	27 Oct	RRH(04)	22:27:05	-

Upstream passage rates for adult Pacific lamprey are being evaluated currently at other mainstem Snake and Columbia River hydroelectric projects by their respective operators using HD PIT tag monitoring. These evaluations must be completed, as well as additional year(s) of monitoring at Rocky Reach to complete this biological objective. Upstream fishway counts (window counts) at Rock Island Dam and Rocky Reach Dam are being compiled to assess minimum conversion rates between the two projects. Adult lamprey passage counts at Rocky Reach Dam are shown in Table 2-5. The RRFF has discussed funding HD PIT tag detection system installation in tributaries (Wenatchee River and Entiat River) to determine tributary escapement, and aid in determining overall passage success of adult lamprey at Rocky Reach (RRFF 2013).

Table 2-5. Adult Pacific lamprey fishway passage counts at Rocky Reach Dam by month, 2008-2013.

Year	May	June	July	August	September	October	November	Total
2008	0	0	11	161	188	8	0	368
2009	0	1	13	155	105	4	0	278
2010	0	0	6	126	110	26	0	268
2011	0	0	0	85	482	51	0	618
2012	0	0	5	251	496	53	0	805
2013	0	0	37	577	1,000	11	0	1,625

2.2 Adult Pacific Lamprey Downstream Passage

The PLMP states that if additional significant ongoing Project effects on adult downstream passage of lamprey are identified through investigation and monitoring of upstream adult passage at Rocky Reach, then Chelan PUD shall in consultation with the RRFF develop and implement appropriate measures to address the effects. Adult monitoring in 2012-2013 did not identify significant downstream passage effects on adult Pacific lamprey. Chelan PUD and the RRFF believe additional monitoring time is needed with additional numbers of tagged adult lamprey to determine if any significant effects are present.

2.3 Juvenile Lamprey Downstream Passage

The Rocky Reach Pacific Lamprey Management Plan (PLMP) requirement in section 4.2.1 is to operate the Rocky Reach Juvenile Bypass System (JFB) in accordance with operations for anadromous salmonids and compatible with bull trout migration per the HCP and Rocky Reach Fish Passage Plan. Chelan PUD operates downstream juvenile passage facilities to maintain safe and volitional passage of juvenile lamprey.

Chelan PUD constructed the Rocky Reach juvenile bypass system to guide juvenile salmon and steelhead away from turbine intakes at Rocky Reach Dam. The system consists of one surface collector entrance (SC) and the intake screen (IS) system in turbine units 1 and 2. Please refer to Mosey et al. (2004) for a detailed description of the bypass production system.

The JFB is operated from April 1 through August 31 each year. Juvenile fish sampling at the Juvenile Sampling Facility (JSF) in 2013 occurred throughout the operating period, Monday through Sunday. Sampling is conducted on the hour for a maximum of 30 minutes from 0800 hours through 1130 hours. The target number of juvenile salmonids to be collected is 350 spring species and 125 summer species. Fish sampled are examined for run timing, fish condition, species composition, and origin of fish stocks and identification of marked (PIT tag; fin clip) individuals.

Each juvenile lamprey collected during sampling is measured for length, examined for fish condition and injury, categorized as migratory (eyes present) or non-migratory (eyes absent), and returned to the river.

Around the clock sampling was conducted from late April through early June at the JSF in 2009 through 2011 in conjunction with implementing survival studies for juvenile spring Chinook salmon. The intent of the increased sampling was to document diel migration of juvenile spring Chinook salmon in order to validate survival study assumptions. Additionally, diel migration data was collected for other spring migrants, such as steelhead, sockeye salmon, and juvenile lampreys.

Data from 2011 show a very strong peak juvenile lamprey passage at Rocky Reach in mid-May (Table 2-6). The vast majority of juvenile observed during the peak migration in 2011 were collected during nighttime hours: from 2200 hours to 0400 hours. A similar trend was

observed in 2009 and 2010 although total numbers of juvenile lampreys were considerably lower than 2011. Higher sample numbers may have been tied to high flow events in upstream tributaries. Few juvenile lampreys have been observed in samples collected outside the dates shown in Table 2-6 for years 2009 through 2013. The reduced number of juvenile lampreys observed in 2012 and 2013 is likely a result of reduced sampling times in those years.

Columbia River turbidity data were collected during May 2011. Nephelometric turbidity Unit (NTU) values from May 1 through May 15, 2001 ranged from 7.5 to 9.0 NTUs from May 1 through May 15. Turbidity increased significantly on May 16, with a daily value of 4 NTUs, dropped to 2.4 NTUs on May 17, and remained between 3.5 and 4.7 NTUs for the remainder of the month. During this period there was not a corresponding increase in mainstem Columbia River flow until May 18. Several theories were discussed by Chelan PUD staff regarding the dramatic increase in juvenile lamprey passage and increased turbidity. One hypothesis is that juvenile lamprey undergoing metamorphoses into macropthalmia migrate actively during nocturnal hours and during periods of increased water turbidity, using light and or reduced water clarity as a cue to initiate downstream migration. Another hypothesis is that higher flow events in tributaries potentially scour juvenile lamprey from rearing areas and forcibly move them downstream, resulting in increased numbers of juveniles observed at the Rocky Reach fish bypass system.

Table 2-6. Juvenile lamprey counts at the Rocky Reach Bypass Juvenile Sampling Facility, 2009-2013.

DATE	2009		2010		2011		2012		2013	
	Migratory	Non-Migr	Migratory	Non-Migr	Migratory	Non-Migr	Migratory	Non-Migr	Migratory	Non-Migr
27-Apr			9							
28-Apr			3	1						
29-Apr	2				1	1				
30-Apr		1	2			1			1	
1-May			1							
2-May						1				
3-May						1				
4-May					1	1				
7-May						1			1	
8-May										
9-May	1				1	1				
10-May	1					2				
13-May		1	2							
14-May					1					
15-May		1								
16-May					266	77				
17-May					349	262				
18-May	1		1	1	9	94				
19-May			2		1	7				
20-May						2				
21-May	1	1	5			2				1
22-May			7			2				
23-May			7			1				
24-May			3	2	1	3				
25-May			1			5				
26-May						4				
27-May					1	11				
28-May						6				
29-May				1		5				
30-May			1	1		3				
31-May		1	1	1		5				
1-Jun						1				
2-Jun		1	1			3				
3-Jun			3	1						
4-Jun			5	3						

Section 4.2.2 of the PLMP requires that during the juvenile lamprey passage period, Chelan PUD shall continue to monitor potential lamprey impingement on turbine intake screens to assure impingement rates remain negligible until such time as the RRFF recommends that monitoring is no longer necessary.

Juvenile lamprey impingement monitoring was conducted at Rocky Reach Dam in 2006 and 2010 (Chelan PUD 2010), and again in 2013 (Chelan PUD 2013b). Although 2006 data were not collected during the timeframe of this Biological Objectives Status Report (2009-2013), the data provided information to the RRFF upon which the Forum made decisions regarding incidence of juvenile lamprey impingement and screen monitoring frequency.

Fish counters reviewed Unit C1 and C2 diversion screen cleaning operations for 23 days in 2006:

- 3 cleanings in April
- 4 cleanings in May
- 6 cleanings in June
- 7 cleanings in July
- 3 cleanings in August

During the 23 days, counters observed six possible juvenile lampreys on the screens: 5 in April and 1 in August. Four lampreys were reported for C1 and C2 screens combined (i.e. when screens in both units were cleaned in one night) and two were reported for C1 screen cleanings only.

Fish counters reviewed C1 and C2 diversion screen cleaning operations for three days in the 2010 monitoring period, April 15 through June 15. No juvenile lampreys were observed during any cleaning operations conducted on May 18, June 5, and June 22 on either C1 or C2 diversion screens.

The Rocky Reach Fish Forum concluded at their February 2, 2011 meeting that "…because of very low incidence of impingement observed over the past several years, … that annual reporting of juvenile lamprey impingement monitoring under USFWS prescription Article 5(b)(2) would no longer be necessary". However, the RRFF will have a bi-annual review to evaluate the necessity to reinstate the monitoring and reporting (RRFF 2011).

During the 2013 screen-monitoring period for juvenile lamprey (mid-May through mid-June), the screens in both units, C1 and C2, were cleaned a total of seven times (13 May, 17 May, 23 May, 28 May, 31 May, 7 June, and 14 June). The total video footage time for the seven cleaning events in 2013 was 15 hours, 45 minutes. Chelan PUD fisheries biologists reviewed the video recording of these cleaning events. No juvenile lampreys were confirmed to be impinged on screens. For the entire period, only two individual "shapes" were reported as possible juvenile lamprey, but determination was inconclusive and described by the reviewing biologist as 50/50 at best.

The RRFF concluded that bi-annual monitoring for turbine intake screen is acceptable based on the existing data demonstrating a "very low incidence of impingement." Additionally,

the RRFF has requested no further action other than bi-annual monitoring. Based on bi-annual monitoring approved by the RRFF, the next screening monitoring year will be spring 2015 at Rocky Reach. These decisions by the RRFF indicate that the Biological Objective of monitoring juvenile downstream passage is being achieved, and that safe volitional passage through turbine intakes is being maintained.

Section 4.2.3 of the PLMP requires that between years two and five of the New License, Chelan PUD shall continue to measure the type and magnitude of any ongoing Project impacts on the downstream passage of juvenile lamprey using appropriate and reasonable methodologies. Specifically, these methodologies will address juvenile lamprey downstream migration timing and passage survival through the Project. Additionally, Chelan PUD is required, in consultation with the RRFF, to develop means to provide sufficient numbers of juvenile lamprey for these evaluations. Chelan PUD, in consultation with the RRFF, may also choose to contribute to other local or regional lamprey investigation programs in order to gain efficiencies in the development of methods for lamprey investigations at the Project.

Efforts to investigate the type and magnitude of ongoing Project effects, and producing test fish are described in the following sections.

Laboratory studies have been conducted to begin to investigate the type and magnitude of Project effects on downstream migration of juvenile lampreys in the Columbia and Snake rivers. Juvenile lamprey have been used as test fish in studies attempting to simulate passage conditions that juvenile lampreys may experience passing hydroelectric projects during their downstream migration. These studies involved introducing juvenile lampreys to high concentrations of total dissolved gas (TDG), which is produced by high spill levels at dams, and conditions that could occur during passage through turbines, such as blade strike, sudden changes in barometric pressure (baro-trauma), and shear stress near turbine blades and in draft tubes. The RRFF developed a draft Juvenile Lamprey Survival at Rocky Reach Dam Effects Analysis (RRFF 2012a) identifying potential sources of mortality, potential effects, level of perceived concern, and corrective actions specific to Rocky Reach Dam. Some excerpts from the effects analysis are as follows:

Total dissolved gas: Brief exposure to shallow depth is not sufficient to develop emboli. Juvenile lampreys generally reside below compensation depth. (Colotelo et al. 2012).

Turbine blade strike: Tests conducted for strike from turbine blades of varying thicknesses with American eels, approximately 300 mm in length, showed survival rates of 100 percent for most test conditions (Amaral, et al. 2008).

Turbine pressure: Limited effects have been observed on juvenile lampreys physical condition, immediate or delayed, and no observed behavioral response of juvenile lampreys to instantaneous pressure drop when applied (Colotelo et al. 2012).

Turbine shear stress: Shear force of 90 cm/sec per cm was applied, which is much higher than applicable to turbine passage. No immediate or delayed effect on survival of treatment juvenile lampreys was observed (Mueller 2012).

The RRFF has not reached consensus on the effects analysis, and significant discussions continue at present regarding the type and magnitude of ongoing Project effects, potential corrective actions if effects are demonstrated, data needs, and area and level of responsibility.

The RRFF conducted several efforts to investigate the ability to produce test fish for survival studies as an additional method to "…measure the type and magnitude of any ongoing Project impacts on the downstream passage of juvenile lamprey." The RRFF commissioned preparation of the report: Pacific Lamprey Artificial Propagation and Rearing Investigations: Rocky Reach Pacific Lamprey Management Plan report (GeoEngineers et al. 2011). The goal of the document was to "provide guidance as to the feasibility of culturing Pacific lamprey, assess types of associated facilities necessary for culture practices, and identify uncertainties for monitoring culture efficacy and rational for implementing Pacific lamprey artificial propagation." With the "ultimate goal" of the PLMP to achieve No Net Impact (NNI) to Pacific lamprey with regard to ongoing operations of the Rocky Reach Hydroelectric Project, the RRFF went forward to conduct the study on potentials for artificial propagation of Pacific lamprey which is considered by the state and federal fishery agencies and Tribes as a potential Protection, Mitigation, and Enhancement measure (PME) for achieving NNI during the term of the current Rocky Reach license.

The document focused on three aspects: 1) developing an artificial propagation manual; 2) researching potential structured rearing facilities; and 3) researching potential riverine rearing facilities.

2.4 Juvenile Lamprey Artificial Propagation Manual

The Manual for the Intensive Culture of Pacific Lamprey was developed by the U.S. Fish and Wildlife Service (Ostrand et al. 2011). The manual demonstrates that culture of Pacific lamprey is definitely possible, from adult collection, spawning, fertilization, and early rearing to larval stage. However, it is recognized in the manual that Pacific lamprey propagation "has not been done intensively (where all life-stages are reared under controlled culture conditions) on a production scale or from gametes to reproductively mature adults." The manual also identifies "significant difficulties for intensive culture because of the long duration of the juvenile period that requires a food supply for anywhere from four to seven years while they are ammocoetes (Beamish 1987; Wydoski and Whitney 2003) and the maintenance of food sources for the parasitic life history form." Other articles corroborate the uncertainty and longevity of the juvenile rearing phase of Pacific lamprey life history (Pletcher 1963; Kan 1975; Richards 1980; Beamish and Northcote 1989). However, the specific length of larvae life of Pacific lamprey is mostly unknown because of inconsistent length frequency data and the lack of bony structures (Close et al. 1995).

The challenge of artificial propagation of Pacific lamprey is highlighted in the manual by the statement "Developing a methodology for the culture of Pacific lampreys through all life history stages will take several years to achieve, and challenges will be encountered with each life history stage until they are successfully raised to adults." Additionally, "This manual describes Pacific lamprey life stages and major bottlenecks to successful culture." The manual

also includes sections on Macropthalmia Rearing/Maintenance/Release, Parasitic Pacific Lamprey Maintenance, and Disease and Treatment.

One conclusion included in the document is that the manual is the first attempt to summarize culture methodologies for rearing all life stages of Pacific lamprey and needs further actions to refine and test culture methods. Additional conclusions were that little is known about the intensive culture of lampreys, most work has been conducted on an experimental basis, and that development of effective and efficient techniques will likely involve the collective efforts of fisheries researchers, fish culturists, and nutritionists. Final recommendations provided in the manual are in the form of research needs to address critical uncertainties and suggestions for future research and evaluation.

Structured Rearing Facilities

Existing state, federal, Tribal, and research hatchery facilities in Washington and Oregon were evaluated for potential Pacific lamprey rearing sites. A questionnaire was developed specific to the needs of a basic lamprey aquaculture facility and sent to the managers and leaders of regional facilities. The focus was on facilities in the vicinity of the Rocky Reach Project near the Wenatchee, Entiat, and Methow drainages. Eleven facilities were identified, based on questionnaire results, and evaluated for hatchery staff experience and interest in lamprey culture, adult holding facilities, incubation and hatching facilities, available rearing space, water quality and quantity, ability to heat or cool water, ability to isolate lamprey culture from salmonids culture facilities, and water source pathogens and contaminants. Of these 11 facilities, 7 were recommended in the report as centers with capability and interest in Pacific lamprey propagation.

Riverine Rearing Facilities

This section of the report "discusses rearing facilities that may be appropriate for propagation of juvenile lamprey in the study area. The purpose of this inventory is to identify natural riverine sites within the study area watersheds (Methow, Chelan, Entiat and Wenatchee) that have high potential value to support the goals of the Pacific lamprey Artificial Propagation Project by providing rearing sites for artificially propagated juvenile Pacific lamprey." Identified in the report are riverine facilities within each watershed that may be suitable for rearing juvenile lamprey. The report also provided monitoring recommendations that could be implemented to evaluate the potential effectiveness sites identified for achieving program goals.

Potential sites were evaluated throughout the Methow, Chelan, Entiat and Wenatchee watersheds. The Okanogan watershed was considered initially, but was eliminated due to time and budgetary constraints and the desire of the RRFF to one "untreated" watershed for potential comparison to "treated" watersheds. Draft criteria for potential lamprey propagation site selection included: 1) ability to recover macropthalmia; 2) land ownership/accessibility; 3) vehicle accessibility; 4) suitable thermal, flow regimes, substrate; 5) oxbow/high-flow side channel; 6) associated downstream habitat; 7) implications of attracting adult lamprey to area; and 8) predation risk. Following is the number of sites in each watershed recommended in the report, based upon the selection criteria, as having the highest habitat value/potential needed for Pacific lamprey release sites: Methow – 2; Chelan – 1; Entiat – 2; and Wenatchee – 3.

A primary conclusion offered in the report is that initial observations indicate that rearing within "riverine facilities" would not be as beneficial as rearing within "structural facilities". Although the concept is viable, environmental factors and predation are not controllable. Within structural rearing facilities it becomes easier to manage environmental factors such as temperature and water quality while completely removing predation factors.

The RRFF commissioned the preparation of the Pacific Lamprey (Lampetra tridentata) Breeding and Rearing Methodologies - Recommendations for Chelan County P.U.D. report (Wade and Beamish 2012) as a further attempt to investigate the potential for providing test fish for juvenile survival studies or to implement other measures to achieve NNI. The objectives of the investigation were to:

1. Evaluate specific growth rates, health, and survival of Pacific lamprey reared at various densities to determine space requirements and vessel designs for culture of various life history stages, particularly ammocoetes; and
2. Identify and develop foods, rations, and feeding methods for optimal juvenile pacific lamprey growth and nutrition.

Information from previous work conducted by Dr. Richard Beamish was compiled and summarized to address both stated objectives, and a literature search was provided to enable decision-makers to determine the best course of action for capture and culture of Pacific lamprey as a component of fulfilling section 4.2.3 Measurement of Impacts on Juvenile Downstream Passage of the PLMP. A very important caveat stated early in the report was that "Dr. Beamish's experience with breeding and culture of lamprey was varied, but in no way was it a commercial scale breeding program; it was for experimental purposes and focused on providing accurate identification of ammocoetes."

The report provided information from Dr. Beamish's experience involving adult capture, culture methods and rearing conditions, transport, broodstock, spawning, egg incubation, rearing ammocoetes, and culture considerations for the artificial propagation of lamprey.

Wade and Beamish (2012) recommended releasing larval young-of-the-year ammocoetes into the wild to supplement natural populations. They suggested also that some cultured lamprey could be held for a year under experimental conditions, but that it may not be possible to raise large numbers of ammocoetes through to metamorphosis, when they could be used as test fish, in captivity due to the time and space required and potential for significant mortality during that time. The report identified that some type of tagging technology is a necessary evaluation component for assessing the efficacy of any supplementation program.

Recommendations in the report were primarily in the form of additional research needs, such as securing pathogen-free water source, holding wild broodstock, identifying appropriate rearing densities, disease treatments, and developing protocols for evaluating program efficacy. One recommendation re-emphasized the suggested strategy of releasing larval ammocoetes versus holding ammocoetes to metamorphosis stage.

The report concluded: "…that the fertilizing and rearing of eggs from Pacific lamprey is not a significant obstacle. If very large numbers of eggs are incubated, typical of large Pacific salmon hatcheries, it will be necessary to develop protocols similar to those used in large production hatcheries." To date, no researcher has attempted to incubate large numbers of eggs nor have protocols or attempts been made to rear large numbers of juveniles to the migratory life-stage.

Considerations in Designing Juvenile Lamprey Survival Studies were presented at the Juvenile Pacific Lamprey Seminar held August 1, 2012 (Skalski 2012). The presentation addressed study design considerations, tag considerations, model assumptions and design options for tagging studies, strengths and weaknesses of design options, potential useful preliminary studies, and appropriate sample size calculations.

Skalski (2012) reported that if PIT-tags were used for a juvenile lamprey survival evaluation, then a large sample size (7,000 to 18,000 fish) would be required in order to achieve the appropriate precision for a survival estimate. Acquiring this number of test fish makes the ability to conduct a survival study prohibitive at the current time. Additional analyses showed that if active (i.e. acoustic) tags were used, then a much smaller sample size (709 to 2076 fish) would be required in order to achieve the appropriate precision of the survival estimate (Skalski and Townsend 2013). However, to date such a tag does not exist that is small enough with sufficient battery life to conduct a survival study. Additionally, Skalski (2012) presented that with either tag technology, a methodology for conducting an unbiased survival study with test fish that may not actively migrate does not exist. Study methods used for salmonid survival studies would be invalid if rearing behavior caused some tagged juvenile lamprey (test fish) to stop their active downstream migration through the study area after release. Active migration of test fish through the study area is critical in paired-release mark-recapture survival studies to achieve unbiased survival study results (Burnham et al. 1987).

Significant progress has been made from 2009 to 2013 toward collecting information and conducting investigations to measure the type and magnitude of any ongoing Rocky Reach Project effects on the downstream passage of juvenile lamprey. However, significant discussion is occurring, and will continue to occur in the foreseeable future within the RRFF as to management options and potential new or modified implementation, monitoring and/or evaluation measures that the RRFF will implement to achieve this Biological Objective. For example, the role of artificial propagation and production of larval Pacific lamprey is unclear at this time and is being discussed at RRFF meetings. Also being debated heavily within the RRFF are Project impacts on adult passage, specifically through the Rocky Reach Reservoir and the level of mitigation responsibility of Chelan PUD to address Project impacts and achieve NNI. These issues are expected to come to some level of agreement within the RRFF during the next 5-year reporting period thus supporting regional coordination and implementation efforts focused on addressing the challenges unique to Pacific lamprey life history and migration.

2.5 Avoid and Minimize Projects Impacts on Juvenile Rearing Habitat

The RRFF commissioned the study report; Distribution, Composition, and Abundance of Juvenile Lamprey (Lampetra sp.) within the Observed Operating Range of Rocky Reach

Reservoir, 2011 (Chelan PUD 2012a). The intent of the report was to address the following objectives:

1. Assess frequency, magnitude, and duration of Rocky Reach Reservoir fluctuations.
2. Identify shoreline shallow water habitat that is consistent with desired juvenile lamprey habitat that may be dewatered by ongoing Project operations.
3. Document presence of juvenile lamprey within and adjacent to habitat.
4. Determine potential effects of Project operations on juvenile lamprey.

Existing aquatic habitat within the Rocky Reach Reservoir with juvenile lamprey rearing characteristics was identified using aerial photographs, bathymetry, shoreline slope, velocity, and substrate characteristics to segregate habitat types into those areas with high (Type 1), medium Type 2), and low (Type 3) potential for use by juvenile lamprey. The magnitude, frequency, and duration of reservoir elevations in reference to habitats identified were assessed in order to identify potential sampling locations.

Juvenile lamprey presence was assessed using an ABP-2 backpack electrofisher in wadeable areas that may be affected by Project operations as well as deeper areas that likely remain watered during normal Project operations. Sampling areas were selected based on lamprey habitat types categorized by Hansen et al. (2003). Type 1 is the preferred habitat for juvenile lamprey and consists of sand, fine organic material, detritus, and/or aquatic vegetation. Type 2 habitat is suitable for juvenile lamprey and consists of shifting sand or gravel with little fine organic material. Type 3 habitat is composed of bedrock or hardpan clay along with larger gravel and is unsuitable for juvenile lamprey.

Juvenile lamprey sampling was conducted at sampling sites identified in Figure 2-1. Details of juvenile lamprey sampling locations, sampling duration, and time of day are shown in Table 2-7.

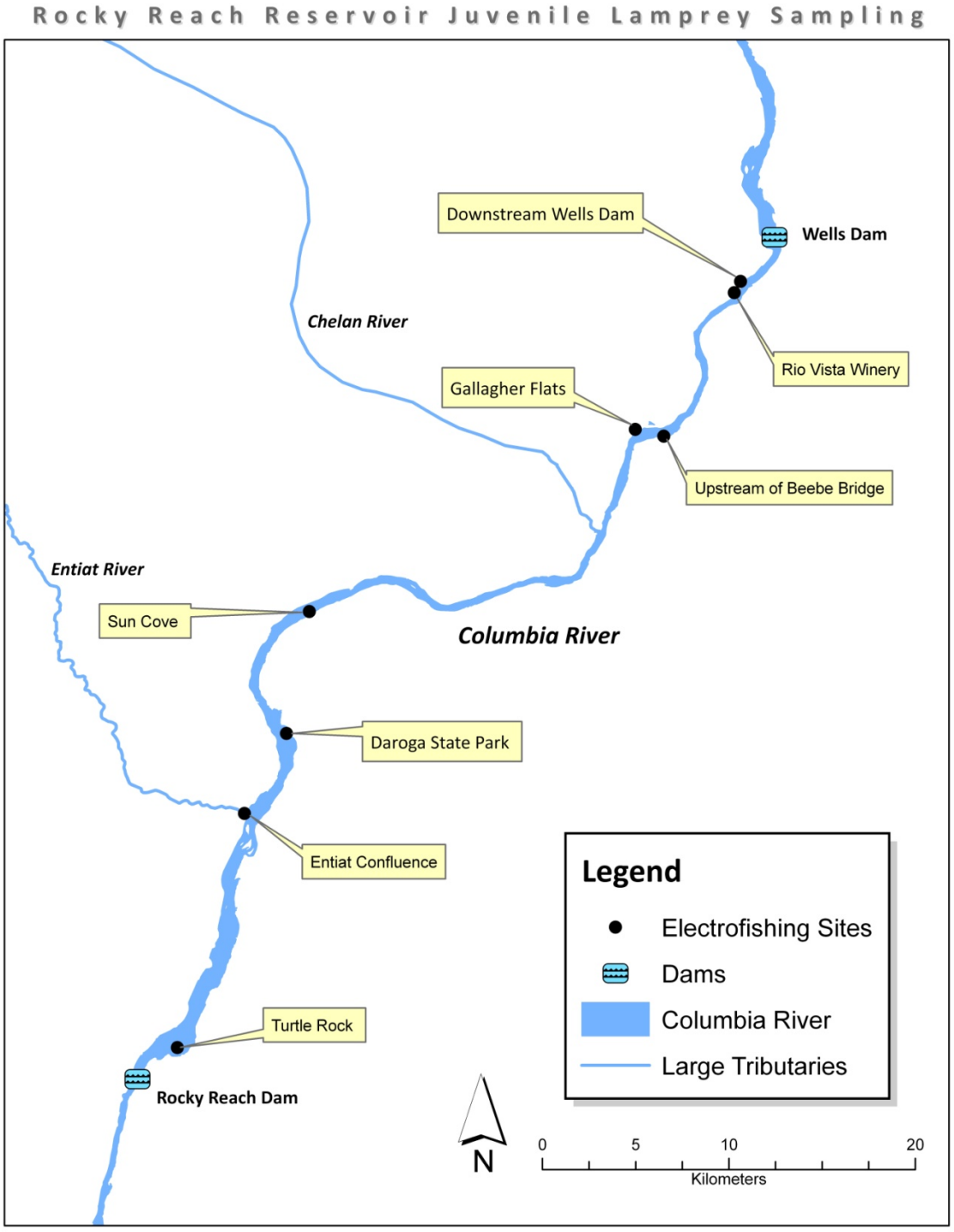

Figure 2-1. Juvenile lamprey electrofishing sample sites in Rocky Reach Reservoir.

Table 2-7. Juvenile Pacific lamprey sampling locations in Rocky Reach Reservoir, including sampling duration and time of day.

Site Name	Latitude	Longitude	Electrofishing Time	Time of Day
Turtle Rock (east side)	47.54682971	-120.2655617	10 min, 45 sec.	8:45
Entiat Confluence	47.66098251	-120.2243807	13 min.	9:30
Daroga State Park	47.70040801	-120.1967424	11 min, 42 sec.	10:01
Sun Cove	47.7595498	-120.1838521	11 min, 45 sec.	10:30
Gallagher Flats	47.8533302	-119.9555106	12 min, 58 sec.	11:59
Rio Vista Winery	47.9209587	-119.8880906	8 min, 10 sec.	12:15
Downstream of Wells Dam	47.9264806	-119.8839092	11 min, 49 sec.	12:30
Upstream of Beebe Bridge	47.8505602	-119.9348802	10 min, 15 sec.	13:30

Substrate was generally Type 1 habitat in all areas sampled. Substrate at the Daroga Park site exhibited more gravel/cobble composition close to shore, with Type 1 habitat more prevalent in water deeper than could be electrofished effectively. Substrate at the site upstream of Beebe Bridge was comprised of fine sand, but also contained large growths of aquatic vegetation.

Juvenile lampreys were captured only at the Sun Cove site. Five juvenile lamprey were captured, anesthetized, measured for total length, allowed to recover, and released at the location of capture. Lengths of the five juvenile lampreys were: 113 mm, 115 mm, 120 mm, 138 mm, and 142 mm.

Discussion of the study objectives is as follows:

1. Assess frequency, magnitude, and duration of Rocky Reach Reservoir fluctuations.

Assessment of Rocky Reach Reservoir fluctuations was conducted during the Bull Trout Stranding Investigation conducted in 2005, 2006, and 2007, and reported in 2008 (Chelan PUD 2008). Headwater elevations were compiled to create headwater duration curves that were then used to identify shallow-water habitat that may be dewatered on a regular basis. Headwater duration curves demonstrated little reservoir habitat was subject to dewatering due to very stable conditions provided by the operation of Rocky Reach. However, sampling stations were established in shallow-water habitat areas identified with the potential for dewatering and containing typical juvenile lamprey substrate size.

Identify shoreline shallow-water habitat that is consistent with desired juvenile lamprey habitat that may be dewatered by ongoing Project operations.

Shoreline shallow-water habitat (Type 1) preferred by juvenile lamprey was identified in the Rocky Reach Reservoir by reviewing aerial photographs, the Rocky Reach Aquatic Habitat

Mapping Study Report (DES 2001), and by conducting a boat survey of the reservoir for suitable sampling locations in November 2011.

2. Document presence of juvenile lamprey within and adjacent to habitat.

Juvenile lamprey captured at the Sun Cove site were found along the outside edge of a fairly steep drop-off, at depths of approximately 0.61 m to about 1.2 m deep, on the upstream side of a point. No juveniles were captured further toward the inner part of the bay inside the point in shallower water. Substrate was comprised primarily of fine sand, but also contained a considerable amount of leaf litter, more so than any other sample site. The size of the juveniles indicated that they were older year classes, and the larger specimens may be approaching the size of metamorphosis from ammocoetes to macropthalmia.

3. Determine potential effects of Project operations on juvenile lamprey.

The sampling crew believed that the location at which the juveniles were collected was deeper than the lowest point of reservoir fluctuation, thus protecting the juveniles from becoming dewatered or stranded. If true, then the sampling conducted in 2011 indicates that juvenile lamprey were not present within suitable habitat within the area of reservoir fluctuations.

To evaluate Rocky Reach Reservoir hydraulic characteristics to identify potential adverse effects of reservoir operations on juvenile lamprey rearing and migration, in 2013 Chelan PUD calculated full content, mean monthly water residence times and flow-through water velocities for the reservoir. Actual river flow data for Rocky Reach were evaluated for years 2001-2012. Mean monthly (January-December) reservoir water resident times ranged between 1.25 to 3.01 days; average monthly water velocities ranged between 0.88 to 2.27 feet per second (Chelan PUD 2012b). Based on these data, the RRFF determined that the strongly riverine-like flow conditions that dominate the reservoir were not likely to be a significant limiting factor on juvenile lamprey rearing or migrating (RRFF 2012b). The RRFF has not requested any additional juvenile lamprey reservoir habitat sampling to date. Additionally, the RRFF has requested no further actions to address potential effects of ongoing reservoir operations on juvenile lamprey reservoir rearing or migrating habitat. The RRFF indicated in its effects analysis that while reservoir operations did not appear to be affecting juvenile lamprey rearing or migrating conditions, future sampling or other investigation may be directed by the RRFF in the next five year period.

2.6 Progress towards achieving No Net Impact

Section 4.4 of the PLMP requires Chelan PUD to identify and implement measures to address unavoidable impacts to achieve NNI. Progress in the first five years of implementing the PLMP and objectives achieved to by Chelan PUD, as directed by the RRFF to address the 10 requirements of the PLMP will be used to identify the framework ultimately used to achieve NNI for Pacific Lamprey. The 10 measures are intended to address the objectives described on page 5-14, section 4: Protection, Mitigation, and Enhancement Measures, which are as follows:

Objective 1: Measure any ongoing Project impacts on upstream and downstream passage of adult Pacific lamprey, and eliminate those impacts to the extent appropriate and reasonable;

Objective 2: Measure any ongoing Project impacts on downstream passage of juvenile Pacific lamprey, and eliminate those impacts to the extent appropriate and reasonable;

Objective 3: Measure any ongoing Project impacts on the existing reservoir habitat used currently by juvenile Pacific lamprey, and eliminate those impacts to the extent appropriate and reasonable; and

Objective 4: Identify and implement appropriate and reasonable measures to address unavoidable impacts to achieve NNI.

Specifically, section 4.4 on the PLMP requires Chelan PUD to "collect and compile information regarding Pacific lamprey distribution, population status and trends, and juvenile downstream migration timing, to identify and implement appropriate and reasonable measures in order to achieve NNI." Additionally, "Chelan PUD shall, in consultation with the RRFF, identify and implement appropriate and reasonable measures to address unavoidable losses at the Project in order to achieve NNI. Chelan PUD… may consider implementation of off-site actions in order to address unavoidable impacts."

The previous sections describe the significant efforts undertaken during the past 5 years to identify, measure, and address avoidable effects on Pacific lamprey due to ongoing Rocky Reach Project operations. These sections highlight areas where Project effects have been identified and have been or are in the process of being addressed, and also many areas where additional data needs to be collected and discussions held in order to identify and address ongoing Project effects. Some areas, such as direct measurement of potential effects on downstream juvenile passage, may not be possible to identify and address until technologies and methods are satisfactorily developed. Discussions are occurring at present within the RRFF to determine the next steps to achieve NNI for Pacific lamprey at the Project.

2.7 Adaptive Management Process to Achieve NNI

Ongoing Adaptive Management discussions within the RRFF (2010-2013) include framing and resolving several key issues for measuring Project impacts. Among them the RRFF has identified:

- Can tag technology produce an active tag in the near time-frame small enough with sufficient battery life to conduct juvenile lamprey Project survival studies?

- If an adequate tag can be developed for measuring juvenile lamprey movements, then can an unbiased, paired-release mark –recapture study method be developed to conduct juvenile lamprey survival studies given unique complexities of juvenile lamprey freshwater life-history and outmigration behavior in the Project?

- What is happening to adult Pacific lamprey in Rocky Reach Reservoir given very low passage counts at the upstream dam and is there an effect attributable to the reservoir?

- Can an accurate assessment of adult lamprey migration and behavior in the reservoir be conducted that can also determine and spawning tributary selection?

- Should half-duplex PIT-tag detection equipment be installed in tributaries to assess adult Pacific lamprey "escapement into tributaries" to aid in solving discrepancies in dam passage counts?

- Is there a role for artificial propagation of lampreys, beyond providing juvenile lamprey for study needs only, but to achieve NNI? If so, what would it entail?

- If juvenile downstream passage studies cannot be conducted to determine unavoidable impacts on juvenile downstream passage, can alternative approaches be used to determine Project impacts?

- If alternate approaches are not possible, how could compensation be determined and provided to achieve NNI?

- How does information collected to answer the previous questions help to achieve NNI?

At present, the RRFF is discussing alternative actions and projects, both on-site and off-site that could be used to achieve NNI for Pacific lamprey. In years one through five of the new License, several key uncertainties for measuring Project impacts (above) have been identified by the RRFF. Study methods and active tags to assess potential Project impacts on downstream migration of juvenile lamprey, and subsequently assess unavoidable impacts, are among these key uncertainties. Ongoing efforts by the RRFF to identify specific actions to achieve NNI will be reported in the next 5-year Biological Objective s Status Report (2019). The RRFF has discussed Potential off-site actions that could be used to mitigate unavoidable impacts once determined, and achieve NNI.

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