# ANNUAL REPORT
# CALENDAR YEAR 2011
# ACTIVITIES UNDER THE AQUATIC SETTLEMENT AGREEMENT

# WELLS HYDROELECTRIC PROJECT
# FERC LICENSE NO. 2149


**Prepared for**

Public Utility District No. 1
of Douglas County, Washington
1151 Valley Mall Parkway
East Wenatchee, Washington 98802-4497

**Prepared by**

Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, Washington 98101



**April 2012**

# TABLE OF CONTENTS



## List of Tables



## List of Appendices

# 1 INTRODUCTION

The Wells Hydroelectric Project (Wells Project) is owned and operated by Public Utility District (PUD) No. 1 of Douglas County (Douglas PUD). The Aquatic Settlement Agreement (Agreement) for the relicensing of the Wells Project (Federal Energy Regulatory Commission [FERC] License No. 2149) was signed by Douglas PUD's commissioners on January 19, 2009, following the receipt of signatures from the Confederated Tribes of the Colville Reservation (CCT; November 10, 2008), Washington State Department of Ecology (Ecology; November 18, 2008), and Washington Department of Fish and Wildlife (WDFW; November 20, 2008). The Yakama Nation signed the Agreement on February 24, 2009; the U.S. Fish and Wildlife Service (USFWS) signed the Agreement on July 23, 2009; and the Bureau of Land Management (BLM) signed the Agreement on November 13, 2009. These signatory entities are collectively referred to as the Parties. Preparation of this report was funded by Douglas PUD as a requirement of the Agreement, and it is the third annual report to be developed for activities accomplished under the Agreement, covering the period from January 1, 2011, to December 31, 2011.

The Agreement is intended to resolve all remaining aquatic resource issues related to compliance with all federal and state laws applicable to the issuance of a new operating license for the Wells Project that are not already addressed by the Anadromous Fish Agreement and Habitat Conservation Plan (HCP) for the Wells Hydroelectric Project (HCP 2002), or other related agreements. The original operating license for the Wells Project will expire May 31, 2012. The Agreement is the culmination of 3 years of collaborative discussions with stakeholders related to relicensing that began in March 2006.

On December 18, 2009, Douglas PUD filed with the FERC the Draft License Application (DLA) for the new operating license, which included this Agreement. A Final License Application (FLA) was filed with the FERC on May 27, 2010, and included a Joint Offer of Settlement related to this Agreement by the Parties. Subject to the reservations of authority in Section 13 (Reservations of Authority) of the Agreement, the Agreement establishes Douglas PUD's obligations for the protection, mitigation, and enhancement of aquatic resources affected by Wells Project operations under the new operating license, as well as its obligations to comply with all related federal and state laws applicable to the issuance of the new operating license for the Wells Project. The Agreement also specifies procedures to be used by the Parties to ensure that the new operating license is implemented consistent with the Agreement and other laws.

The six Aquatic Resource Management Plans (White Sturgeon Management Plan, Bull Trout Management Plan, Pacific Lamprey Management Plan, Resident Fish Management Plan, Aquatic Nuisance Species Management Plan, and Water Quality Management Plan) contained in Attachments B through G, respectively, of the Agreement, together with the HCP, will function as the Water Quality Attainment Plan (WQAP) in support of the Clean Water Act (CWA) Section 401 Water Quality Certification for the Wells Project. As of the effective date of the Agreement, pursuant to Section 5 of the Agreement (Term of License and this Agreement), the Parties agreed that the measures set forth in the Aquatic Resource Management Plans are adequate to identify and address Wells Project impacts to Aquatic Resources and are expected to achieve the goals and objectives set forth in each of the six Aquatic Resource Management Plans. However, during the course of the New Operating License, there may be instances where the measures found in individual management plans may need to be adapted. In these instances, "Adaptive Management" will be used to achieve the biological goals and objectives.

In October 2011, the FERC released the Final Environmental Impact Statement for the Wells Project license. Douglas PUD anticipates the release of the final CWA Section 401 Certification by Ecology and the final Biological Opinions under Section 10 of the Endangered Species Act (ESA) from USFWS and the National Marine Fisheries Service (NMFS) in early 2012. Following these publications, Douglas PUD anticipates that the FERC will issue a new license by May 2012.

# 2 PROGRESS TOWARD IMPLEMENTING THE AGREEMENT AND THE AQUATIC RESOURCE MANAGEMENT PLANS

Section 11.7 of the Agreement requires preparation of an annual report that includes all relevant materials associated with Agreement activities during the year. The subsequent sections of this chapter describe activities implemented during 2011 toward implementing the Agreement and Aquatic Resource Management Plans.

## 2.1 2011 Aquatic Settlement Agreement Decisions, Agreements, and Milestones

Decisions, agreements, and milestones reached by the Aquatic Settlement Work Group (Aquatic SWG) during 2011 and related to the Agreement are shown in Table 1 and documented in the Aquatic SWG meeting minutes (Appendix A).

**Table 1**

**2011 Summary of Decisions, Agreements, and Milestones – Aquatic SWG**

| Aquatic SWG Decisions, Agreements, and Milestones | Meeting Date |
|---|---|
| Douglas PUD agreed to install half-duplex Passive Integrated Transponder tag detection equipment in the fishways at Wells Dam. | April 13, 2011 |
| The Aquatic SWG agreed to request approval by the HCP Coordinating Committees to change nighttime fishway entrance operating conditions to a 1.0-foot head differential from August 7 through September 30, 2011. | April 13, 2011 |
| The Aquatic SWG approved the Wells Broodstock Collection and Breeding Plan and the Sturgeon Supplementation Request for Proposals. | September 23, 2011 |
| The Aquatic SWG agreed to continue investigations into obtaining adult lamprey from Rocky Reach, Priest Rapids Dam, or other downriver dams for use in evaluating adult lamprey passage efficiency at Wells Dam. | December 12, 2011 |

### *2.1.1 Development of White Sturgeon Broodstock Collection and Breeding Plan*

In March 2010, the Aquatic SWG agreed to develop a White Sturgeon Broodstock Collection and Breeding Plan (Supplementation Plan) based on the Wells Project White Sturgeon Management Plan. A preliminary draft Supplementation Plan was provided to the Aquatic SWG for comment in August 2010. In October 2010, a second draft of the Supplementation

Plan was presented to the Aquatic SWG and revisions to the draft were agreed to. However, with discussions regarding sturgeon supplementation ongoing outside the Aquatic SWG (which also included many Aquatic SWG members), the Aquatic SWG decided to wait until after an important sturgeon stakeholder's meeting could occur in January 2011, and then consider further revisions to the Supplementation Plan. Discussion among sturgeon stakeholders at the January 2011 meeting was expected to result in additional information regarding white sturgeon broodstock collection strategies associated with similar programs being implemented by Chelan PUD and Grant PUD. Following the January 2011 meeting, further revisions were made to the Supplementation Plan by the Aquatic SWG and at the September 14, 2011, Aquatic SWG meeting, the Supplementation Plan was approved by all present Aquatic SWG members (CCT, WDFW, and Douglas PUD). Members not present at that meeting (Yakama Nation, USFWS, BLM, and Ecology) provided concurrence with the approval of the Supplementation Plan by email by September 21, 2011. On November 18, 2011, it was brought to the attention of Douglas PUD that some revisions to the Supplementation Plan approved at the September 14, 2011, Aquatic SWG meeting were not included in the final version appended to the White Sturgeon Supplementation Request for Proposals (RFP) and advertised in October 2011 (Section 2.1.2). Douglas PUD made the changes to the Supplementation Plan and notified the Aquatic SWG by email on November 18, 2011, of the revisions. The revised final Supplementation Plan, with the edits captured in Track Changes (MS Word editing tool) and the email notifying the Aquatic SWG of the corrected language are included in Appendix C.

### 2.1.2 White Sturgeon Supplementation Request for Proposals

In August 2010, the Aquatic SWG began working with Douglas PUD to develop a draft RFP, which would address implementation of the artificial propagation program identified in the Wells Project White Sturgeon Management Plan. Douglas PUD indicated that the RFP needed to be submitted to the FERC for approval, along with the Supplementation Plan, prior to implementation of the program. Douglas PUD planned to implement the Wells Project White Sturgeon Management Plan in the first year following approval of the Wells Project New Operating License, which was anticipated to be issued in May 2012. The stocking of juvenile sturgeon was then scheduled to begin in Year 2 of the new license (2013), requiring collection of sturgeon broodstock or larvae in 2012. On September 14, 2011, the Aquatic SWG recommended that Douglas PUD proceed with finalizing the RFP.

On October 20 and 27, 2011, Douglas PUD advertised the RFP (Appendix C - RFP #11-19-W) in local newspapers with a November 30, 2011, deadline for proposals.

In response to the RFP, Douglas PUD received two proposals, one from the Yakama Nation, and one from CCT and Golder Associates. At the December 12, 2011, Aquatic SWG meeting, Douglas PUD opened discussion regarding the technical merit of the two proposals. Douglas PUD indicated that both proposals had strengths and weakness and said that they were willing to support either proposal recommended by consensus of the Aquatic SWG. The Aquatic SWG agreed to review the proposals and, beginning with the January 9, 2012 meeting, to work toward selecting a preferred proposal. The selection of a proposal in early 2012 would allow for early implementation of broodstock collection activities in 2012 rather than in 2013, as required in the Wells Project White Sturgeon Management Plan.

### *2.1.3 Installation of Half-duplex Passive Integrated Transponder tag Detectors*

In 2004, 2007, and 2008, adult lamprey passage evaluations were conducted using radio telemetry at the default, 1.5-foot head differential, fishway operating condition at Wells Dam. In 2009 and 2010, Douglas PUD investigated lamprey passage at Wells Dam fishways using Dual-Frequency Identification Sonar (DIDSON) camera technology. In 2009, both fishways entrances were monitored and passage was evaluated at the 0.5-, 1.0-, and 1.5-foot head differential. In 2010, as in 2009, fish passage at both fishway entrances was monitored using DIDSON technology; however, only two fishway entrance operating conditions were evaluated (1.0- and 1.5-foot head differentials). Also in 2010, in an attempt to increase sample size, the duration of monitoring and the hours of sampling per day were expanded compared to the 2009 study. In 2009, tests were conducted from 9:00 pm to 1:00 am, August 21 through September 23. In 2010, tests were conducted from 5:00 pm to 1:00 am, August 7 through September 30. The draft 2010 DIDSON Study Report was distributed to the Aquatic SWG on June 10, 2011, for review and Douglas PUD presented a summary of the results to the Aquatic SWG at the July 13, 2011, meeting. The Aquatic SWG members provided comments by the August 10, 2011, review deadline.

The results of the radio telemetry studies in 2004, 2007, and 2008 indicated that once lamprey made it past the sill in the fishway entrances, approximately 90 percent remained in the fishway and proceeded up the ladder. In 2009 and 2010, the small sample size did not yield statistically valid results; however, the observed behavior of the lamprey at the fishway entrance suggested that the lower head differential (1.0-foot) enhanced entrance and passage success. Based on the observed results, the Aquatic SWG requested and received HCP Coordinating Committees' approval of a change in fishway operations for 2011 from a 1.5-foot head differential to a 1.0-foot head differential from 5:00 pm to 1:00 am, August 7 through September 30, 2011 (lamprey operations; also see Section 2.2.1). Lamprey operations would be implemented 3 days following the date when the cumulative count of adult lamprey passing Rocky Reach Dam reached five individuals.

During review of the draft 2010 DIDSON Study Report, Aquatic SWG and HCP Coordinating Committees' members commented on one primary concern regarding the possible effects on salmonid migration and delay from changes to the head differential at the Wells fishway entrances. Because head differential at the fishway entrances had been optimized for ESA-listed salmonids, analysis was requested to determine if the flow changes designed for lamprey and implemented in 2011 had a measureable effect on ESA-listed Upper Columbia steelhead and Upper Columbia spring Chinook. At the end of 2011, Douglas PUD was working on this analysis with Dr. John Skalksi, Columbia Basin Research. Once completed, the analysis will be added to the draft 2010 DIDSON Study Report and finalized. The final report will be distributed to the Aquatic SWG in 2012. Copies of the Final 2009 DIDSON Study Report and the Draft 2010 DIDSON Study Report are included in Appendix C (2009 DIDSON Study Report and Draft 2010 DIDSON Study Report).

For 2011 and beyond, the Aquatic SWG discussed several options for additional investigations of adult lamprey passage at Wells Dam, including additional monitoring of passage using DIDSON or high resolution underwater infrared video cameras, and monitoring passage of lamprey with half-duplex (HD) PIT-tag detectors installed in the fishways. To increase sample sizes, translocating lamprey from downriver locations to the tailrace of Wells Dam was discussed. The Aquatic SWG concluded that the most promising approach for future years involved the use of translocated lamprey tagged with radio and/or HD PIT-tags, and the installation of HD PIT-tag detectors in the Wells Dam fishways. Douglas PUD agreed to proceed with the installation of HD PIT-tag detection arrays in the Wells Fishways during the 2011/2012 winter fishway maintenance. However, because of the late release of the new HD PIT-tag detection transceiver (FS2020) by Biomark, and the short (2 week) maintenance window in 2011/2012 for the east fish ladder, installation of the HD PIT-tag detection arrays in the east fishway was delayed until the winter of 2012/2013. Installation of the HD PIT-tag system in the west ladder will occur in January 2012.

### *2.1.4 Translocation of Adult Lamprey for Future Lamprey Passage Efficiency Studies*

As noted in Section 2.1.3, the Aquatic SWG discussed the possibility of translocating adult lamprey from downstream dams for use in evaluating adult lamprey passage efficiency at Wells Dam in 2012. Douglas PUD agreed to explore this option with fishery co-managers in anticipation of passage studies in 2012, after the installation of HD PIT-tag detectors in the Wells Dam fishways in 2011/2012. Possible adult lamprey collection locations include Rocky Reach Dam, Priest Rapids Dam, Bonneville Dam or other downriver dams. However, because of the late release of the new HD PIT-tag transceivers by Biomark and the resulting inability to install the new detectors in the east ladder, as explained in Section 2.1.3, a lamprey passage study will not be implemented in 2012 (for further explanation, see Section 2.3).

## 2.2 Completed Studies 2011

### *2.2.1 2011 Fishway Entrance Velocities Testing*

Based on the observed results of the 2009 and 2010 adult lamprey passage studies using DIDSON camera technology, the Aquatic SWG requested HCP Coordinating Committees' approval for a change in fishway operating conditions from the 1.5-foot head differential at the fishway entrances, to a 1.0-foot head differential from 5:00 pm to 1:00 am, August 7 through September 30, 2011 (lamprey operations). Lamprey operations would be implemented 3 days following the date when the cumulative count of adult lamprey passing Rocky Reach Dam reached five individuals. As a condition of approving this change in fishway entrance operating conditions, the HCP Coordinating Committees requested that Douglas PUD empirically measure (rather than model) water velocities at the fishway entrances. Testing was conducted March 1 and 2, 2011, and velocities were measured under both low and high tailwater conditions at 1.0- and 1.5-foot head differentials using Acoustic Doppler Velocimeters (ADVs). The results were presented to the Aquatic SWG on April 13, 2011, and to the HCP Coordinating Committees on May 24, 2011, along with a memo documenting the test results (Appendix C – Wells Dam Fishway Entrance Velocity Measurements). The results of the velocity tests, when compared to the documented swimming performance for adult Pacific lamprey, suggested that the entire orifice area was passable for lamprey at both high and low tailwater elevations at the 1.0-foot head differential. The results suggested that passage conditions would likely be most difficult for lamprey at the 1.5-foot head differential at low tailwater elevations.

On July 26, 2011, the HCP Coordinating Committees approved the Aquatic SWG's request for a 1.0-foot operating condition for 2011, with the understanding that Douglas PUD would continue to develop plans to investigate lamprey passage using HD PIT-tag detection technology in future years. The HCP Coordinating Committees indicated they would not likely approve a permanent change in fishway operating criteria at the Wells fishway entrances until Douglas PUD conducted a study to evaluate the potential effects on salmonid passage. To address the HCP Coordinating Committees' concern regarding potential negative effects to salmonids as a result of changes to fishway entrance operating conditions, in August 2011, Douglas PUD requested that Dr. John Skalski, Columbia Basin Research, conduct a statistical analysis of passage times of adult salmonids at the 1.0-foot and 1.5-foot head differential entrance conditions. The analysis was to be designed to test if adult salmonid passage behavior was altered when operating the fishway entrance with a reduced head differential. Results from this analysis will be made available to the Aquatic SWG and HCP Coordinating Committees in the spring of 2012.

In 2011, no adult lamprey were counted in the Wells fishways during lamprey operations. The only adult lamprey counted at Wells Dam in 2011 was on June 18, 2011; based on timing, this individual was likely a reservoir hold-over from the 2010 migration. As stated in Section 2.3, Douglas PUD intends to request approval from the HCP Coordinating Committees in 2012 for a modified night-time fishway operation during the peak of lamprey migration, similar to what was approved by the HCP Coordinating Committees in 2011. The HCP Coordinating Committees' approval will be contingent on the results from Dr. Skalski's analysis of the effects of operating the adult fishway with a reduced head differential at the entrance.

### 2.2.2 2011 Total Dissolved Gas Monitoring

On March 31, 2011, Ecology approved Douglas PUD's 2011 Total Dissolved Gas (TDG) Abatement Plan (GAP) (included as an appendix to the Wells Project TDG Abatement Plan 2011 Annual Report). In December 2011, Douglas PUD reported to Ecology the results of measures implemented in 2011 to meet state water quality standards for TDG during spill operations at the Wells Project (Appendix C – TDG Abatement Plan 2011 Annual Report). Exceptionally high flows in the Columbia River began in mid-May 2011 and persisted into August 2011. Large volumes of spill at Grand Coulee Dam resulted in a high frequency of flows with TDG levels out-of-compliance entering the Wells Project (greater than 115 percent). Additionally, there were numerous days (34) when flows at Wells Dam were above the 7Q-10 flood flow. In consideration of these conditions, Douglas PUD, through the implementation of its spill playbook, achieved 97.5 percent compliance with the TDG waiver standards. Douglas PUD will continue monitoring TDG on an annual basis, providing annual reports of data as required by the Ecology-approved GAP. Douglas PUD will submit the draft 2012 GAP to Ecology in early 2012.

As part of the GAP, Douglas PUD is required to examine migrating salmonids for Gas Bubble Trauma (GBT) if TDG in the Wells tailrace exceeds 125 percent during the fish spill season (April 12 and August 26, 2011). Results of monitoring for GBT are reported in the Wells Project 2011 GBT Monitoring Report, revised in February 2012 (Appendix C – Wells Project 2011 GBT Monitoring Report). Monitoring was initiated on May 21 and continued daily until May 30, 2011, and then occurred on a 3 day per week schedule, approved by Ecology, into late July. Examinations were made at Rocky Reach Dam; GBT expression in juvenile salmon examined varied by species but appeared to track TDG concentrations reasonably well. Coho expressed the highest incidence of GBT with steelhead and yearling Chinook expressing intermediate GBT and sockeye and subyearling Chinook appearing to be the most resilient to high TDG concentrations. Throughout the season, adult fish sampled at Wells Dam showed few symptoms of GBT, even when TDG was above 130 percent in the Wells Dam tailrace.

### *2.2.3 2011 Bull Trout Monitoring and Management Plan*

As in previous years, bull trout monitoring and management efforts continued in 2011; the results are recorded in the 2010 Bull Trout Monitoring and Management Plan (BTMMP) Annual Report (Appendix C). These efforts included coordination with regional groups, and PIT-tagging bull trout at Wells Dam and off-site locations in Methow River tributaries (a coordinated effort with WDFW). Sixty-six adult bull trout were counted at Wells Dam fish ladders in 2011, which is consistent with the 13-year mean count (since counts began in 1998). Seasonal distribution of these fish, captured at Twisp River and Methow River screw traps, and incidental encounters at the Twisp Weir will be summarized and provided in the 2011 BTMMP annual report. The final 2011 BTMMP Annual Report will be filed with the FERC by March 31, 2012, and provided to the Aquatic SWG by April 11, 2012.

### *2.2.4 Aquatic Nuisance Species Monitoring*

In June 2010, the Aquatic SWG approved plans to implement ANS monitoring efforts consistent with proposed requirements contained in the Aquatic Nuisance Species (ANS) Monitoring Plan for the new FERC license. Although these are not currently required activities, Douglas PUD began early implementation of these projects in 2010 and continued the work in 2011. In 2011, Douglas PUD monitored for ANS with an emphasis on zebra/quagga mussels, macrophytes, crayfish, and northern pike (Appendix C – 2011 ANS Monitoring PowerPoint Presentation). To date, no adult zebra or quagga mussels have been detected at the Wells Project during ANS sampling. Crayfish were collected incidental to sampling of salmonids in June 2011, confirming the presence of the non-native northern crayfish (*Orconectes virilis*). Northern pike have not yet been found in any fish sampling efforts in the Wells Reservoir. On September 30, 2011, Douglas PUD conducted an aquatic plant survey. Eurasian milfoil was not dominant but was subdominant in 15 percent of samples taken (Appendix C– Memorandum: Wells Project swimming areas macrophytes).

## 2.3 Planned Monitoring and Studies 2012

Douglas PUD will continue annual monitoring of TDG at the Wells Project as required by the Ecology-approved GAP. The monitoring is expected to begin in April and continue through August 2012.

Douglas PUD had planned an evaluation of lamprey passage at Wells Dam in 2012 using HD PIT-tag detection; however, due to delays as described in Section 2.1.3, the HD PIT-tag detection arrays were only installed in the Wells west fishway. Without full detection capabilities, it will not be possible to conduct a scientifically sound study to evaluate lamprey passage efficiencies at Wells Dam in 2012. Douglas PUD intends to request approval from the HCP Coordinating Committees in 2012 for a modified night-time fishway operation during the peak of lamprey migration, similar to what was approved by the HCP in 2011. Douglas PUD plans to complete the installation of HD PIT-tag detection arrays during the 2012-2013 winter maintenance period and plans to conduct a lamprey passage study in the fall of 2013 using translocated adult Pacific lamprey.

Douglas PUD will explore the possibility of using infrared cameras to monitor lamprey passage in 2012 through the picketed lead area of the adult fishway. Continued support and implementation of the BTMMP will occur in 2012. Information regarding this program's activities will be provided to the Aquatic SWG as they occur. An annual report for the BTMMP will be submitted to the FERC and the Aquatic SWG in spring 2012, which will summarize activities and results 2011. A new license is expected to be issued by the FERC in May 2012. The new license will likely require a different bull trout monitoring protocol. The BTMMP report submitted in the spring of 2012 will likely be the final report for that monitoring plan.

In 2012, Douglas PUD will collect bull trout for a radio telemetry study to evaluate adult passage conditions at the Twisp Weir in the Methow Basin as required by Section 4.2.2 of the Aquatic Settlement Agreement Bull Trout Management Plan. A study proposal to evaluate passage at the Twisp Weir will be provided to the Aquatic SWG in early 2012 for approval and implementation in 2012. Implementation of this study is subject to Douglas PUD receiving a new Project license by May 2012.

Douglas PUD will continue to support and implement ANS efforts in 2012, intending to develop a survey proposal to sample for crayfish to document crayfish species composition in the Wells Reservoir. Tracking of the spread of northern pike in the upper Columbia River system will continue, with potential regional coordination and participation and zebra and quagga mussel early-detection monitoring will continue in coordination with WDFW and

Portland State University. Douglas PUD has also agreed to manage and treat macrophytes within swimming areas of the parks in Pateros, Brewster, and Bridgeport in 2012, consistent with the Wells Project Recreation Management Plan.

# 3 AGREEMENT ADMINISTRATION

This section lists events of note that occurred in 2011 related to the administration of the Agreement, and lists reports published in 2011 that relate to the Aquatic SWG.

## 3.1 HCP Coordination

In June 2011, the Aquatic SWG requested approval from the HCP Coordinating Committees for implementation of a 1.0-foot head differential from 5:00 pm to 1:00 am, August 7 through September 30, 2011, at the Wells fishway entrances in 2011(lamprey operations). Lamprey operations would be implemented 3 days following the date when the cumulative count of adult lamprey passing Rocky Reach Dam reached five individuals. Following the results of a test measuring fishway entrance velocities at a 1.5-foot and a 1.0-foot head differential on March 1 and 2, 2011, which indicated that the 1.0-foot head differential at the fishway entrance had no apparent effect on salmonid passage, in July 2011, the HCP Coordinating Committees approved implementation of lamprey operations for 2011.

## 3.2 Aquatic Settlement Work Group Members

A designated technical representative and a separate designated policy representative for each of the Parties make up the Aquatic SWG established under the Agreement. The Aquatic SWG meets collectively to expedite the process for overseeing and guiding the implementation of the Agreement. The policy representatives will meet at least once annually during the term of the New Operating License to review progress and implementation of the Agreement. Minutes from the monthly meetings are compiled in Appendix A of this report. Appendix B lists current members of the Aquatic SWG.

## 3.3 Agreement-related Reports Published in Calendar Year 2011

The following documents were finalized by the Aquatic SWG in 2011 (Appendix C):

- White Sturgeon Broodstock Collection and Breeding Plan
- Final 2009 Assessment of Adult Pacific Lamprey Response to Velocity Reductions at Wells Dam Fishway Entrances (2009 DIDSON Study Report)
- Draft 2010 Assessment of Adult Pacific Lamprey Response to Velocity Reductions at Wells Dam Fishway Entrances (2010 DIDSON Study Report)

- 2010 Bull Trout Monitoring and Management Plan Annual Report
- 2011 Wells Project Gas Bubble Trauma Biological Monitoring Report
- 2011 Wells Dam Fishway Entrance Velocity Measurements Memo
- 2011Wells Project Total Dissolved Gas Abatement Plan (GAP) Annual Report
- 2011 Aquatic Macrophyte Species Survey Letter to Ecology

# APPENDIX A
# AQUATIC SETTLEMENT WORK GROUP 2011 MEETING MINUTES AND CONFERENCE CALL MINUTES

**From:** Carmen Andonaegui
**To:** Virginia See
**Subject:** FW: Aq SWG: Jan meeting cancelled
**Date:** Tuesday, January 31, 2012 8:45:25 AM

---

**From:** Carmen Andonaegui
**Sent:** Wednesday, January 05, 2011 4:12 PM
**To:** Beau Patterson (bpatterson@dcpud.org); Bill Towey (bill.towey@colvilletribes.com); ble@longviewassociates.com; Bob Jateff (jatefrjj@dfw.wa.gov); Bob Rose (brose@yakama.com); 'Brad James'; 'Bret Nine'; 'Chad Jackson'; 'Donella Miller'; Jeff Korth (korthjwk@dfw.wa.gov); 'Jessi Gonzales'; Joe Kelly (j1kelly@or.blm.gov); Joe Peone (joe.peone@colvilletribes.com); 'Jon Merz'; 'Karen Kelleher'; kirk.truscott@colvilletribes.com; 'Mary Mayo'; Mike Schiewe (mschiewe@anchorqea.com); Molly Hallock (hallomh@dfw.wa.gov); Pat Irle (pirl461@ecy.wa.gov); 'Patrick Luke'; Patrick Verhey (Patrick.Verhey@dfw.wa.gov); Paul Ward (ward@yakama.com); Shane Bickford (sbickford@dcpud.org); 'Steve Lewis'; 'Steve Parker (parker@yakama.com)'; 'Tony Eldred'
**Cc:** Bob Dach (Robert.dach@bia.gov); Keith Hatch (Keith.Hatch@bia.gov)
**Subject:** Aq SWG: Jan meeting cancelled

Hi Aq SWG: the January 12 meeting is cancelled due to a lack of agenda items this month. Our next scheduled meeting is February 9. As the date nears, I'll send out a request for agenda items.

Thanks!
-Carmen

**Carmen Andonaegui**
**ANCHOR QEA, LLC**

candonaegui@anchorqea.com
23 S. Wenatchee Avenue, Suite 120
Wenatchee, WA 98801
T 509.888.0240
C 509.881-0198
F 509.888.2211

www.anchorqea.com

# Final Meeting Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: March 9, 2011

**From**: Michael Schiewe (Anchor QEA)

**re**: Final Minutes of February 9, 2011 Aquatic SWG Conference Call

## I. Summary of Decisions

1. There were no decision items at this meeting.

## II. Summary of Action Items

1. Steve Lewis will forward the preliminary juvenile lamprey presence/absence study plan to Carmen Andonaegui for distribution to the Aquatic SWG (Item III-4).

2. Carmen Andonaegui will set up a conference call line for the next Aquatic SWG meeting on March 9, from 10am to NLT 2pm (Item IV-1).

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review** – Mike Schiewe welcomed Aquatic SWG members and opened the meeting. Schiewe reviewed the agenda and asked for approval of the revised December 8, 2010 meeting minutes. There were no additions to the agenda and the meeting minutes were approved as revised. Carmen Andonaegui will finalize the revised meeting minutes and distribute them to the Aquatic SWG.

2. **White Sturgeon Broodstock Collection and Breeding Plan** – Beau Patterson reported that the Wells Project White Sturgeon Broodstock Collection and Breeding Plan (Plan) was last reviewed during the October Aquatic SWG meeting. At that time, the Aquatic SWG agreed to consider proposed revisions to the Plan after a planned regional technical meeting, which was held this past January in Boardman, Oregon. Patterson said that based on those discussions there were no proposed revisions at this time. Patterson also reported that in December 2010, the Yakama Nation and the Washington Department of Fish and Wildlife (WDFW) suggested that Douglas PUD join with Chelan and Grant PUDs to support a coordinated white sturgeon broodstock collection program. Beau said Douglas PUD conceptually is open to the recommendation, provided it is approved by Aquatic SWG; however, he noted that a proposal has not yet been brought before this group.

3. **Update: Consolidated Sturgeon and Lamprey Meetings Proposal** – Bob Rose reported that several interested parties met yesterday (February 8) regarding the YN proposal to establish separate technical workgroups for white sturgeon and for lamprey; he indicated that those present were generally supportive of the concept. He indicated that at yesterday's meeting the parties agreed to three distinct broodstock collection activities in 2011, with Grant PUD focusing collection in the Priest Rapids Project reservoirs, Chelan possibly hiring charter boats to fish the McNary Reservoir, and the Yakama Nation focusing fishing efforts in the Bonneville Reservoir. Rose said that it was these kinds of technical details that he anticipated would be addressed in the technical forums, with the information being reported back to the Aquatic SWG and the Fish Forums for decision-making. Rose acknowledged that Douglas PUD did not have their new FERC license yet and hence was on a different schedule than Chelan and Grant PUDs for implementing their program. Accordingly, he noted that the fishery managers were comfortable with moving forward with only Grant and Chelan PUDs at this time. Rose suggested that after Douglas PUD received their new license they would benefit by working with these technical workgroups as well.

   Beau Patterson said that Douglas PUD is interested in participating in technical discussions at the regional level, but not in multi-party discussions regarding Wells Aquatic Settlement programs implementation outside of the Aquatic Settlement Work Group; he indicated that those discussions will occur within the Aquatic SWG. Shane Bickford further clarified the position, saying that Douglas PUD's management plans are very different from Grant and Chelan PUDs' plans, and that preliminary discussions regarding joint implementation has lead to several misunderstandings and confusion over responsibilities.

4. **Updates on Current/Future Pacific Lamprey Activities** – Beau Patterson reported that the 2010 study to monitor lamprey passage using DIDSON cameras had been conducted in both Wells Project fishways. Daily monitoring and total duration of monitoring was increased in 2010 in an attempt to increase sample size. Patterson said the draft study report, intended for release at the end of January by the study consultant, has been delayed and is now expected in mid-March. He indicated that preliminary review of the video data failed to show any attempts by lamprey to enter the fishway. Shane Bickford said lamprey had not even been observed near the fishway entrance, the result of a very low number of migrating lamprey making it to the Wells Project.

   Bob Rose asked about the possibility of translocating and tagging lamprey captured from the Priest Rapids Project and introducing them further upstream in the Columbia River to monitor their movements. The Aquatic SWG discussed the low population abundance, and the effect on sample size, and tagging/marking limitations. Shane Bickford said Douglas PUD would consider installing half-duplex (HD) PIT tag detection arrays at Wells Dam during the 2012 January/February fishway work window, if there would be the possibility of their use for at least two years. Patterson said he will be attending a U.S. Army Corps of Engineers meeting in the near future on technologies and marking strategies under investigation for monitoring lamprey movement. He said this meeting should provide information useful for future lamprey studies. Regarding whether or not to repeat monitoring in 2011 using the DIDSON cameras, Rose said he believes it would be helpful to continue this work. The Aquatic SWG determined that there is about a two month period before a decision needs to be made as to how to continue monitoring in 2011 and that the decision should be informed by the predicted lamprey migration run size.

Patterson agreed to provide the Aquatic SWG with updates on the results of the lamprey passage study as they become available. He expected a draft report will be available for discussion at the April Aquatic SWG meeting.

Rose asked Steve Lewis about any discussions between USFWS and Douglas PUD concerning presence/absence surveys for juvenile lamprey in the Wells Project area. Lewis said the USFWS has been discussing such a survey only with Chelan PUD because it was included in their new license. He reported that USFWS and Chelan PUD has developed a preliminary proposal for presence/absence monitoring of juvenile lamprey in the Rocky Reach Project area. Lewis asked if Douglas PUD was interested in discussing participation in a similar survey in the Wells Project area. Bickford said it would be difficult to implement any electro-fishing surveys, as proposed in the preliminary proposal, given the ESA-listing status of salmonids. Lewis agreed and indicated he would forward an information copy of the preliminary study plan to Carmen Andonaegui for distribution to the Aquatic SWG.

## V. Next Meetings

*1.* Upcoming meetings: ***March 9 (conference call), April 13 (in-person), and May 2 conference call)***

The Aquatic SWG agreed to hold the April 13 meeting in-person and conduct the March and May meetings by conference call. Carmen Andonaegui will set up a conference call line for March 9, from 10 am to NLT 2 pm.

## List of Attachments

Attachment A – List of Attendees

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | Aquatic SWG Chair | Anchor QEA, LLC |
| Carmen Andonaegui | Administrative | Anchor QEA, LLC |
| Beau Patterson | SWG Technical Rep. | Douglas PUD |
| Andrew Gingerich | SWG Technical Rep./Alternate | Douglas PUD |
| Shane Bickford | SWG Policy Rep. | Douglas PUD |
| Keith Hatch | Observer | BIA |
| Patrick Verhey | SWG Technical Rep./Alternate | Washington Department of Fish and Wildlife |
| Chad Jackson | Technical Resource | Washington Department of Fish and Wildlife |
| Steve Lewis | SWG Technical Rep. | U.S. Fish and Wildlife Service |
| Bob Rose | SWG Technical Rep. | Yakama Nation |

# Final Conference Call Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: April 13, 2011

**From**: Michael Schiewe (Anchor QEA)

**re**: Final Minutes of March 9, 2011 Aquatic SWG Conference Call

## I. Summary of Decisions

1. There were no decision items for this conference call.

## II. Summary of Action Items

1. Beau Patterson will ask Grant PUD for a copy of Andrea Drauch Schreier's paper on the analysis of sturgeon genetics and the expert panel review for distribution to the Aquatic SWG (Item III-2).

2. Beau Patterson will provide the Aquatic SWG a summary of tomorrow's meeting with the U.S. Army Corps of Engineers (Corps) (Item III-3).

3. Beau Patterson will email the September version of the Broodstock Plan to the Aquatic SWG (Item III-2).

4. Beau Patterson will provide the preliminary Draft 2010 DIDSON Lamprey Passage Study Report and the 2010 study of fishway entrance velocities to the Aquatic SWG (Item III-3).

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review** – Mike Schiewe welcomed Aquatic SWG members and opened the meeting. Schiewe reviewed the agenda and asked for approval of the February 9, 2011 meeting minutes. There were no additions to the agenda and the meeting minutes were approved as revised. Carmen Andonaegui will finalize the revised meeting minutes and distribute the minutes to the Aquatic SWG.

2. **Draft White Sturgeon Broodstock Collection and Breeding Plan and RFP Update** – Beau Patterson updated the Aquatic SWG on the status of the Broodstock Collection and Breeding Plan (Broodstock Plan) and the status of the Request for Proposals (RFP). Since October, when discussions were tabled pending the outcome of the Boardman meeting in January 2011, Patterson said there have been several discussions with Washington Department of Fish and Wildlife (WDFW) and the Yakama Nation about participating in

the development of a joint sturgeon broodstock collection program; however, he noted that any decisions regarding participation in a joint sturgeon broodstock collection program would have to be approved by the Aquatic SWG. Patterson explained that if Douglas PUD receives the new Wells license on schedule, they expect to start collection of broodstock in 2012 for release in 2013.

Bob Rose said there are still many uncertainties regarding broodstock collection, and that what is currently in place should be considered a pilot collection plan. He said it was probably best to wait on finalizing a Wells Project broodstock collection plan until after mid-summer when Grant and Chelan PUDs' 2011 broodstock collection is completed, and lessons learned can be incorporated into the Wells plan. Patterson said consensus approval by the Aquatic SWG of a Wells broodstock collection plan is needed by October 2011 so Douglas PUD can be prepared to implement broodstock collection in 2012 if their new licensed is issued. Patterson said Douglas PUD was not opposed to waiting until after July to finalize collection plans.

Patterson noted that there had been a recent genetic analysis of white sturgeon population structure in the mid- and upper-Columbia by Andrea Drauch Schreier (UC Davis). He said he was checking with Grant PUD (who funded the study) to see if it was available for distribution to the Aquatic SWG. Rose noted that Drauch Schreier's analysis is still being reviewed and discussed. The Aquatic SWG agreed to continue working on the Wells Broodstock Collection and Breeding Plan with the goal of finalizing the plan in August 2011.

Patterson agreed to email the September version of the Broodstock Plan to the Aquatic SWG for review along with Drauch Schreier's genetic analysis (if available). Rose noted that Grant PUD also convened an expert panel to review Drauch Schreier's work and suggested that Patterson also ask if that too could be made available to the AqSWG. Shane Bickford stated that Douglas PUD's goal is to have either a consensus agreement by the Aquatic SWG on a Broodstock Plan or to have a contract in place by October 2011. He said Douglas PUD will go forward with an RFP by the fall of 2011.

3. **2011 Douglas PUD Lamprey Activities** – Beau Patterson reminded the Aquatic SWG that the Habitat Conservation Plan (HCP) Coordinating Committees (CC) had required empirical measurement of fishway entrance velocities as a condition of their approval of the 2010 Lamprey Passage Study. The testing has been completed and these data will be provided to the Aquatic SWG as soon as the report is available.

   Patterson said Douglas PUD is still considering options for lamprey passage testing in 2011. He noted that he will meet with the U.S. Army Corps of Engineers (Corps) tomorrow to discuss lamprey tagging methods/tools, and will send out an after-meeting summary to the Aquatic SWG. Patterson said Douglas PUD is considering either a third year of DIDSON camera monitoring at Wells Dam or possibly installing Half-Duplex PIT-tag detectors in the fishways in 2011 during normal maintenance closure for use in

2012. Douglas PUD is discussing the possibility of trans-locating lamprey from downriver locations to the Wells Dam tailrace to increase sample size.

Molly Hallock asked what fishway entrance flows will be used in 2011. Patterson said the default agreed to by the HCP CC is a 1.5-foot differential during all operations. Any changes to entrance velocities have to go through the CC. Molly asked if the 1-ft head differential was not the preferred option based on the 2010 study results. Patterson said the 2010 sample size was only two lamprey and that it is difficult to recommend a change in fishway velocities base on such a limited sample size. He said the 2010 Lamprey Report will be available March 18 and he will provide it to the Aquatic SWG. Mike Schiewe said he did not think the CC would be opposed to repeating a lamprey passage study at 1- and 1.5-foot head differentials. Steve Lewis asked if the 2010 results included any discussion of potential impacts to salmonids. Patterson said that the measurement of fishway entrance velocities had been requested by Bryan Nordlund, NMFS, to specifically evaluate effect on salmon. Lewis asked if other two PUDs were aware that collection of lamprey at the Priest Rapids Project was being discussed. Patterson said he thought it would be brought up at tomorrow's meeting with the Corps of Engineers.

## V. Next Meetings

*1.* Upcoming meetings. April meeting will be face-to-face: ***April 13 (in-person), May 11 (conference call), and June 8 (in-person).***

## List of Attachments

Attachment A – List of Attendees

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | Aquatic SWG Chair | Anchor QEA, LLC |
| Carmen Andonaegui | Administrative | Anchor QEA, LLC |
| Beau Patterson | SWG Technical Rep. | Douglas PUD |
| Andrew Gingerich | SWG Technical Rep./Alternate | Douglas PUD |
| Shane Bickford | SWG Policy Rep. | Douglas PUD |
| Molly Hallock | Technical Resource | Washington Department of Fish and Wildlife |
| Brett Nine | Technical Resource | Colville Confederated Tribes |
| Patrick Verhey | SWG Policy Rep | Washington Department of Fish and Wildlife |
| Steve Lewis | SWG Technical Rep. | U.S. Fish and Wildlife Service |
| Bob Rose | SWG Technical Rep. | Yakama Nation |

# Final Meeting Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: July 13, 2011

**From**: Michael Schiewe (Anchor QEA)

**re**: Final Minutes of April 13, 2011 Aquatic SWG Meeting

## I. Summary of Decisions

1. There were no decision items for this meeting.

## II. Summary of Action Items

1. Pat Irle will check with Jenifer Parsons, Washington Department of Ecology (Ecology), regarding her availability to make a presentation at a future in-person meeting of the Aquatic Settlement Work Group (Aquatic SWG) on Aquatic Nuisance Species (ANS) Best Management Practices (Item III-1).

2. Beau Patterson will provide the Aquatic SWG with draft comments on the Draft Environmental Impact Statement (DEIS) that Douglas PUD will be providing to the Federal Energy Regulatory Commission (FERC); although not expected to be complete, Douglas PUD will provide these on or about May 1 (Item III-2).

3. Douglas PUD will provide the draft Lamprey DIDSON Study and results of the fishway entrance velocity testing to the Aquatic SWG for review when available (Item III-4).

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review** – Mike Schiewe welcomed the Aquatic SWG members and opened the meeting. Schiewe reviewed the agenda and asked for approval of the March 9, 2011, conference call minutes. Schiewe provided two editorial changes to the draft minutes. The minutes were approved as revised. Carmen Andonaegui will finalize the revised meeting minutes and distribute the minutes to the Aquatic SWG. No additions were made to the agenda.

   Pat Irle reported that Jennifer Parsons, Ecology, gave a presentation to both Chelan and Grant PUDs on ANS Best Management Practices. She suggested that Parsons could also give the presentation to the Aquatic SWG at a future meeting. Irle will check with Parsons on her availability to attend an Aquatic SWG meeting in the near future to give the presentation.

Schiewe said the 30-day review period for the 2010 Aquatic SWG Annual Report has passed and that the report will be finalized and delivered to Douglas PUD.

2. **Discussion of FERC DEIS Response Process** – Shane Bickford said FERC released the DEIS for the Wells Hydroelectric License last week. He said the release starts a 60-day review period with comments due by May 31, 2011. Bickford said that FERC did not include many of the provisions included in the locally developed Settlement Agreement (SA). Bickford said FERC has scheduled public meetings to take comments on the DEIS on May 12 and 13 at the Douglas PUD auditorium. The meeting on May 12 will be from 6:30 to 8:30 p.m. to accept public comments. The meeting on May 13 will be from 10 a.m. to 12 p.m. to accept agency comments, as well as additional public comments. Bickford said the May 13 meeting is an opportunity for agencies to get their positions on the DEIS on the public record. He said testifying in support of the Aquatic SA at the meeting would be very helpful in that it would put agency positions on record.

   Bickford said FERC traditionally includes in a DEIS only those license conditions that they would normally require of all hydropower projects, and excludes those that are developed in local SAs. He said FERC does this to avoid setting broad precedents. For example, he said in the case of the Wells DEIS, FERC rejected about 60 percent of the bull trout measures, including the bull trout monitoring plan, and rejected the requirement to implement a sturgeon hatchery program. He said that, under Ecology's Clean Water Act (CWA) 401 water quality certification authority and the U.S. Fish and Wildlife Service (USFWS) Endangered Species Act (ESA) consultation requirement, most, if not all, of the measures contained in the SA management plans that were eliminated by FERC will ultimately be reinserted as license conditions. He said FERC understands that agencies will reinsert rejected license measures through other licensing processes like the 401 certification and Section 7 of the ESA.

   Bickford said Douglas PUD will provide draft comments on the DEIS to the Aquatic SWG for their information prior to submitting their final written comments to FERC. He said Douglas PUD's comments will support the SA and he encouraged other SA parties to submit supporting comments as well. Steve Lewis asked if Douglas PUD could make their draft comments available as early as May 1, because of his agency's timeline for approving final comments. Bickford agreed to make available a copy of Douglas PUD's draft comments to the Aquatic SWG by May 2, although at that early time, the document may only be a bulleted list of conditions that either have been agreed to in the SA but were not included in the DEIS, or included in the DEIS and not included in the SA. Jessie Gonzales said the USFWS will take the lead on providing detailed comments on the DEIS related to bull trout.

   Pat Irle noted two license conditions that FERC included in the DEIS that were not included the Water Quality Management Plan (WQMP), and said that the Aquatic SWG should consider adding these to the WQMP. One condition was the requirement that

Douglas PUD comply with Total Dissolved Gas (TDG) standards at Wells Dam outside of the fish migration season; and the second condition was a condition requiring Douglas PUD to comply with present and future mainstem mid-Columbia River temperature total maximum daily load (TMDL) measures. Irle said she would provide comments to FERC on the DEIS that these conditions will be included as license measures in the 401 certification. Beau Patterson said Douglas PUD agreed that these conditions should be added to the WQMP.

Bickford said FERC sent letters yesterday to the USFWS and the National Marine Fisheries Service (NMFS) requesting concurrence on the "Effects Determination" included in the DEIS. Also, FERC is requesting that the Services waive ESA consultation regarding bull trout and for the listed salmonid species already covered under the Habitat Conservation Plan (HCP). Bickford said that the Services were asked by FERC to respond to the request within 30 days. He said the USFWS letter was addressed to Allison O'Brian at the Department of the Interior and Keith Kirkendahl at NMFS.

3. **Introduction of Andrew Gingerich** – Beau Patterson introduced Andrew Gingerich, the newest Douglas PUD biologist. Gingerich will be Patterson's alternate technical representative on the Aquatic SWG, and will be conducting gas bubble disease monitoring and water temperature monitoring, and working on HCP juvenile survival studies. He will also be leading bull trout and ANS efforts.

4. **Preliminary Report of DIDSON Lamprey Study Results** – Beau Patterson gave a Power Point presentation summarizing preliminary results of the 2010 DIDSON Wells Lamprey Passage Study. Patterson said the passage study is one of two related 2010 studies for which preliminary results are available; the other is a study of empirical fishway entrance velocities. The latter study was conducted at the request of the HCP-Coordinating Committees (CC). He said the draft reports will be available for review prior to the next Aquatic SWG meeting. The passage study was the second year of fishway monitoring using a DIDSON camera. Patterson reviewed the study methods and provided diagrams showing the location of the DIDSON camera in the fishway and the camera field of view. Video was shown of the two lamprey passage attempts documented during the study period. Both attempts were at the 1.0-foot head differential. Patterson described how the lamprey entered the fishway, attaching to the sill, and then using burst speed to move into the collection gallery.

   Patterson summarized the history of lamprey passage evaluations at Wells Dam, including results that led to the 2010 DIDSON study. Previous studies were conducted in 2004, 2007, 2008, and 2009. The first 3 years of study used radio telemetry; 2009 and 2010 used DIDSON camera technology. In general, results suggest that passage entrance efficiency is highest at the 1.0-foot differential, and that operations can be modified to enhance lamprey fishway entrance efficiency. Patterson emphasized that the Douglas PUD study results are based on very small sample sizes and that Douglas

PUD is not prepared to recommend operational changes at this point without further study.

Patterson said the next step is to finalize the 2010 draft lamprey passage study report, including the associated salmonid passage effects, for review by the Aquatic SWG and the HCP-CC. He reiterated that lamprey passage efficiency within the DIDSON field of view at the 1.0-foot differential looked promising; however, Douglas PUD, in concert with the HCP-CC, still needed to document whether the 1.0-foot head differential affected salmonid passage. Patterson said the DIDSON studies focused on lamprey behavior in the water column 3 feet above the entrance sill area. This focus was based on the assumption that lamprey would pass within 3 feet of the sill. He said it is possible that lamprey may enter higher in the water column and are not seen, but that fish entering higher would have limited opportunity to attach and would be blown out of the entrance by high water velocity. Shane Bickford said the results of the radio telemetry studies at Wells indicated that once lamprey made it past the sill, about 90 percent remained in the fishway and proceeded up the ladder. Steve Rainey asked if other measures may be appropriate to improve passage through the collection gallery, like changing the gratings. Patterson said additional measures to address the collection gallery environment are included in the SA Lamprey Management Plan and will be addressed during license implementation. Bickford said there are at least five structural changes to the fishway that will need to be implemented in the first year of the new license. He said that Douglas PUD is moving forward with wiring the fishway for Half-Duplex (HD)-Passive Integrated Transponder (PIT) tag detection for future studies to allow for a better understanding of fish behavior within the fishways.

Patterson said another step identified for continuing the evaluation and improvement of lamprey fishway passage efficiency at Wells Dam is to investigate high resolution (HR), underwater (UW), infra-red (IR) video monitoring technologies and to continue to explore with the HCP-CC the issues of potential salmonid effects related to operation changes that may benefit lamprey passage.

5. **Preliminary Report of Fishway Entrance Velocity Test Results** – Beau Patterson explained that, as a condition for approving the 1.0-foot head differential for 2010 DIDSON Lamprey Study, the HCP-CC requested that Douglas PUD directly measure water velocity at the fishway entrance orifices. The test was conducted March 1 and 2, 2011, and measured velocities at low and high tailwater conditions at 1.0- and 1.5-foot head differentials using Acoustic Doppler Velocimeters (ADVs) to collect measurements in 3-D within the fishways. Patterson said the limit of performance for free-swimming lamprey based on lab studies is 0.9 meters per second (3 feet per second) but that burst and attach movements suggest indicate an upper limit of 2.1 meters per second (6.9 feet per second). He said low tailwater conditions at the 1.5-foot differential created entrance conditions that proved most difficult for lamprey. Measured velocities in the entrance exceeded the burst swimming performance threshold for lamprey, with the exception of

the area at the top of the water column. The highest velocities at both head differentials were measured along the sides of the fishway. At the 1.0-foot differential, test results showed that the entire orifice area was passable for lamprey at both high and low tailwater elevations based on swimming performance thresholds. Shane Bickford said that, prior to making a permanent change in the head differential at the entrance to the fishway, NMFS has said they would require a study to evaluate the potential effect on salmonid passage, particularly steelhead. Bickford said Wells Dam was designed to operate at a 1.0-foot differential and that the 1.5-foot differential operation is implemented in response to NMFS requirements. Bickford explained the background leading to the target 1.5-foot operating differential at Wells and at the other mid-Columbia PUD dams.

Bickford said Douglas PUD will continue to evaluate the 1.0-foot differential as the preferred operating condition at the Wells fishway entrance. An HD PIT tag array will be installed during the 2011/2012 maintenance period. He said Douglas PUD is proposing at this time to install the HD PIT tag array for use in a 2012 study to further evaluate the 1.0- and 1.5-foot head differential for lamprey. Bickford said that, if the results of the 2012 study indicated that a 1.0-foot differential is beneficial to lamprey passage, Douglas PUD will request approval from the HCP-CC to change the fishway entrance head differential. If the HCP-CC requires a salmonid passage study, Douglas PUD will conduct such a study.

Steve Lewis asked if it would be possible to request a change to a 1.0-foot differential in 2011 from the HCP-CC if a relatively large lamprey run showed up in 2011. Schiewe said the HCP-CC would be open to such a request. Lewis said he wanted to make sure the option of going to a 1.0-foot differential is not taken off the table for 2011. Patterson said the analysis of salmonid effects related to a change in head differential at the fishway entrance is in progress with the draft report due within the next month. He said he would discuss the results at the May meetings of the HCP-CC and the Aquatic SWG.

6. **Further Discussion of Study Options and Measures for Lamprey 2011/2012** – Beau Patterson continued the above discussion by reiterating that all of the 2010 study results will be presented to the HCP-CC at their May meeting. At that time Douglas PUD could request approval to implement a 1.0-foot head differential during the lamprey passage migration period. He also said that in 2011 Douglas PUD will evaluate the use of a HR UW IR video camera to monitor fish behavior at the fishway entrance. The HD PIT tag detection arrays would not be installed until the winter maintenance period in 2011/2012. Molly Hallock said she is supportive of lowering the head differential to 1.0 foot as soon as possible, as did all members of the Aquatic SWG. Steve Lewis said the USFWS would like to explore reducing the head differentials and hoped the HCP-CC would be supportive. Douglas PUD agreed to request implementation of a 1.0-foot head differential at the fishway entrance in 2011 regardless of lamprey run size.

## V. Next Meetings

*1.* Upcoming meetings: ***May 11 (conference call), June 8 (in-person), and July 13 (conference call).***

## List of Attachments

Attachment A – List of Attendees

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | SWG Chair | Anchor QEA, LLC |
| Carmen Andonaegui | Administrative | Anchor QEA, LLC |
| Beau Patterson | SWG Technical Rep. | Douglas PUD |
| Andrew Gingerich | SWG Technical Rep./Alternate | Douglas PUD |
| Shane Bickford | SWG Policy Rep. | Douglas PUD |
| Molly Hallock* | Technical Resource | Washington Department of Fish and Wildlife |
| Chad Jackson* | Technical Resource | Washington Department of Fish and Wildlife |
| Bill Towey* | Technical Resource | Colville Confederated Tribes |
| Pat Irle | SWG Technical Rep. | Washington Department of Ecology |
| Steve Rainey* | Technical Resource | U.S. Fish and Wildlife Service contractor |
| Jessie Gonzales* | SWG Policy Rep. | U.S. Fish and Wildlife Service |
| Steve Lewis* | SWG Technical Rep. | U.S. Fish and Wildlife Service |
| Bob Rose* | SWG Technical Rep./Alternate | Yakama Nation |

*participated by phone

**From:** Carmen Andonaegui
**To:** Virginia See
**Subject:** FW: Aquatic SWG: 5/11 mtg cancelled
**Date:** Tuesday, January 31, 2012 8:45:02 AM

---

**From:** Carmen Andonaegui
**Sent:** Friday, May 06, 2011 5:34 PM
**To:** Andrew Gingerich (andrewg@dcpud.org); Beau Patterson (bpatterson@dcpud.org); Bill Towey (bill.towey@colvilletribes.com); ble@longviewassociates.com; Bob Jateff (jatefrjj@dfw.wa.gov); Bob Rose (brose@yakama.com); 'Brad James'; 'Bret Nine'; 'Chad Jackson'; 'Donella Miller'; Jeff Korth (korthjwk@dfw.wa.gov); 'Jessi Gonzales'; Joe Peone (joe.peone@colvilletribes.com); 'Jon Merz'; 'Karen Kelleher'; kirk.truscott@colvilletribes.com; 'Mary Mayo'; Mike Schiewe (mschiewe@anchorqea.com); Molly Hallock (hallomh@dfw.wa.gov); Pat Irle (pirl461@ecy.wa.gov); 'Patrick Luke'; Patrick Verhey (Patrick.Verhey@dfw.wa.gov); Paul Ward (ward@yakama.com); Shane Bickford (sbickford@dcpud.org); 'Steve Lewis'; 'Steve Parker (parker@yakama.com)'
**Cc:** Bob Dach (Robert.dach@bia.gov); Keith Hatch (Keith.Hatch@bia.gov)
**Subject:** Aquatic SWG: 5/11 mtg cancelled

Hi Aquatic SWG: the May 11 Aquatic SWG meeting has been cancelled due to a lack of agenda items. The next meeting is scheduled as an in-person meeting on June 8.

Thanks!
Carmen

**Carmen Andonaegui**
**ANCHOR QEA, LLC**

candonaegui@anchorqea.com
23 S. Wenatchee Avenue, Suite 120
Wenatchee, WA 98801
T 509.888.0240
C 509.881-0198
F 509.888.2211

www.anchorqea.com

| | |
|---|---|
| **From:** | Carmen Andonaegui |
| **To:** | Virginia See |
| **Subject:** | FW: Aquatic SWG: cancellation of the June meeting |
| **Date:** | Tuesday, January 31, 2012 8:44:15 AM |

**From:** Carmen Andonaegui
**Sent:** Friday, June 03, 2011 12:01 PM
**To:** Andrew Gingerich (andrewg@dcpud.org); Beau Patterson (bpatterson@dcpud.org); Bill Towey (bill.towey@colvilletribes.com); ble@longviewassociates.com; Bob Jateff (jatefrjj@dfw.wa.gov); Bob Rose (brose@yakama.com); 'Brad James'; 'Bret Nine'; 'Chad Jackson'; 'Donella Miller'; Jeff Korth (korthjwk@dfw.wa.gov); 'Jessi Gonzales'; Joe Peone (joe.peone@colvilletribes.com); 'Jon Merz'; 'Karen Kelleher'; kirk.truscott@colvilletribes.com; 'Mary Mayo'; Mike Schiewe (mschiewe@anchorqea.com); Molly Hallock (hallomh@dfw.wa.gov); Pat Irle (pirl461@ecy.wa.gov); 'Patrick Luke'; Patrick Verhey (Patrick.Verhey@dfw.wa.gov); Paul Ward (ward@yakama.com); Shane Bickford (sbickford@dcpud.org); 'Steve Lewis'; 'Steve Parker (parker@yakama.com)'; 'Steve Rainey'
**Cc:** Bob Dach (Robert.dach@bia.gov); Keith Hatch (Keith.Hatch@bia.gov)
**Subject:** Aquatic SWG: cancellation of the June meeting

Hi Aquatic SWG: next week's June 8 meeting has been cancelled due to a lack of agenda items. The next meeting is scheduled for July 13.

Enjoy the day!
Carmen

**Carmen Andonaegui**
**ANCHOR QEA, LLC**

candonaegui@anchorqea.com
23 S. Wenatchee Avenue, Suite 120
Wenatchee, WA 98801
T 509.888.0240
C 509.881-0198
F 509.888.2211

www.anchorqea.com

# Final Meeting Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: August 10, 2011

**From**: Michael Schiewe (Anchor QEA)

**re**: Final Minutes of July 13, 2011 Aquatic SWG Meeting

## I. Summary of Decisions

1. There were no decision items for this meeting.

## II. Summary of Action Items

1. Carmen Andonaegui will review the upcoming Aquatic Settlement Work Group (Aquatic SWG) meeting schedule to determine when the next in-person meeting will occur after the August 10, 2011, in-person meeting, and request Jenifer Parsons' (Washington State Department of Ecology [Ecology]) presentation to the Aquatic SWG on Aquatic Nuisance Species (ANS) Best Management Practices (Item III-1).

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review** – Mike Schiewe welcomed the Aquatic SWG members and opened the meeting. Schiewe reviewed the agenda and asked for any additions. No additions were made to the agenda. Schiewe asked for comments or changes to the April 13, 2011, meeting minutes. There were no comments or edits and the meeting minutes were approved. Carmen Andonaegui will finalize the meeting minutes and distribute them to the Aquatic SWG.

   Pat Irle commented that she had spoken with Jenifer Parsons at Ecology regarding having Parsons give a presentation to the Aquatic SWG on ANS Best Management Practices. This was an Action Item for Irle from the last Aquatic SWG meeting on April 13, 2011. Irle said Parsons could conduct a short workshop for the Aquatic SWG this fall. Schiewe said he and Carmen Andonaegui will review the upcoming Aquatic SWG meeting schedule to determine when the next in-person meeting will occur in the fall. They will contact Irle to request Parsons' attendance to give her presentation at the next fall in-person meeting.

2. **Modified FERC Terms and Conditions** – Beau Patterson said that the Colville Confederated Tribes (CCT) had submitted Terms and Conditions (T&C) to the Federal Energy Regulatory Commission (FERC) on Douglas PUD's new license application for the

Wells Project that were in conflict with the Habitat Conservation Plan (HCP) and the Wells Aquatic Settlement Agreement (SA), to which they are signatories. He said the CCT has since provided clarification to FERC on their original comments. Mike Schiewe asked whether, following the CCT's clarification, there were still any conflicts with either the HCP or SA. Patterson said that the CCT's clarifying comments to FERC resolved the issues relative to the SA, and that the CCT would seek resolution on any concerns with the HCP through the HCP committees.

Steve Lewis said the U.S. Fish and Wildlife Service (USFWS) will submit T&C by August 1, 2011, but that their T&C do not substantially change the fishway prescriptions associated with the SA. Lewis said the FERC's National Environmental Policy Act (NEPA) analysis selected some but not all of the SA fishway prescriptions, but they then concluded that they would include all the USFWS fishway prescriptions in the new license as required by USFWS's mandatory authority under relicensing.

3. **2011 Fish Ladder Operations – Fishway Entrance Head Differentials for Lamprey** – Beau Patterson summarized background information leading up to his request to the HCP Coordinating Committee (CC) to change nighttime fishway operations at Wells Dam to potentially enhance lamprey passage. He said he presented the Dual-Frequency Identification Sonar (DIDSON) camera study results, and Tom Kahler (Douglas PUD CC representative) presented the results of the Wells fishway entrance velocities study to the CC at their May 24, 2011, meeting. Patterson said he informed the CC that Douglas PUD would be seeking approval of a Statement of Agreement (SOA) at the HCP CC meeting on June 28, 2011, to allow Douglas PUD to implement a change in nighttime fishway operations for lamprey passage.

   Mike Schiewe reported that all HCP signatory parties were present at the June 28, 2011, CC meeting when the SOA was presented to the CC requesting a change in fishway operations during the period of August 7 through September 30 from 5:00 pm to 1:00 am. He said several CC members requested that additional information be added to the draft SOA. For example, as written, the SOA did not clearly state that the request was for only one year (2011). Also, Bryan Nordlund (National Oceanic and Atmospheric Administration [NOAA]) asked that additional information be included on how Douglas PUD planned to study the effects of the change in operations on steelhead passage. Schiewe said that the original intent was to approve the revised SOA by email by July 8, 2011, but due to the request by Nordlund for additional clarification in the revised SOA, it will be on the agenda for the next CC meeting on July 26, 2011. Kahler has agreed to follow-up with Nordlund to make sure the revised SOA captured Nordlund's concerns for the July 26, 2011, vote.

   In response to a question by Steve Rainey (consultant to USFWS), Patterson stated that Douglas PUD is not interested in questioning the HCP salmonid passage criteria, but rather in implementing fishway operations that benefit lamprey passage consistent with meeting HCP goals. Schiewe reiterated that it is likely that the Douglas PUD request to the CC to change fishway operations for lamprey will be approved for a 1-year period.

Rainey said that USFWS would like to know if NOAA would support changes to the fishway entrance head differential during daytime operations. Patterson reiterated that the request for a change in operation that is currently before the CC is only for nighttime operations from August 7 to September 30, from 5:00 pm to 1:00 am. Patterson said that with the wiring of the fishway with half-duplex passive integrated transponder tag (PIT–tag) detectors, they will be able to gather more data on lamprey returns beginning in 2012 and beyond. When there is a good lamprey-return year, Douglas PUD is proposing to conduct a study of lamprey passage using trans-located adult lamprey. For 2011, Douglas PUD would like to implement the change in nighttime operations even though they do not anticipate getting much data.

Steve Lewis asked whether the CC SOA had considered the possibility of changing daytime operations as well as nighttime operations. Shane Bickford said the CC would not likely be supportive of a change in daytime operations due to the potential effect on dam passage for all salmonid species. With a change in nighttime operations, only one Endangered Species Act (ESA)-listed species, steelhead, is likely to be affected. Patterson said that during the 8-hour window for which the change of operations is being requested, about 11 percent of the steelhead migration passes Wells Dam during those operational hours. Of the other salmonid species in the upper Columbia River, only unlisted Chinook are passing the dam during the period for which the change is being requested.

Schiewe said the CC needs to be allowed to work through the SOA process. Assuming the SOA is approved by the CC on July 26, 2011, which he believes is likely, Schiewe recommended that the Aquatic SWG let the new fishway operations be put into effect for 2011, and if they want to extend the operations, to revisit the issue at that time. Schiewe cautioned that making recommendations to the CC at this stage to implement both daytime and nighttime changes in fishway operations may delay CC approval of nighttime operation changes for this year. Schiewe agreed to inform the CC that the Aquatic SWG expressed interest in a possible change in fishway operations during the day as well as during the evening hours identified in the SOA.

4. **Final Draft Wells Lamprey Fishway Entrance Efficiency Study** – Mike Schiewe noted that review comments on the draft Wells Lamprey Fishway Entrance Efficiency Study are due to Douglas PUD no later than August 10, 2011. Beau Patterson encouraged the Aquatic SWG to provide comments.

5. **Update on the Release of Ecology's 401 Water Quality Certification for the Wells Project** – Shane Bickford said that FERC's draft Environmental Impact Statement (DEIS) did not include about 25 percent of the Aquatic SA measures. This omission has resulted in some confusion over which species require consultation under the ESA, and

specifically what studies and measures would need to be carried out under the new license. Bickford said that Douglas PUD wants to ensure that FERC includes all SA measures in the new license. He said that the best way to ensure that outcome is to have the 401 certification issued prior to FERC issuing its final EIS and Record of Decision (ROD), with the 401 certification incorporating all of the SA measure. Pat Irle said Ecology's plan is to have a draft 401 completed by early August 2011 and to present the draft to the Aquatic SWG for review around that time.

## V. Next Meetings

1. Upcoming meetings: ***August 10 (in-person), September 14 (conference call), and October 12 (conference call).***

   Mike Schiewe said waiting to have an in-person meeting in August was intended to allow for completion of the 2011 sturgeon field work conducted by Chelan and Grant PUDs. He said it would be timely to have conversations with Bob Rose about getting his sturgeon issues for Douglas PUD back on the Aquatic SWG agenda for August. Beau Patterson said Douglas PUD would follow up with Rose.

## List of Attachments

Attachment A – List of Attendees

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | SWG Chair | Anchor QEA, LLC |
| Carmen Andonaegui | Administrative | Anchor QEA, LLC |
| Beau Patterson | SWG Technical Rep. | Douglas PUD |
| Shane Bickford | SWG Policy Rep. | Douglas PUD |
| Patrick Verhey | SWG Policy Rep. | Washington Department of Fish and Wildlife |
| Chad Jackson | Technical Resource | Washington Department of Fish and Wildlife |
| Pat Irle | SWG Technical Rep. | Washington Department of Ecology |
| Steve Rainey | Technical Resource | U.S. Fish and Wildlife Service contractor |
| Steve Lewis | SWG Technical Rep. | U.S. Fish and Wildlife Service |

# Final Meeting Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: September 21, 2011

**From**: Michael Schiewe (Anchor QEA)

**re**: Final Minutes of August 10, 2011 Aquatic SWG Meeting

## I. Summary of Decisions

1. There were no decision items for this meeting.

## II. Summary of Action Items

1. Carmen Andonaegui will contact Jenifer Parsons, Washington State Department of Ecology (Ecology), and request a presentation to the Aquatic SWG on aquatic nuisance species Best Management Practices at the November 9, 2011, meeting.

2. Bob Rose will email his edits on the Draft White Sturgeon Broodstock Collection and Breeding Plan (Plan) to Carmen Andonaegui tomorrow (August 11, 2011) for distribution to the Aquatic SWG.

3. Aquatic SWG members' comments on the Plan are due by August 19, 2011, to Douglas PUD. A copy of these comments will be sent to Carmen Andonaegui.

4. Carmen Andonaegui will compile all comments received from the Aquatic SWG on the Plan and distribute a revised Plan with compiled comments to the Aquatic SWG by August 25, 2011.

5. A subgroup of the Aquatic SWG will meet on August 29, 2011, at Douglas PUD offices to discuss comments on and revisions to the Plan. A revised Plan based on the August 29, 2011, discussions will be prepared by Douglas PUD and distributed to the Aquatic SWG no later than September 6, 2011, for approval at the September 14, 2011, Aquatic SWG meeting.

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review** – Mike Schiewe welcomed the Aquatic SWG members and opened the meeting. Schiewe reviewed the agenda and asked for any additions. No additions were made to the agenda. Schiewe asked for comments or changes to the draft July 13, 2011, meeting minutes. There were no

comments or edits and the meeting minutes were approved. Carmen Andonaegui will finalize the meeting minutes and distribute them to the Aquatic SWG.

2. **Yakama Nation Update on 2011 Sturgeon Broodstock Collection and Breeding Efforts** – Donella Miller reported that the Yakama Nation fished for three weeks in the Bonneville Pool immediately downstream of The Dalles Dam, capturing 250 white sturgeon. She said that of the 250 sturgeon captured, 2 ripe females and 9 mature males were transferred to the hatchery. Chelan PUD fished the same reservoir using fishing guides who caught 26 fish over 3 days of fishing, none of which were mature. Golder Associates fished for Grant PUD in the Wanapum Reservoir and captured one mature male sturgeon. A Wenatchee fishing guide hired by Grant PUD to fish the Wanapum Reservoir caught one ripe female that was ready to spawn as soon as it was brought into the hatchery. The ripe female was spawned with the one mature male captured by Golder Associates for a 1x1 cross. Miller reported that the Yakama Nation was not able to synchronize any of the females from The Dalles with the mature males. She also said that they were not able to get chillers installed for the 2011 captive breeding activities, but hoped to have temperature control for next year. Miller said that in 2012, they are planning to have multiple 20-foot tanks available for holding females and two tanks for males, all with temperature control. Both Miller and Bob Rose said that there is still a lot to learn regarding how, where, and when to catch females and males so that they can maximize producing offspring.

   Bao Le asked how many juveniles they expect to have for Grant PUD from the 1x1 cross. Rose said that they hope to release about 2,000 juveniles from the 1x1 cross into Grant PUDs' two reservoirs, about 2,000 into the Rocky Reach Reservoir, and a couple hundred for release in Wells Reservoir. He said there have been no discussions about releasing sturgeon juveniles into the Rock Island Reservoir and that he had not yet had discussions with Douglas PUD about releasing any juveniles in the Wells Reservoir. Rose acknowledged the concern about distributing high numbers of the progeny from a single mating too broadly throughout multiple mid-Columbia reservoirs. He said that there will be a meeting of the Mid-Columbia Technical Sturgeon Workgroup at Chelan PUD on August 31, 2011, to discuss technical issues regarding sturgeon broodstock collection and breeding, including what was learned in 2011 and how to implement broodstock collection and breeding in 2012.

   Patterson asked if Grant PUD would be able to meet their license obligation with the progeny from the 1x1 cross. Rose said that the Priest Rapids Project license Clean Water Act (CWA) 401 Certificate states that "up to" 6,500 yearling sturgeon will be placed in Project reservoirs, and that as long as Grant PUD is doing the best they can to meet this obligation, the Yakama Nation considers them to be meeting the requirements of their 401 Certification.

Miller reported that fishing for sturgeon broodstock was conducted from May 30 through June 17, 2011, and that the water temperature during this period was about 56 degrees Fahrenheit. She confirmed that water temperatures in the Wanapum Reservoir were comparable to water temperatures in the fishing area in the Bonneville Pool. Rose suggested that fishing efforts will need to be enhanced in 2012, but the specific changes have yet to be determined. Le suggested that because almost 300 sturgeon were captured, and only 11 were mature, then capture itself was not the problem; rather, the problems were the timing of the broodstock collection and the inability to synchronize the male and female breeding cycles once in the hatchery. Rose indicated that enhancement of fishing refers to not only fishing effort but also to where fishing occurs. He said that there were also logistical issues that need to be addressed; for example, it was not until they started fishing near The Dalles Dam that they found out that the U.S. Army Corps of Engineers (Corps) requires a second boat to be on site in stand-by mode, fully staffed for safety reasons but not allowed to fish, resulting in a loss of efficiency that was not anticipated. Rose said that issues like high water also limited access to some good fishing areas, and that the Yakama Nation would like to broaden the fishing period to capture the shoulder spawning periods to increase diversity of the broodstock.

3. **Finalization of Wells Broodstock Collection and Breeding Plan and the Sturgeon Supplementation Request for Proposals** – Beau Patterson said that Douglas PUD requested that the Plan and the Sturgeon Supplementation Request for Proposals (RFP) be brought before the Aquatic SWG as a decision item today. He said that Douglas PUD's plan to implement sturgeon collection and rearing activities in 2012, rather than in 2013 as indicated in the Wells Project license application to the Federal Energy Regulatory Commission (FERC), requires approval of a final Plan to include in the RFP. Patterson said the RFP needs to be issued no later than October 2011 for a 2012 start date.

   Bob Rose said that based on what was encountered and learned from this year's broodstock collection and breeding activities, there is a need for a major revision to the draft Plan, especially in Section 3.0. For example, he said that prioritization of possible broodstock collection locations is important, starting with the Wells Reservoir, but that the options of collecting broodstock in the John Day or the Bonneville reservoirs are missing in the draft Plan. Rose said that there have been conversations over the last year among fisheries management agencies about broadening the area from which sturgeon broodstock could be collected, with the recognition that sturgeon from Bonneville Dam to Chief Joseph Dam represent a single population. He said that the issue of what is appropriate broodstock for the mid-Columbia is still being explored, and that this discussion needs to be captured in the Plan. Rose said that in Section 5.0, he would take out any reference to future contracting and structure the section into two components: 1) a 5-year broodstock collection strategy to implement in the Dalles, John Day, and Wanapum reservoirs that would not change much over that period of time; and 2) actions that would likely be implemented, without being too prescriptive.

Patterson said that in March 2011, the Aquatic SWG recommended that the Plan not include prioritization of broodstock options. This is reflected in the current version of the Plan in Track Changes mode in Microsoft Word. Patterson said that Douglas PUD believes their role is to fund implementation of the Plan in the most appropriate and cost-effective manner, with the fisheries managers deciding which broodstock source(s) to use. He said that when the Yakama Nation, the Colville Confederated Tribes (CCT), and the Washington Department of Fish and Wildlife (WDFW) all agree on a broodstock source, Douglas PUD will implement the recommendation upon agreement of all other Aquatic SWG parties.

Jason McLellan said that from a technical perspective, collection of adult broodstock may not be the most efficient way to obtain juveniles for supplementation. He said that alternative approaches have been successfully used in the Lake Roosevelt sturgeon program. McLellan said that collecting adult broodstock requires a lot of effort to collect a limited number of sturgeon, and described that the Lake Roosevelt Sturgeon Recovery Project staff collected more than 10,000 sturgeon larvae in Lake Roosevelt in 8 days and transported them to a hatchery for rearing. He recommended that collection of larvae for the sturgeon supplementation program should be discussed in the Aquatic SWG. Patterson said that the Aquatic SWG was not aware of the larval collection alternative when the original Plan was developed, and agreed that it should be given more consideration, along with other lessons learned from this year's broodstock collection and breeding activities.

The Aquatic SWG discussed both broodstock collection and breeding, and larval collection. Factors to consider include supplementation sources, level of effort, how to prioritize one collection effort over another, and funding level. McLellan said that if larval collection were used, broodstock collection may not be needed. He said that the Washington component of the Lake Roosevelt sturgeon program has abandoned the collection of adult broodstock and now uses only wild caught larvae to produce juveniles for release; however, the Canada component of the Program still collects adult broodstock. McLellan described the use of modified D-rings for sturgeon larvae collection, saying WDFW has been using D-rings to collect sturgeon larvae in Lake Roosevelt since 2005. In 2010, they began experimental rearing of the wild larvae. McLellan reported that survival from larval collection to release was about 20 percent in that pilot year, despite challenging hatchery logistical conditions. He said that a 50 percent survival rate is probably a reasonable expectation. Rose said that a technical discussion on how to fit larval collection into Douglas PUD's Plan is needed, but that broodstock collection is still needed over the next couple of years. He said that larval collection is something to consider transitioning into with Douglas PUD's sturgeon program, but that he would not advocate for this to Grant PUD or Chelan PUD.

Patterson said that assuming approval of the Plan cannot be achieved today, Douglas PUD needs to work over the next few weeks to get a Plan that can be approved at the next Aquatic SWG meeting in September 2011. He said that specific details on how broodstock would be captured and prioritization of broodstock sources are not required for the RFP as long as there is an agreed-to list of potential broodstock sources to include all areas from Bonneville Dam to Chief Joseph Dam. Brett Nine said the CCT have unresolved concerns about the genetic implications of selecting broodstock sources.

Rose agreed to email Carmen Andonaegui a copy of the Plan with his edits shown in Track Changes on August 11, 2011, for distribution to the Aquatic SWG. The Aquatic SWG will have one week to review the Plan, with comments due August 19, 2011. Comments will be provided in Track Changes to Carmen Andonaegui, who will compile the comments and email the revised Plan with comments shown, to the Aquatic SWG within one week (by August 25, 2011). On August 29, 2011, a subgroup of interested Aquatic SWG representatives will meet at the Douglas PUD offices to discuss the comments and revisions to the Plan. Based on discussions at the August 29, 2011, meeting, Douglas PUD will prepare a revised final Plan for distribution to the Aquatic SWG no later than September 6, 2011, for approval at the September 14, 2011, Aquatic SWG meeting.

Mike Schiewe asked if Douglas PUD was going to expand the scope of the RFP to include proposals for collecting both broodstock and larvae. Patterson said that he sees advantages to some flexibility regarding collection methods, but that Douglas PUD will consider costs as one factor in selecting a proposal. Rose said that the Yakama Nation would strongly recommend broodstock collection continue as the primary tool for obtaining juveniles for supplementation until it could be demonstrated that there was a reliable alternative. Patterson said that Douglas PUD is planning to meet their obligation in the most efficient and cost-effective way possible, from the agreed-upon collection areas.

Patterson said that the Aquatic SWG would be asked to participate in the review of the proposals, and that acceptance and early implementation of a proposed supplementation plan in 2012 would require consensus of the Aquatic SWG. Bao Le asked how Aquatic SWG members who submitted a proposal would avoid the appearance of a conflict of interest. Schiewe suggested that an Aquatic SWG member whose organization submits a proposal might participate in the review discussions, but would recuse themselves from voting. Patterson said that because of the consensus-based decision-making framework of the SWG, he does not feel this is a big problem; if consensus is not reached, Douglas PUD will not implement measures prior to FERC license requirements.

4. **Status Discussion regarding Request to Habitat Conservation Plans Coordinating Committees for Reduced Fishway Entrance Head Differential Night-time Lamprey Operations** – Beau Patterson reported that Douglas PUD presented their request to

implement a change in nighttime operating conditions at the Wells adult fishway for lamprey passage benefits to the Habitat Conservation Plans (HCP) Coordinating Committees (CC). He said that the HCP CC discussed and approved implementing the change in operations for 2011 only. The approved operations will be implemented 3 days following the date when the cumulative count of lamprey passing Rocky Reach Dam reaches five individuals. Patterson said that as of today, August 10, 2011, that trigger has not been met. He said that the lamprey run this year is late; however, the Corps is predicting the run this year to be about 50,000 rather than the approximately 20,000 lamprey counted in 2010. Steve Rainey asked what new data will be collected this year to evaluate the benefits of the nighttime operations to lamprey passage. He suggested that additional data may be needed to support a decision on whether to continue the nighttime operations in 2012. Patterson said that the evaluations in 2011 were oriented towards impact to salmonids, not benefits to lamprey. He said that the HCP CC's concern regarding approval of the request for a change in nighttime operations to benefit lamprey was with Douglas PUD's conclusion that there would be no effects on salmonids. Patterson said that the National Marine Fisheries Service (NMFS) CC representative had questioned the statistical analysis used to support the conclusion; therefore, Douglas PUD agreed to have a third party expert (Dr. John Skalski, Columbia Basin Research) conduct an independent analysis of the effects of the change in operations on steelhead passage at the Wells Dam fishway. Skalski will conduct the analysis using the statistical methods requested by NMFS staff, as well as other statistically accepted methods. The analyses will be used to inform the decision about whether to continue operations in 2012 or for a potentially longer term with continuing evaluation. Patterson said that the Half Duplex (HD) passive integrated transponder tag (PIT-tag) detection array will be installed this winter (2011/2012), allowing for use of PIT-tag detections at Wells Dam in 2012. He said that if enough lamprey adults are available in the future, Douglas PUD is willing to trap, tag, and translocate fish for use in evaluating adult lamprey passage at Wells Dam.

Patterson said that whether or not lamprey nighttime operations at Wells Dam fishway will continue in 2012 will necessarily be determined, not by lamprey passage data, but rather by the ability to demonstrate minimal or no effects on adult salmonid passage. He said that NMFS does not support continuing the changed nighttime operations for lamprey without an analysis of the effects on steelhead, and he stated that Skalski's analysis on steelhead passage will be completed this winter.

5. **Update on Current Lamprey Activities at Wells Dam** – Beau Patterson said that Douglas PUD is monitoring adult lamprey passage at Rocky Reach Dam, and that they are prepared to implement the 2011 nighttime operations at Wells Dam as per the agreement. He said that Douglas PUD is preparing for installation of the HD PIT-tag array during the scheduled winter 2011/2012 fishway maintenance window.

## V. Next Meetings

1. Upcoming meetings: ***September 14, 2011 (conference call), October 12, 2011 (conference call), and November 9, 2011 (in person).***

## List of Attachments

Attachment A – List of Attendees

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | SWG Chair | Anchor QEA, LLC |
| Carmen Andonaegui | Administrative | Anchor QEA, LLC |
| Beau Patterson | SWG Technical Rep. | Douglas PUD |
| Andrew Gingrich | Alt. SWG Technical Rep. | Douglas PUD |
| Bao Le | Technical Resource | Douglas PUD contractor |
| Molly Hallock | Technical Resource | Washington Department of Fish and Wildlife |
| Chad Jackson* | Technical Resource | Washington Department of Fish and Wildlife |
| Bob Rose* | SWG Technical Rep. | Yakama Nation |
| Donella Miller* | Technical Resource | Yakama Nation |
| Brett Nine | Technical Resource | Colville Confederated Tribes |
| Jason McLellan | Technical Resource | Colville Confederated Tribes |
| Steve Rainey* | Technical Resource | U.S. Fish and Wildlife Service contractor |

* Joined by phone.

# Final Conference Call Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: October 12, 2011

**From**: Michael Schiewe (Anchor QEA)

**Re**: Final Minutes of September 14, 2011 Aquatic SWG Conference Call

## I. Summary of Decisions

1. The Colville Confederated Tribes (CCT), Washington Department of Fish and Wildlife (WDFW), and Douglas PUD representatives approved the revised Wells Broodstock Collection and Breeding Plan and the Sturgeon Supplementation RFP; representatives not present at today's meeting (Yakama Nation [YN], U.S. Fish and Wildlife [USFWS], Bureau of Land Management [BLM], and Washington State Department of Ecology [Ecology]) will be asked to approve the revised Broodstock Collection and Breeding Plan by email.

## II. Summary of Action Items

1. Beau Patterson will send the revised Wells Broodstock Collection and Breeding Plan to Mike Schiewe today (September 14, 2011), and Schiewe will circulate the document to the Aquatic SWG representatives not present today for their approval by the end of the day on September 21, 2011 (Item III-4).

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review** – Mike Schiewe welcomed the Aquatic SWG members and opened the meeting. Schiewe reviewed the agenda and asked for any additions. Steve Rainey requested that the lamprey discussion be moved up to come first. Beau Patterson requested that a discussion of the swim area weed control be added to the end of the agenda. Schiewe asked for comments or changes to the draft August 10, 2011, meeting minutes. There were no comments or edits and the meeting minutes were approved. Carmen Andonaegui will finalize the meeting minutes and distribute them to the Aquatic SWG.

2. **Update on Current Lamprey Activities at Wells Dam** (Beau Patterson) – Beau Patterson said that the Half-Duplex passive integrated transponder tag (PIT tag) detectors would be installed at Wells Dam in the December 2011 to February 2012 timeframe when the fishways are dewatered for routine maintenance. Steve Rainey asked that USFWS be notified of the exact timing as they would like to see the dewatered ladder. Rainey

asked Patterson if any lamprey had passed Wells Dam since the lamprey operation was implemented. Patterson responded that no lamprey had been counted at Wells Dam since the nighttime 1-foot differential was implemented. Overall, only 1 lamprey has been counted at Wells Dam so far this season (on June 18), and it was almost certainly a lamprey that overwintered in a lower river reservoir. Patterson went on to summarize recent trends in lamprey counts at Wells Dam. He said that conversion from Rocky Reach to Wells for 2001 through 2005 averaged 37 percent (with a range of 18 to 56 percent); however, for the period 2006 through 2010, that average has been only 3 percent (with a range of 0.7 to 5.4 percent). This year looks like it will be similar to last year. Based on average run-timing, more than 80 percent of the lamprey run should have passed through by now, which gives a projected conversion rate for 2011 of 0.4 percent. Patterson believes this marked shift in conversion efficiency is a function of temperature increases and/or altered water chemistry in the Chewuch watershed resulting from the 2006 Tripod Fire. He noted that the Chewuch River watershed probably contains 95 percent of suitable lamprey habitat above Wells Dam. He speculated that with greatly reduced ammocoetes larval densities in recent years, there would be markedly reduced concentrations of pheromones in the water that would attract returning adult lamprey. Patterson further speculated that translocation of lamprey to the Chewuch might be a method to re-establish the ammocoete population in the Chewuch and to re-establish attraction. Rainey asked if it would be premature to attempt translocation without restoration of suitable habitat in the fire-damaged area. Patterson stated that some of the habitat has been restored although it gets worse the closer you get to the headwaters. The trigger for making a translocation attempt should be when summer temperatures in the affected reaches are documented to be reaching a maximum of no more than 22 degrees Celsius, as ammocoete survival declines when temperatures exceed 22 degrees Celsius.

3. **Wells Broodstock Collection and Breeding Plan Comments, Revisions, and Approval** (Beau Patterson) – Beau Patterson opened discussion of the Wells Broodstock Collection and Breeding Plan, stating that Douglas PUD is satisfied with the document, but open to any changes members might suggest. The documents were prepared with the goal of being inclusive rather than exclusive. Mike Schiewe reported that prior to this morning's call, Bob Rose called to say that the YN approved both documents provided there were no major changes. Rose also requested one minor correction: on page 10, in the last sentence prior to Section 4.0, he suggested striking out "as recommended by the Wells Reservoir Sturgeon Managers." This correction was approved.

   The CCT requested that, also on page 10, the specific dates in parentheses in bullet "i" and in the paragraph below the bullets (just before Section 4.0) be removed, and the group approved these edits. The CCT also requested that the sentence in bullet "i" on page 10 be modified so that it reads "Additional collection areas may be considered by the Aquatic SWG." After discussion, all of these edits were approved by the members present, and the CCT, WDFW, and Douglas PUD voted to approve the Plan. Patterson requested that members of the Aquatic SWG not present today be asked by email to also approve the Plan. Mike Schiewe asked Patterson to make the approved changes and forward him a revised Plan with the revisions shown in Microsoft Track Changes. Schiewe agreed to send the revised Plan to the YN, USFWS, Ecology, and BLM representatives, and request their approval of the revised Plan by the end of the day on September 21, 2011.

4. **Approval of the Sturgeon Supplementation RFP** (Beau Patterson) – Beau Patterson asked if there were any final comments or concerns regarding the content of the RFP. Patterson clarified that there are still several steps involved in the Douglas PUD internal approval process to go through before this RFP is finalized and is released for submission of proposals. The Aquatic SWG representatives recommended no changes to the draft RFP and agreed that Douglas PUD should proceed with moving it through their internal process.

5. **Douglas PUD Pikeminnow Removal and Research Program** (Andrew Gingerich) – Andrew Gingerich said Carmen Andonaegui distributed a report that summarizes the Pikeminnow Removal and Research Program results for 2010 (Final 2010 Douglas PUD Pikeminnow Removal and Research Program report distributed by email September 1, 2011). Over the last 10 years, Douglas PUD has taken out approximately 20,000 pikeminnow annually. Although this program is coordinated with the HCP Coordinating Committees, Gingerich said Douglas PUD wanted to put this program on the Aquatic SWG's radar as it fits with their oversight role for resident fish. For 2011, approximately 13,000 pikeminnow have been removed from the project area so far this year, with a projected total removal of approximately 16,000 pikeminnow for the whole year. The Aquatic SWG had no comments or questions regarding this document or the program.

6. **Swim Area Weed Control** (Beau Patterson) – Beau Patterson reported that Douglas PUD had received complaints about weeds, particularly milfoil, in swimming areas. It has been suggested by some that Douglas PUD should work with Chelan PUD to bring in their rotovators to remove the milfoil. However, Douglas PUD is not planning to pursue this removal action. Patterson said Douglas PUD wanted to raise the issue with the Aquatic SWG as it ties directly into the aquatic nuisance management plan. Douglas PUD does not practice mechanical control of milfoil based on information available and research into the effectiveness of that type of control. Patrick Verhey stated that WDFW understands that rotovators chopping up the milfoil actually often hastens the spread of milfoil, and so they agree with Douglas PUD not employing mechanical control. In November, an Ecology representative will attend the Aquatic SWG meeting (Jenifer Parsons) and make a presentation on aquatic nuisance control, which will coincide nicely with this topic.

## V. Next Meetings

1. Upcoming meetings: ***October 12, 2011 (conference call, if necessary), November 9, 2011 (in person), and December 14, 2011 (conference call, if necessary).***

## List of Attachments

Attachment A – List of Attendees

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | SWG Chair | Anchor QEA, LLC |
| Virginia See | Administrative | Anchor QEA, LLC |
| Beau Patterson | SWG Technical Rep. | Douglas PUD |
| Andrew Gingerich | Alt. SWG Technical Rep. | Douglas PUD |
| Shane Bickford | SWG Policy Rep. | Douglas PUD |
| Patrick Verhey | SWG Policy Rep. | Washington Department of Fish and Wildlife |
| Jason McLellan | Technical Resource | Colville Confederated Tribes |
| Steve Rainey | Technical Resource | U.S. Fish and Wildlife Service contractor |

# Final
# Conference Call Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: November 10, 2011

**From**: Michael Schiewe (Anchor QEA)

**Re**: Final Minutes of October 12, 2011, Aquatic SWG Conference Call

## I. Summary of Decisions

1. There were no decision items at today's conference call meeting.

## II. Summary of Action Items

1. Andrew Gingerich will email Carmen Andonaegui the link to the U.S. Fish and Wildlife (USFWS) website to download the *Pacific Lamprey Assessment and Template for Conservation Measures* (October 2011) for distribution to the Aquatic SWG (Item III-2).

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review:** Mike Schiewe welcomed the Aquatic SWG members and opened the conference call. Schiewe reviewed the agenda and asked for any additions. There were no additions to today's agenda. Schiewe asked for comments on or changes to the draft September 14, 2011, conference call minutes. There were no comments or edits and the minutes were approved. Carmen Andonaegui will finalize the September 14, 2011, conference call minutes and distribute them to the Aquatic SWG.

   As a follow-up on the vote to approve the Wells White Sturgeon Broodstock Collection and Breeding Plan during the September 14, 2011, conference call, concurrence was requested and received by September 23, 2011, from those Aquatic SWG members not present on the September 14, 2011 call: USFWS, the Bureau of Land Management (BLM), Yakama Nation, and Washington Department of Ecology (Ecology).

2. **Update on Lamprey Activities at the Wells Project** (Andrew Gingerich): Andrew Gingerich reported that 3 weeks ago, Douglas PUD requested a Statement of Work (SOW) and budget for installation of Half-Duplex (HD) passive integrated transponder tag (PIT–tag) detection arrays at Wells Dam from two consultants. The deadline for submission is October 14, 2011. Gingerich said that Douglas PUD staff at Wells Dam will

be given the opportunity to install the detection arrays at Wells Dam. If they decline due to workload, a contractor will be selected by October 21, 2011. Installation will occur during normal maintenance and dewatering of the Wells Dam adult fishways during December 2011/January 2012.

Gingerich reported that as of October 7, 2011, only one Pacific lamprey had been counted at Wells Dam. Mike Schiewe asked if this was the fish from June 18, 2011 and Gingerich confirmed. He said that if adult lamprey numbers at Wells Dam remain low, the Aquatic SWG may need to consider how to better address the issue of evaluating adult passage for a fish with such low counts. For discussion with the Aquatic SWG, Gingerich said Douglas PUD is considering the option of trans-locating adult lamprey to the Wells tailrace to support an adult lamprey passage study at Wells Dam in the near future.

Gingerich said that the USFWS released a document this month titled *Pacific Lamprey Assessment and Template for Conservation Measures* (October 2011). He said that the document discusses the status of Pacific lamprey in the Columbia Basin and future conservation approaches. Gingerich said that the Aquatic SWG's consideration of a passage study using trans-located adults and HD PIT-tag detection fits within the recommendations in the USFWS document. Gingerich will email Carmen Andonaegui the link to the USFWS website to download a copy of the document for distribution to the Aquatic SWG.

Steve Lewis asked if adult lamprey had been tagged at the lower Columbia River dams that might be detectable at Wells Dam. Gingerich said that his understanding is that 2 percent of the adult Pacific lamprey run is tagged annually with HD PIT-tags by the U.S. Army Corps of Engineers at their lower Columbia River projects. He said that Douglas PUD does not currently have HD PIT-tag detection capabilities at Wells Dam, but that they do have the capacity to detect passage based on visual counts at the adult fish ladder count windows. He said that Chelan PUD is installing a HD PIT detection array at Rocky Reach Dam, which is not yet fully operational, but that using visual counts, 605 adult lamprey have been counted at the adult fish count window at Rocky Reach Dam in 2011. He said that Grant PUD had HD PIT-tag detection capabilities, but that he did not have this information on hand[1]. Lewis asked if Chelan PUD is considering providing lamprey for trans-location this year for a Wells Dam passage study. Gingerich said that Douglas PUD will not be conducting an adult lamprey passage study in 2011 because the HD PIT-tag detection arrays will not be in installed until December 2011/January 2012.

Gingerich said that there have been no operational changes implemented at Wells Dam that might change the ability to detect adult lamprey at the fish count windows, and

[1] As of October 10, 2011, total count of adult Pacific Lamprey at Priest Rapids Dam was 3,699 (http://www.fpc.org/lamprey/adultladder_lamprey_query.html).

therefore it is likely that a proportion of lamprey continue past the Wells count windows undetected as reported in previous Douglas PUD lamprey reports. Lewis asked about past lamprey conversion rates. Mike Schiewe noted that conversion rates were reported at the September 14, 2011, Aquatic SWG meeting and are captured in those meeting notes[2]. Gingerich said that adult Pacific lamprey counts from 2001 through 2005 were on the order of 200 annually; from 2006 to October 2011, the annual count has been 35 fish or less.

## V. Next Meetings

1. Upcoming meetings: November 9, 2011 (in person), December 14, 2011 (conference call, if necessary), and January 11, 2011 (conference call, if necessary).

   Mike Schiewe said that Jenifer Parsons of Ecology will be giving a presentation to the Aquatic SWG at the November 9, 2011, meeting, on aquatic nuisance species control.

## List of Attachments

Attachment A – List of Attendees

[2] Conversion from Rocky Reach to Wells for 2001 through 2005 averaged 37 percent (with a range of 18 to 56 percent); for the period 2006 through 2010, that average was 3 percent (with a range of 0.7 to 5.4 percent).

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | SWG Chair | Anchor QEA, LLC |
| Carmen Andonaegui | Administrative | Anchor QEA, LLC |
| Andrew Gingerich | Alt. SWG Technical Rep. | Douglas PUD |
| Patrick Verhey | SWG Policy Rep. | Washington Department of Fish and Wildlife |
| Molly Hallock | Technical Resource | Washington Department of Fish and Wildlife |
| Steve Lewis | SWG Technical Rep. | U.S. Fish and Wildlife Service |
| R.D. Nelle | Technical Resource | U.S. Fish and Wildlife Service |

# Final Meeting Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties  **Date**: December 12, 2011

**From**: Michael Schiewe (Anchor QEA)

**Re**: Final Minutes of the November 9, 2011, Aquatic SWG Meeting

## I. Summary of Decisions

1. There were no decision items for today's meeting.

## II. Summary of Action Items

1. Beau Patterson will notify Aquatic Settlement Work Group (Aquatic SWG) members when winter maintenance begins at the Wells Project and which fish ladder will be dewatered first (Item III-2).

2. Molly Hallock will email a copy of Unger's Fisheries Society publication on crayfish to Carmen Andonaegui for distribution to the Aquatic SWG (Item III-4).

3. Carmen Andonaegui will contact Aquatic SWG members to reschedule the December 2011 meeting (Item IV).

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review** (Mike Schiewe)**:** Mike Schiewe welcomed the Aquatic SWG members and opened the meeting. Schiewe reviewed the agenda and said that Jenifer Parsons, Washington State Department of Ecology (Ecology), will give a presentation on Aquatic Nuisance Species (ANS) at 11:00 am. He asked for any additions to the agenda. Pat Irle said that Ecology is working on the Clean Water Act (CWA) 401 Certification for the Wells Project and that Ecology had been discussing water temperature-related issues with the Douglas PUD. There were no additions to the agenda.

   Schiewe asked for comments on, or changes to, the draft October 12, 2011, conference call meeting minutes. There were no comments or edits and the minutes were approved. Carmen Andonaegui will finalize the minutes and distribute them to the Aquatic SWG.

2. **Update on Lamprey Activities at Wells Project** (Beau Patterson)**:** Beau Patterson reported that no additional adult lamprey had been counted at Wells Dam since one

adult was counted on June 18, 2011. In contrast, 618 adult lamprey have been counted at Rocky Reach Dam. He said that at Wells Dam, adult lamprey counts are typically higher at the east fish ladder than at the west fish ladder, showing approximately a 70/30 split in passage preference since 1997.

Patterson said that Douglas PUD will be installing Half-Duplex Passive Integrated Transponder (HD PIT) tag detection arrays in both fishways at Wells Dam during the 2011/2012 fishway maintenance period. Patterson said that BioMark is the contractor installing the HD PIT tag detection arrays. He said that the installation has turned out to be challenging because of the hydro-combine and fishway design, but mainly because of the size of the fishway entrances, which have orifices 8 feet wide and 30 feet high. The size of these entrances creates potential for missing detections and the contractor is working to resolve this. In contrast, he said that the installation of the three detectors within the ladders themselves appears to be relatively straightforward. Patterson said that he will continue to provide updates to the Aquatic SWG on the progress of the installation. He said that he may contact interested parties before the next Aquatic SWG meeting in December if there is a need to discuss installation issues. The plan is to have HD PIT tag detection capabilities at each fishway entrance, at each fishway exit, and at the exit from the fishway collection gallery into the ladder itself. The detection point will be located at about pool 8 or 10, given that the first fishway pools are submerged. Patterson said that he would invite the Aquatic SWG to tour the fishways. The first fishway is scheduled to be dewatered on December 5, 2011, with fish salvage occurring December 6, 2011. The dewatered fishway will then be open for inspections after fish salvage is completed. Opportunities for inspection of the second fishway could be as late as mid-February 2012. Patterson suggested that the east adult fish ladder is preferred by lamprey because a large eddy provides for lower velocity approach conditions, unlike at the approach to the west ladder where the entrance is in the main flow of the river. Patterson will notify the Aquatic SWG which adult fish ladder will be taken down first and when that will occur.

Steve Rainey expressed concern about low lamprey counts at Wells Dam compared to Rocky Reach Dam. Patterson reviewed recent adult lamprey conversion rates from Rocky Reach Dam to Wells Dam, emphasizing that since 2006, the conversion rate has been less than 1 percent, but that it was 30 percent from 1997 to 2005. He briefly summarized a hypothesis regarding the relationship between declining lamprey counts and the effects of the Tripod Fire in 2006 on juvenile lampreys and altered habitat in the Chewuch River. Mike Schiewe reminded Rainey that this issue had been discussed in detail at the September SWG meeting and that he should see the meeting summary for additional detail.

Patterson said that Douglas PUD’s efforts to improve lamprey passage at Wells Dam were initially focused on improving detection capabilities at the fishway entrance and operations to improve entrance efficiency. He said that efforts to investigate lamprey passage may require the use of translocated adult lamprey. Patterson said that the installation of an HD PIT tag detection array is part of Douglas PUD's effort to participate in the Columbia Basin-wide lamprey passage effort. Molly Hallock asked if any macropthalmia or ammocetes have been detected emigrating from the Okanogan River Basin. Patterson said he had not checked with the Colville Confederated Tribes (CCT) staff recently, but that juvenile lamprey have been detected migrating out of the Okanogan system in the past, although in very low numbers and only very sporadically; water temperatures in the Okanogan River are not favorable for juvenile lamprey. Detection capabilities are also very limited.

3. **Sturgeon Request for Proposals** (Beau Patterson): Beau Patterson asked for confirmation from Aquatic SWG members that they had received copies of the white sturgeon Request for Proposals (RFP), and asked if there were any additional interested parties that any Aquatic SWG members were aware of who still needed a copy of the RFP. All Aquatic SWG members present confirmed receipt of the RFP, and no additional interested parties were identified. Patterson reported that the RFP has a November 30, 2011, deadline for submissions. He said that the RFP was advertised in the local newspapers on October 20 and 27, 2011. There were no questions or comments from the Aquatic SWG.

4. **Update on Wells Aquatic Nuisance Species Measures** (Andrew Gingerich)**:** Andrew Gingerich presented an update on Douglas PUD's ANS management program, emphasizing Zebra/quagga mussels, macrophytes, crayfish activities, and northern pike. He provided a PowerPoint presentation, which was distributed to the Aquatic SWG by Carmen Andonaegui via email on November 8, 2011 (Attachment B). To date, no adult zebra or quagga mussels have been detected at the Wells Project during ANS sampling. Gingerich said preferred sampling locations were on the docks at the Bridgeport, Brewster, and Pateros public boat launch areas, and on the exit of the east fish ladder in the forebay of Wells Dam. Sampling containers were mounted on the docks, but vandalism forced Douglas PUD to relocate them to areas less accessible to the public while remaining as close to high-use areas as possible. Douglas PUD is working to deal with vandalism of sampling containers at the docks.

   Douglas PUD has agreed to manage and treat macrophytes within the swimming areas of the parks in Pateros, Brewster, and Bridgeport, as requested by city officials and as required by the Douglas PUD Recreation Management Plan. Douglas PUD conducted an aquatic plant survey on September 30, 2011, using sampling methods described in Le and Kreiter (2006)[1]. The results were summarized in a memorandum dated October 5, 2011, and sent to Ecology. The memorandum is available to Aquatic SWG members, if

[1] Le, B. and S. Kreiter. 2006. Aquatic Macrophyte Identification and Distribution Study, Wells Hydroelectric Project, FERC No. 2149. Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, WA.

requested. In the 2011 sampling, Eurasion milfoil was not dominant but was subdominant in 15 percent of samples taken. The treatment being considered by Douglas PUD is an herbicide application since physical removal tends to disperse Eurasian milfoil.

Crayfish were collected incidental to sampling of salmonids in June 2011. A photograph sent to a University of Washington expert on crayfish, Dr. Julian Olden, confirmed it was a non-native species, the northern crayfish (*Orconectes virilis*). Molly Hallock will email a published article on the distribution of non-native crayfish in Washington State by Dr. Olden to Carmen Andonaegui for distribution to the Aquatic SWG. Only native crayfish were observed during relicensing sampling efforts for invertebrates conducted in 2005; however, sampling gear may have biased captures to smaller invertebrates, and adult crayfish are required for definitive species identification. Douglas PUD has renewed its scientific collection permit from the Washington Department of Fish and Wildlife (WDFW) to sample for crayfish in 2011 and 2012. Gingerich said that Douglas PUD will likely develop a survey proposal for implementation in 2012 to document crayfish species composition in the Wells Project.

Northern pike have not yet been found in any fish sampling efforts in the Wells Reservoir to date, although they have been reported in Lake Roosevelt. The concern is with movement of this invasive species downstream into the Wells Project. Gingerich said that Douglas PUD will continue to track the spread of northern pike in the upper Columbia River system as part of its Aquatic Settlement and Habitat Conservation Plan (HCP) activities, with potential regional coordination and participation.

Pat Irle suggested coordination between the Wells Recreation and Aquatic Workgroups to address possible conflicting interests in removing shoreline submerged vegetation for recreational interests and in maintaining submerged vegetation for aquatic ecosystem benefits. Kreiter said that the Recreation Workgroup had committed to control aquatic plants in three locations, but said that these are small, confined areas at the city swimming areas. John Brown said that perhaps applying herbicide control treatments during drawdowns using Ecology's 5-year applicator's permit seemed the most effective approach for controlling nuisance aquatic species at the three city park sites. The Aquatic SWG discussed some of the benefits and potential concerns associated with aquatic nuisance species control alternatives.

5. **Preventing the Spread of Aquatic Nuisance Species and Aquatic Plant Control:** Jenifer Parsons from Ecology reviewed a PowerPoint presentation on measures to minimize the spread of ANS during field work (Attachment C). She provided background information on why it is important to control the spread of ANS and how the spread of ANS occurs.

   Parsons also presented information on invasive species issues in Washington State; these included Zebra/quagga mussels, Didymo (a native algae), the New Zealand mudsnail, and animal diseases (i.e., amphibian fungus and whirling disease). She spoke about enforcement efforts to control the transportation of invasive species, and about protocols Ecology has developed to prevent the spread of invasive species. Parsons provided contact information for reporting invasive species, both to WDFW (animals) and to Ecology (plants).

Parsons provided information on methods used to control invasive aquatic plant species including herbicides, harvesting, bottom barriers, hand-pulling, and water level drawdown. The effectiveness of each method varies depending on conditions, costs vary considerably, and timing is a critical factor to consider when selecting a plant control method. Treatment effectiveness is dependent on the timing of application and fish protection windows must also be observed.

## IV. Next Meetings

1. Upcoming meetings: December 14, 2011 (conference call, if necessary), January 11, 2011 (conference call, if necessary), and February 8, 2012 (in-person). The Aquatic SWG discussed rescheduling the December 14, 2011 meeting to avoid a conflict with the HCP Hatchery Committees meeting. Carmen Andonaegui will email Aquatic SWG members to reschedule the December meeting, which will be a conference call.

## List of Attachments

Attachment A – List of Attendees
Attachment B – Douglas PUD ANS Update presentation
Attachment C – Ecology ANS presentation

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | SWG Chair | Anchor QEA, LLC |
| Carmen Andonaegui | Administrative | Anchor QEA, LLC |
| Andrew Gingerich | Alt. SWG Technical Rep. | Douglas PUD |
| Beau Patterson | SWG Technical Rep. | Douglas PUD |
| Scott Kreiter | Technical Resource | Douglas PUD |
| John Brown | Technical Resource | Douglas PUD |
| Patrick Verhey | SWG Policy Rep. | Washington Department of Fish and Wildlife |
| Molly Hallock* | Technical Resource | Washington Department of Fish and Wildlife |
| Pat Irle | SWG Technical Rep. | Washington State Department of Ecology |
| Jenifer Parsons | Technical Resource | Washington State Department of Ecology |
| Bob Dach* | Observer | U.S. Bureau of Indian Affairs |
| Jason McLellan* | SWG Technical Rep. | Colville Confederated Tribes |
| Steve Rainey* | Technical Resource | U.S. Fish and Wildlife Service contractor |

*Participated by phone

# Douglas ANS monitoring 2011

1. Zebra/Quagga Mussels
   - Monitoring/early detection
2. Macrophytes
   - Distribution update (rec/swimming areas)
3. Crayfish
   - Permitting and distribution in Wells Project 2012
4. Northern Pike
   - Box Canyon reservoir: Staying informed

DOUGLAS COUNTY PUD

# Zebra & Quagga

1. Veliger plankton tows
   - Three samples taken this year- sent to WDFW for analysis

2. Settlement substrates
   - Examined four X this year with no presence of adults
   - Continued vandalism at these locations (docks): Brewster, Pateros, & Bridgeport
     - Relocated two samplers

No Zebras or Quagga mussels in Wells Project to date


DOUGLAS COUNTY PUD

# Macrophytes

- Contacted by city stakeholders

Douglas Rec. Management Plan requires management of aquatic veg. in rec. areas: Pateros, Brewster, and Bridgeport

Photo: Bridgeport swimming area Sept 2011

- Sept 30th evaluated dpp. dominance in swimming areas
  - n = 26 substrate samples following Le and Kreiter 2005
  - Results summarized in a memo dated Oct 5th to the Dept. of Ecology (Can share with group if interested)
  - EWM: not dominant in any of the samples. Sub-dominant in 15% of the samples
  - Treatment options being considered: Herbicide? Others include mats, and physically removing

DOUGLAS COUNTY PUD

# Crayfish

- Northern crayfish (*Orconectes virilis)* found in the Brewster swimming area late June 2011
  - Dr. J. Olden (UW) confirmed its ID via pictures
- Absence of baseline crayfish data
  - Permit to capture in 2012 spring/summer
  - Development of informal study plan through the winter
  - Collection 2012

Wells Project July 2011- Northern Crayfish

Native Signal Crayfish (*Pacifasticus leniusculus*)

DOUGLAS COUNTY PUD

# Northern Pike- Staying informed

- Box Canyon (5th Project upstream):
  - 300 in 2004 → Estimated 10,000 in 2011
- Few, but have been, reported in Lake Roosevelt
- Unclear impact on salmonids/bull trout
- Biology:
  - Piscivorous, apex fish species
  - Ideal water temp is 17-21 C
  - Spawn between ~2-8 C
  - Eggs adhere to macrophytes
  - Broadcast- no parental care
- Not to be confused with Northern pikeminnow

***Ptychocheilus oregonensis***

***Esox lucius***

July 22 2011 L. Roosevelt *Esox L.*

# Going forward

- Continued veliger tows, and substrate samples for Z and Q mussels in 2012
- Aquatic veg. control
- Crayfish sampling plan development
- Northern Pike watch during AS and HCP activities
  - potential regional coordination/participation
  - Additional info on NP available at CBB: http://www.cbbulletin.com/411841.aspx "*Invasive Northern Pike Disaster For Pend Oreille Native Fish; Will Move Further Into Columbia Basin*?" Posted on Friday, Aug. 26, 2011

DOUGLAS COUNTY PUD

Attachment C

# Why this is Important

Invasive Species -

- Harm Habitat
  - are the 2nd biggest threat to biodiversity
  - listed as a cause of 48% of listed endangered species
- Cost $$$
  - cost the US approx $120 billion per year, 1.4 trillion globally
  - invasive aquatic plants cost the U.S. approx $100-275 million/year
  - Washington State spends at least $30 million every biennium on invasive species

# How invasive species spread

- Big jumps mainly through international trade
  - intentional (animals and plants imported for nursery or pet trade) or
  - by accident (shipping ballast, HITCHHIKERS)
- Smaller jumps
  - Nursery and pet suppliers
  - Education supply releases
  - ***HITCHHIKERS*** on boats and gear

*What we are trying to prevent*

# What are likely aquatic hitchhikers?

- Invasive non-native
  - Plants
  - Animals
  - algae
- Diseases

# Invasive Plants

- 28 species of aquatic and wetland weeds on the State Noxious Weed lists
- Illegal to transport plants on vehicles in Washington
- Ecology has on-line database with aquatic plant and weed data


Fullerton

# Invasive Animals

- Many – some examples
  - Zebra/quagga mussels
  - New Zealand mudsnails
  - Marine organisms like tunicates
  - Asian clams
  - Bullfrogs
  - Amur goby and other fish
  - Mystery snails

# Invasive Animal - Highlight

Zebra/Quagga mussels

- Not here yet
- On-going monitoring


Britton

# Algae

Didymo

- Confirmed nuisance populations
- Other similar diatoms (*Cymbella*)

# Diseases

- Amphibians
  - Chytrid fungus
- Fish
  - VHS – Viral Hemorrhagic Septicemia
  - Whirling Disease
  - Infectious Hematopoietic Necrosis (IHN) virus

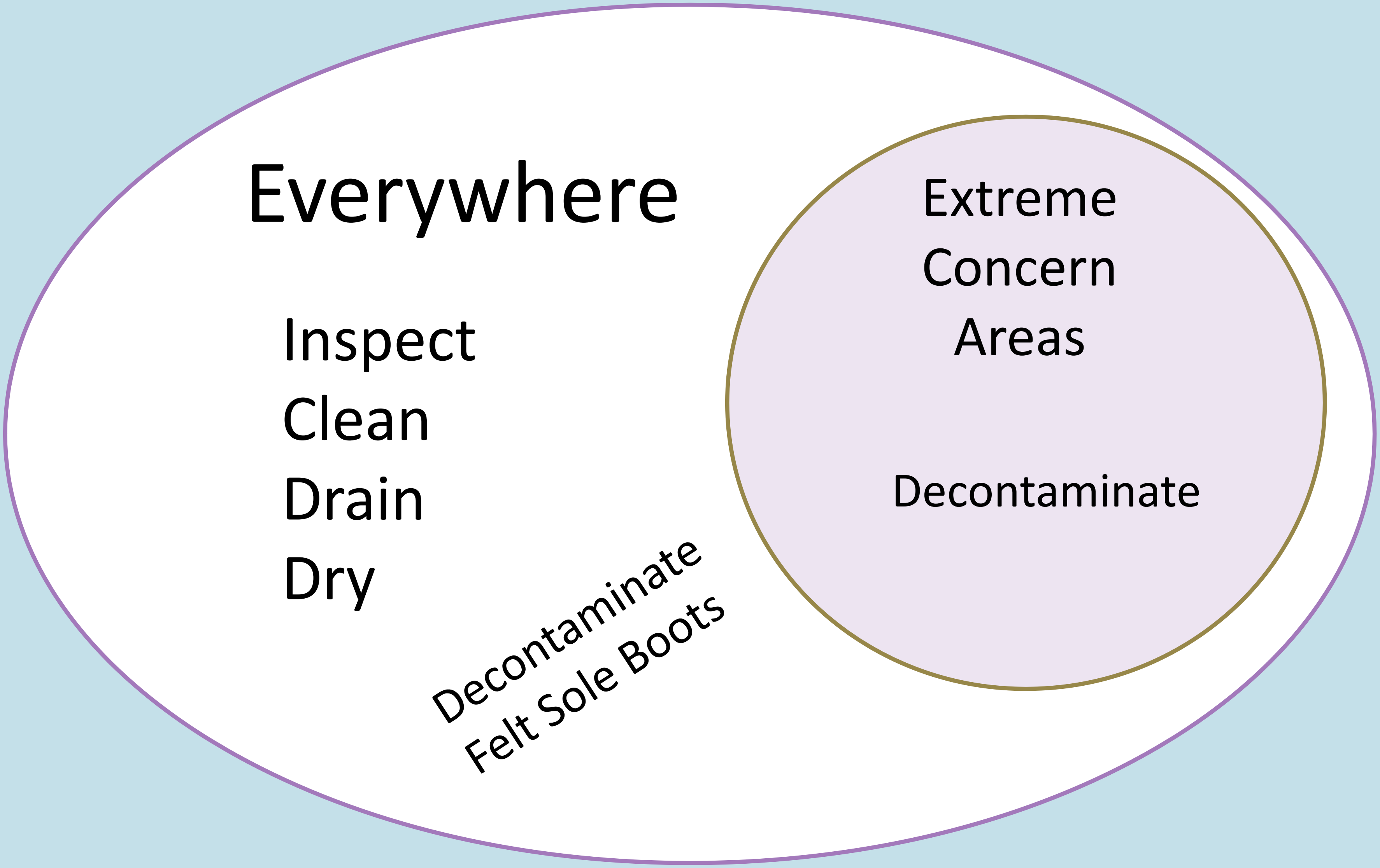
# What is being done about hitchhikers?

- General public: WDFW has enforcement officers and work with State Patrol to enforce laws against transporting aquatic plants and animals
- State Agency:
  - Ecology, ISC and WDFW have developed protocols

# Ecology's Protocols
## for cleaning field gear

- There is a helpful website
  - http://www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html
- Used a risk-based approach
  - divided the state into areas of
    - Extreme concern
    - Moderate concern

# Basic Overview



# Prior to field work in water

- Try to find out if New Zealand mudsnails are known from your area
- There are maps on the internet site
  - Currently presence of New Zealand mudsnails is the only thing triggering an ‘Extreme Concern’ designation.

# Why the extra concern - New Zealand mudsnail

Draheim

- Very hard to see, cling to gear, actively crawl onto gear
- Limited distribution - lower Columbia, tribs to mid-Columbia and Snake, Capitol Lake
- Only takes one
- Hard to kill


# Maps and GIS layer files

# Prior to aquatic field work (con't)

- Plan field activities to minimize contact with sources of contamination
- Select equipment that can be easily inspected and cleaned
- Plan for cleaning or decontamination needs – time and materials

# After Field Work

Clean Drain Dry


# Clean

- Inspect equipment, clean off any mud, plants or other debris.
- Scrub and rinse with clean water (from the site or brought in) if necessary.
- Flush areas that can't be seen until clean

# Where to clean

- Clean at the sampling site where practical
- Interim sites can also be used for inspection and cleaning (such as commercial car wash).
- Ensure no debris will contaminate another waterbody during transit or cleaning

# Extra Care Cleaning

- Nets
- Inner boat surfaces

Don't Forget!

**Clean vehicles** when leaving areas of high weed growth or mud

# Drain

Drain all water in bilges, samplers or other equipment that could hold water from the site.

# Felt sole boots

- **Clean** and then **Decontaminate** where ever they are used


- Consider Non-felt alternatives

# Extreme Concern Areas

- All equipment that contacted sediment, aquatic plants or fish:
  - If equipment is smooth and small – wipe dry
  - Everything else needs to be decontaminated

# Decontamination Options

| Treatment | Concentration or temperature | Exposure Time | comments |
|---|---|---|---|
| hot water wash or soak | 60° C (140° F) | 5 min for felt-soled boots and nets; 10 sec for all other equipment | Ensure all parts of the equipment reach temperature for the full exposure time |
| cold | -4° C | 4 hours minimum | Time starts after the equipment reaches -4 °C |
| drying | low humidity, in sunlight is best | 48 hours | Time starts after the equipment is thoroughly dry |
| Formula 409 All-Purpose Cleaner[1] | 100% (full strength) | 10 min | Follow proper procedures for storage and handling. |
| sparquat 256[2] | 3.1% or higher | 10 min | Follow proper procedures for storage and handling. |
| Quat 128 | 4.60% | 10 min | Follow proper procedures for storage and handling. |
| Hydrogen peroxide[3] | 30,000 ppm (3%) | 15 min | Spray on until soaked, then keep damp for contact time (cover or place gear in a dry bag) |

# WDFW also recommends

- Virkon Aquatic solution
- Spray or soak gear with 1% solution*
- Once saturated, let sit 10 min
- Dry if possible
- Rinse to protect gear
- Solution will degrade, need to use test strips
- *note: recent study results 2% for 20 min required for 100% mortality of NZMS

# Hot water, freezing or drying preferred over chemicals

- Chemicals have storage and disposal issues – and may contaminate water if gear isn't thoroughly rinsed
- Caution – hot water may damage some gear (goretex)

# Dry

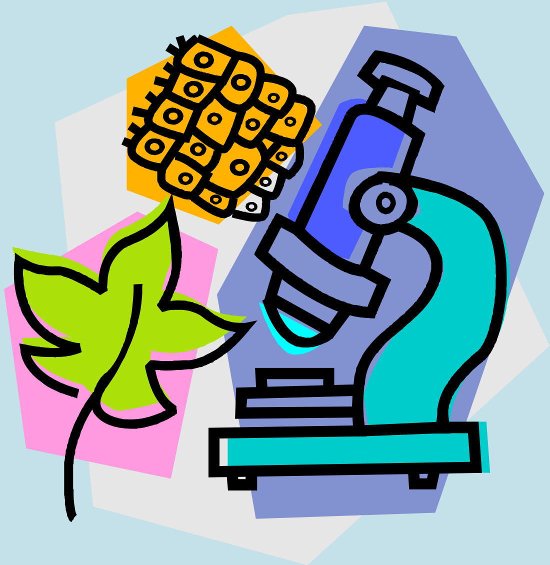
- After all cleaning and decontamination are complete, store equipment to facilitate drying

# Helpful links

- http://www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html Ecology's field gear cleaning methods page
- http://nas.er.usgs.gov/queries/washington/default3.asp USGS Non-indigenous Aquatic Species database for Washington
- http://wdfw.wa.gov/fish/ans/ Washington Aquatic Nuisance Species page

# What if I find something?

- take a photo and/or collect and preserve some
- GPS and take notes on the location
- Contact:  Ecology 509-457-7136 (plants/algae)
  - WDFW 1-888-WDFW-AIS



# Aquatic Plant Control

# Herbicides for submersed plants

- Require an ‘aquatic plant and algae’ permit from Ecology
  - Reissued in 2011, changes
  - Required 60 day waiting period for coverage
  - Permit fees likely to go up
  - Permit valid for multiple years
- Fish timing window, treatment would be after July 15th for endothall, diquat or 2,4-D (also flumioxazin, carfentrazone-ethyl)

# Herbicides available

- Systemic – kills whole plant
  - Fluridone – long contact time
  - 2,4-D – broad leaf
  - Triclopyr – broad leaf
  - Imazamox – newer, impacts to natives not well studied
  - (penoxsulam)  - long contact time
  - (bispyribac-sodium) – long contact time
- Contact – kills only what it contacts
  - Endothall
  - Diquat
  - (Flumioxazin)
  - (Carfentrazone-ethyl)

# What makes the most sense?

- Diquat
- Endothall
- Imazamox

# Harvesting

- Can avoid discomfort some people feel with herbicides
- Target specific areas
- Downsides: fragments, keeps plants in active growth phase, harvest invertebrates and fish

# Bottom Barrier

- Target specific areas, instant results
- Can cover limited areas without HPA, larger areas would need one
- Require maintenance
- Need to be well anchored

# Hand Pulling

- Target exactly what you want
- Need to remove roots
- expensive

# Water level drawdown

- Winter freeze of dry sediment is an effective plant control
- Need fairly long term drawdown, snow cover may reduce effectiveness


More Info:
jenp461@ecy.wa.gov, 509-457-7136
http://www.ecy.wa.gov/programs/wq/links/plants.html

# Final Conference Call Minutes

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: January 9, 2012

**From**: Michael Schiewe (Anchor QEA)

**Re**: Final Minutes of the December 12, 2011, Aquatic SWG Conference Call

## I. Summary of Decisions

1. There were no decision items during today's conference call.

## II. Summary of Action Items

1. Beau Patterson will work with Grant PUD to obtain the use of their infrared camera to test visibility at Wells fishway locations, to determine suitability for enumerating lamprey passage at Wells Dam (Item III-2).

2. Beau Patterson will look into opportunities for obtaining adult lamprey at Priest Rapids or Rocky Reach dams for translocation to Wells Dam for adult passage studies (Item III-3).

3. Aquatic Settlement Work Group (SWG) members will review the white sturgeon supplementation program proposals for discussion on January 9, 2012 (Item III-4).

## III. Summary of Discussions

1. **Welcome, Agenda Review, and Meeting Minutes Review** (Mike Schiewe)**:** Mike Schiewe welcomed the Aquatic SWG members to the conference call and opened the meeting (attendees are listed in Attachment A to these minutes). Schiewe reviewed the agenda and asked for any additional agenda items.

   - Pat Irle requested a discussion of potential translocation of adult lamprey from Rocky Reach Dam to the Wells forebay.

   - Steve Lewis requested the opportunity to provide an update on the status of the Bull Trout Biological Opinion for the Wells Project.

   Schiewe asked for comments on, or changes to, the revised draft November 9, 2011, meeting minutes. There were no comments or edits and the minutes were approved. Carmen Andonaegui will finalize the minutes and distribute them to the Aquatic SWG.

   Beau Patterson said that he had not heard many responses from Aquatic SWG members regarding Douglas PUD's offer of a tour of the Wells dewatered east fish ladder on

December 14, 2011. He said that Patrick Verhey had asked for an alternate tour date for either December 21 or 22, 2011, both of which are available. Steve Lewis asked for a tour on January 4, 2012, to accommodate Steve Rainey's schedule. Patterson said he would check to see whether that date was available as rewatering of the ladder was planned for January 5, 2012, and would confirm with Lewis. Lewis asked for a tour for himself at 3:00 pm on December 14, 2011; Patterson confirmed the date. Schiewe said that if anyone had a preference for a tour on December 21 or 22, 2011, to contact Patterson to schedule the tour.

2. **Update on Lamprey Activities at Wells Project** (Beau Patterson)**:** Beau Patterson reported that Douglas PUD had run into some challenges with getting the east fish ladder at Wells Dam wired with the Half-Duplex (HD) Passive Integrated Transponder (PIT) detection array. He said that, as a result, wiring of the east ladder would not be accomplished during the winter 2011/2012 fishway maintenance period for use in 2012. Patterson said that difficulties included installation delays associated with the vendor not being able to deliver equipment on time and problems addressing noise generated by interference with nearby steel plates at the facility. He said that BioMark would be conducting on-site testing during the current maintenance dewatering period to evaluate shielding options. He referred Aquatic SWG members to the memorandum sent to Carmen Andonaegui for distribution by email to the Aquatic SWG on December 9, 2011 (Attachment B). Patterson said that the HD PIT detection system would be installed in the west fish ladder during this winter's maintenance period.

   Pat Irle asked if the planned lamprey passage studies would still be implemented in 2012 with only one fish ladder wired for detection. Patterson said that Douglas PUD did not see any value in conducting studies in 2012 unless they could simultaneously collect passage information from both ladders. However, he said that Douglas PUD would be submitting a request to the Habitat Conservation Plan (HCP) Coordinating Committees (CC) asking for approval of a reduced entrance velocity night-time operation during the peak of the lamprey migration, as was approved by the HCP CC in 2011. He said that, given that the analysis of the effects of reduced velocity night-time operations on steelhead dam passage showed no effect, he did not anticipate a problem getting approval from the HCP CC for another year of reduced night-time entrance velocity.

   Steve Lewis asked if any additional lamprey had been detected passing Wells Dam. Patterson said only the one lamprey was counted at the Wells Dam fish count window in 2011 and that was on June 18, 2011. He acknowledged the possibility that some lamprey might be passing the count window by going behind the picketed lead through a 4-inch gap. Lewis asked how difficult it would be to get a video camera installed to monitor for lamprey passage through the picketed lead section. Patterson said that he would like to use an infrared camera for this purpose and that Grant PUD had agreed to loan Douglas PUD one of their infrared cameras. He said that if the section behind the picketed lead turned out to be turbulent and bubbles obscured detection, then they could look at other technologies, like the DIDSON camera. Patterson said that he was confident a video monitoring camera could be installed to count passage through the picketed lead section. He said that, once a monitoring system was in place behind the picketed lead, there would be close to 100 percent detection at the Wells Dam fish count windows.

3. **Trapping Lamprey at Rocky Reach** (Beau Patterson)**:** Steve Lewis said that during the last Rocky Reach Fish Forum meeting there was discussion of trapping adult lamprey at Rocky Reach for translocation to the Wells Dam Reservoir. Beau Patterson said that Douglas PUD is open to using any source of downstream lamprey for use in a Wells adult lamprey passage efficiency study. Bob Rose said that the Yakama Nation and the Umatilla Tribes recommend translocating adult lamprey from lower in the Columbia River system where more adults are available. Patterson said that this possibility had been discussed internally by Douglas PUD staff, and that he liked the suggestion. He also noted that an HD PIT detection array could be installed at the mouth of the Entiat River to assist in analyzing the fate of lamprey passing upstream of Rocky Reach Dam. The Aquatic SWG discussed the option of using lamprey trapped at Priest Rapids Dam for translocation to the Wells Reservoir as an enhancement measure. Rose said he thought efforts to enhance the population above Wells Dam to be premature. RD Nelle said he would be interested in more information on the Entiat lamprey run and integrating the HD PIT detection arrays with the existing Full Duplex (FD) detection arrays in the Entiat River.

   Molly Hallock questioned the wisdom of collecting adult lamprey for translocation in 2012, given the limited detection capabilities at Wells Dam in 2012 and the low overall number of adult lamprey in the Columbia River system. Patterson said that, on average, 70 percent of lamprey use the east ladder for upstream passage at Wells Dam. Given the low percent passage at the Wells Dam west ladder and the small number of adult fish passing upstream of Wells Dam, he reiterated that he would not recommend trying to get an estimate of passage efficiency at Wells Dam without full detection capabilities there. Patterson said that a decision did not need to be made today and that the conversation should continue. Meanwhile, he said that he would pursue with Grant PUD and Chelan PUD the options for obtaining adult lamprey trapped at those facilities for when the Aquatic SWG was prepared to start the passage studies. He said that, in past discussions with Grant PUD, they appeared willing to provide as many adult lamprey as the co-managers felt would be needed for a Wells Project study. The Aquatic SWG agreed that investigations into obtaining adult lamprey from Rocky Reach Dam, Priest Rapids Dam, or other downstream dams for use in evaluating passage at Wells Dam should continue.

4. **Responses to the Sturgeon Request for Proposals** (Beau Patterson): Beau Patterson said that Douglas PUD received two proposals in response to the white sturgeon supplementation Request for Proposals (RFP): one from the Yakama Nation (Attachment

C) and one joint proposal from the Colville Confederated Tribes (CCT) and Golder Associates (Attachment D). The Yakama Nation proposal focused on broodstock collection and juvenile rearing. The CCT/Golder Associates proposal proposed the collection of larval fish in-river and transport to the Wells Hatchery for subsequent rearing. Patterson said that Douglas PUD staff thought that either proposal would meet the supplementation objectives contained in the Wells Aquatic Settlement Agreement White Sturgeon Management Plan. He said that the Yakama Nation proposal was less expensive, but acknowledged that there is more to consider than costs alone when making the selection. Patterson said that a decision is not being requested today but that he was opening up the discussion. Mike Schiewe asked what actions Douglas PUD was looking for to move the selection forward. Patterson said that Douglas PUD is hoping for consensus among the Aquatic SWG members regarding which proposal to select. He said that if no consensus is reached, once a new Federal Energy Regulatory Commission (FERC) license is issued for the Wells Project, Douglas PUD will select an entity to implement the white sturgeon supplementation program as would be required by the license.

Chad Jackson asked Patterson if the final contract would include genetic testing of captured sturgeon. Patterson said that this was outside the scope of the RFP and would not be conducted by Douglas PUD. There were no additional questions from Aquatic SWG members. Patterson asked that any questions be directed to him between now and the next Aquatic SWG meeting in January 2012. Schiewe said that if questions were submitted in advance of the January 2012 meeting, they could be distributed to all Aquatic SWG members, or questions could be brought to the meeting for discussion. Patterson asked whether the Aquatic SWG preferred that the next meeting be in person or a conference call, which was already scheduled as a conference call for January 11, 2012. All expressed preference for an in-person meeting. Bob Rose said that the January 11, 2012, meeting date conflicted with the January 2012 Boardman meeting date. All agreed that January 9, 2012, would work as an alternate meeting date. Pat Irle asked if Bob Rose and Jason McLellan wrote the RFPs and, if so, would they each be available to attend the January 9, 2012, meeting in person. Both responded that they planned to attend in person and would be prepared to address any questions regarding the Yakama Nation and CCT/Golder proposals.

5. **Wells Project Bull Trout Biological Opinion Update** (Steve Lewis): Steve Lewis said that he would have the Draft Wells Project Bull Trout Biological Opinion to Douglas PUD by December 13 or 14, 2011. He said that Douglas PUD would have one week to provide comments and then the U.S. Fish and Wildlife Service (USFWS) would meet with Douglas PUD after the holidays to address their comments. He clarified that review and comments are only being sought from Douglas PUD.

# IV. Next Meetings

1. Upcoming meetings: January 9, 2011 (in-person); February 8, 2012 (in-person); and March 14, 2011 (conference call).

# List of Attachments

Attachment A – List of Attendees

Attachment B – HD PIT Detection Arrays Installation Update Memo

Attachment C – Yakama Nation White Sturgeon Supplementation Program proposal

Attachment D – Colville Confederated Tribes/Golder Associates White Sturgeon Supplementation Program proposal

# Attachment A
# List of Attendees

| Name | Role | Organization |
|---|---|---|
| Mike Schiewe | SWG Chair | Anchor QEA, LLC |
| Carmen Andonaegui | Administrative | Anchor QEA, LLC |
| Andrew Gingerich | Alt. SWG Technical Rep. | Douglas PUD |
| Beau Patterson | SWG Technical Rep. | Douglas PUD |
| Chad Jackson | Technical Resource | Washington Department of Fish and Wildlife |
| Molly Hallock | Technical Resource | Washington Department of Fish and Wildlife |
| Pat Irle | SWG Technical Rep. | Washington State Department of Ecology |
| Bob Rose | SWG Technical Rep. | Yakama Nation |
| Keith Hatch | Observer | U.S. Bureau of Indian Affairs |
| Jason McLellan | SWG Technical Rep. | Colville Confederated Tribes |
| Steve Lewis | SWG Technical Rep. | U.S. Fish and Wildlife Service |
| RD Nelle | Technical Resource | U.S. Fish and Wildlife Service |

# Memo

*Aquatic Settlement Work Group*

**To**: Aquatic SWG Parties **Date**: December 8, 2011

**From**: Beau Patterson

**Re**: HD PIT Detection Arrays Installation Update

I will be providing an additional update on the HD PIT installation during the December 12 conference call, but felt that this information should be provided as soon as possible. I was informed recently that Biomark will likely NOT be able to install HD PIT detection arrays in the Wells East Ladder during the annual dewatering and maintenance period. This is partly due to supply logistics complications associated with the manufacturing and delivery of the new 2020 HD PIT transceivers, Biomark's decision to move their fabrication shop to a new location during the month of December, and partly due to unforeseen design complications and potential for significant interference with the existing full duplex (FDX) PIT tag detection system at Wells Dam. This effectively precludes installing the detection system in the East Ladder this winter. We are still on track to get HD PIT detection installed in the West Fish Ladder during Jan/Feb 2012 timeframe.

Biomark will be onsite during the East Ladder dewatering to field inspect the proposed installation sites, and conduct a noise listening study to evaluate whether antenna shielding will be required to preclude interference with the FDX detection system (and if so, determine the requirements for that shielding).

I realize this is a disappointing development; however, Douglas PUD believes it is paramount that we ensure the new HD detection system does not affect the efficiency and reliability of the existing FDX detection system used for the detection of PIT tagged adult salmon, steelhead and bull trout.

Confederated Tribes and Bands
of the Yakama Nation

Established by the
Treaty of June 9, 1855

November 30, 2011

To: Douglas County Public Utility District
1151 Valley Mall Parkway
East Wenatchee, WA 98802

From: Paul Ward
Yakama Nation
Fisheries Resources Management Program
P.O. Box 151
Toppenish, WA 98948

**RE: Letter of Interest: White Sturgeon Population Supplementation, Proposal # 11-19-W**

The Yakama Nation has long been involved with the management and rebuilding of White sturgeon populations within the Columbia River Basin. These sturgeon populations have seen considerable decline since the development of Columbia River hydroelectric facilities and from over fishing. Not only are they an important food and commercial resource for the Yakama Nation, they are an important ecological component to this great river system.

Douglas County Public Utility District (DCPUD) is now beginning to provide needed mitigation measures that support the rebuilding of White sturgeon populations. The Yakama Nation welcomes these initial efforts and encourages DCPUD to join other, and established regional efforts which share similar objectives, specifically the collection of sexually mature adults from which to obtain multiple genetically diverse families of juveniles to seed mid-Columbia hydro-electric reservoirs.

The Yakama Nation, in close coordination with the Washington Department of Fish and Wildlife (jointly recognized by the State and Federal governments as "Co-Managers" of fisheries resources within the Pacific Northwest) have provided considerable leadership in recent years towards brood collection and juvenile rearing efforts. We have developed an experienced staff and substantial facility to accommodate these tasks in a highly competent manner. We believe that both DCPUD and other ongoing regional brood collection and spawning activities would benefit directly by DCPUD contributing to efforts through contracts with the Yakama Nation in the collection and spawning of adult White sturgeon and rearing of juvenile offspring.

For these and other reasons, the Yakama Nation hereby submits to Douglas County Public Utility District a Proposal to support important objectives contained within the White Sturgeon Management Plan and the Wells White Sturgeon Broodstock Collection and Breeding Plan, both developed by the DCPUD Aquatic Settlement Work Group and contained within the Aquatic Settlement Agreement: October, 2008. This Proposal is oriented towards providing high quality fertilized eggs to DCPUD, based upon passed conversations between the Yakama Nation and DCPUD. We are fully capable in rearing juveniles to release, and we request to preserve this option for contract considerations if that would be to the advantage and preference of DCPUD.

Sincerely,
Paul Ward

Yakama Nation
Program Manager
YN FRMP

**Proposal to Support White Sturgeon Supplementation**

*in response to the Douglas County Public Utility District*

**Request for Proposals 11-19-W White Sturgeon Supplementation**

*by the*

**Yakama Nation**
**Fisheries Resource Management Program**
P.O. Box 151
Toppenish, Washington 98948
November 30, 2011

## Purpose

The purpose of this Proposal is to illustrate the experience and capacity of the Yakama Nation to safely and reliably supply wild origin fertilized White sturgeon eggs to Douglas County Public Utility District (DCPUD) toward fulfillment of DCPUD's obligation to supplement the Wells Reservoir White sturgeon population with up to 5,000 marked and tagged yearling White sturgeon annually in years 2 and 3 of the new FERC license (2013 and 2014), consistent with the DCPUD White Sturgeon Management Plan and the Brood Stock Collection and Breeding Plan, expected to be incorporated in the new FERC license.

As such, this Proposal anticipates brood stock collection efforts in the spring of 2012 and 2013 which will occur within regional purview and guidance from the states of Oregon, Washington and the member tribes of the Columbia River Inter-Tribal Fish Commission (CRITFC) as well as the guidance from the Wells Aquatic Settlement Work Group (ASWG). Collection efforts will be in close coordination with similar activities supported by the Yakama Nation and undertaken by both Chelan County Public Utility District (CCPUD) and Grant County Public Utility Districts (GCPUD), both of which have similar needs described in their own FERC fisheries mitigation obligations and Settlement Agreements contained therein. Through these ongoing and regionally coordination efforts, the Yakama Nation is able to provide DCPUD the highest assurance to successfully obtain sufficient, high quality and genetically diverse White sturgeon eggs fully consistent with state and tribal fisheries Co-Manager objectives and as outlined in said Plans indicated above.

**Background**
Over the past five years, the Yakama Nation has been planning and developing a White sturgeon hatchery and rearing facility on its reservation lands near Toppenish, Washington. The primary purpose of this facility is two-fold: 1) to fully support White sturgeon conservation efforts within the Columbia River Basin and 2) to develop an economically self-sustaining commercial operation emphasizing sturgeon fillets and caviar.

Over the past two years, the Yakama Nation has been able to use this facility and staff to successfully collect brood stock from the Columbia River, spawn and fertilize eggs and rear juveniles without operational issues leading to unexpected or significant mortality levels or other complicating factors. These operations have significantly contributed to FERC mitigation obligations for both Chelan County and for Grant County Public Utility Districts (PUDs). Our efforts will continue to contribute to both Chelan and Grant PUDs for both the 2012 and 2013 brood collection season and associated juvenile rearing (through juvenile release into the Grant PUD reservoirs). The Yakama Nation anticipates our facilities being a key and central conservation facility for the Columbia River Basin as is currently being planned through efforts by the Columbia River Inter-Tribal Fish Commission using the 3-Step Process directed by the Northwest Power and Conservation Commission.

The goal of this Proposal is for the Yakama Nation to support DCPUD in meeting or exceeding obligations outlined in the White Sturgeon Management Plan and related White Sturgeon Broodstock Collection and Breeding Plan (incorporate by reference, Exhibit A of the DCPUD Request for Proposals #11-19-W; September, 2011) as developed and agreed to by the Wells Aquatic Settlement Work Group.

Through the contributions of the DCPUD, this Yakama Nation Proposal will expand ongoing broodstock collection efforts in a manner that increases assurance for providing sufficient numbers of reproductively viable adults, and to obtain sufficient fertilized sturgeon eggs to deliver to DCPUD in a timely manner. DCPUD will then rear these eggs, larva and juveniles within their own facilities with the intent to eventually provide up to 5,000 genetically diverse juveniles for release into the Wells reservoir.

**Technical Section**
Supplementation Objective: For the purposes of this Proposal, the over-arching supplementation objectives will focus on 1) the collection of reproductively viable adults from the Columbia River between Chief Joseph Dam and Bonneville Dam, 2)

appropriate gamete crosses and fertilization of eggs to insure the greatest contribution of genetic variability available to the fisheries managers at the time of fertilization and 3) incubation, rearing and support to DCPUD toward appropriate stocking numbers and release of the juveniles through the spring of the following year (8-12 month age class upon release).

*1) Brood Collection*:

The Yakama Nation has provided substantial regional leadership in the past two years towards brood stock collection within the Mid-Columbia River. These efforts are closely coordinated with the Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), CCPUD, GCPUD and the member tribes of the CRITFC (jointly referred to as the Co-Managers). The Yakama Nation is currently under contract with the CCPUD and GCPUD to collect and spawn White sturgeon broodstock from the Columbia River in a very similar effort as that being undertaken by DCPUD. These contracts, similar to that being proposed by DCPUD will persist through year 2013.

*2) Brood Spawning and Release:*

Prior to the 2012 broodstock collection season the Yakama Nation will have capacity to simultaneously hold up to 8 female and 8 male sexually mature adults for approximately 30-45 days prior to spawning. The design objective for this facility is to provide sufficient resources for two crosses of three males and three females while providing for additional broodstock as needed. This design objective is consistent with conservation objectives to annually obtain as many maternal crosses as is possible (up to a six by six female to male matrix), depending upon availability of sexually viable broodstock. As has been demonstrated in the past two years experience, obtaining viable fish to support these crosses is not assured, particularly during the early, "exploratory" years (2010 - 2013) of the initiation of these regional supplementation programs. Upon collection and spawning of broodstock from the Columbia River, the Yakama Nation will release each fish back to its location of origin.

Prior to spawning, the Yakama Nation will provide a broodstock mating plan to be reviewed by the ASWG which assures that enough broodstock are on station for the appropriate number of family groups (depending upon brood stock availability).

*3) Egg Incubation and Juvenile Rearing:*

The Yakama Nation is fully equipped to support the fertilization, incubation and juvenile rearing of White sturgeon in excess of all current and foreseeable conservation needs for DCPUD and other mid-Columbia River supplementation efforts. We currently maintain and operate sufficient water flow capacities and ideal temperatures, fertilization and incubation vessels, tanks and related equipment to maximize fungus control and bio-security at all levels of handling from gametes through rearing and release.

Prior to spawning, the Yakama Nation will provide an incubation plan to be reviewed by the ASWG that assures sufficient vessels to maintain maternal family groups and the appropriate conditions are on station.

Deliverables:

The Yakama Nation will provide to DCPUD an adequate number (determined based upon success in brood stock collection) of fertilized White sturgeon eggs consisting of multiple parental crosses (as available based upon reproductive success of broodstock) to rear and to release into the Wells Reservoir. The total number of eggs delivered will consider 1) "natural" or expected mortalities rates typically observed by juveniles in the hatchery environment and 2) the number of parental crosses available at the conclusion of the broodstock collection and spawning season (approximately July 1). The overall intent is for the Yakama Nation to provide to DCPUD sufficient number of genetically diverse eggs such that up to 5,000 8-12 month old progeny of multiple parental crosses (approximately 3-6 maternal families) will be released into the Wells Reservoir, consistent with mitigation obligations outlined in the White Sturgeon Management Plan and the Brood Stock Collection and Breeding Plan.

The Yakama Nation will conduct brood stock collection efforts in the Columbia River between Chief Joseph Dam and Bonneville Dam in coordination with ongoing regional White sturgeon conservation efforts and under the purview of tribal, state and federal fisheries Co-Management authorities.

*Delivery of Gametes*

The Yakama Nation will deliver fertilized White sturgeon eggs to DCPUD as soon as possible after appropriate gamete crosses have been made (likely between early and late June 2012 and 2013), through close coordination with DCPUD and at a time that is mutually agreed upon by both Yakama Nation and DCPUD. Due to uncertainties in broodstock collection and timing of fertilization, it is possible that eggs could be delivered in two or more separate "batches". In either case, fertilized eggs become susceptible to higher incidence of mortality over time and will be delivered to the Wells Hatchery immediately after fertilization (estimated within 12 hours) and will be in excellent condition upon delivery.

*Investigations in Larval Collection*

At this time, the Yakama Nation has a strong interest in evaluating the potential use of collecting naturally fertilized larval White sturgeon from the Columbia River. However, this type of collection technique has not been appropriately described and vetted by regional Co-Management authorities. We believe that substantial work will be required to identify viable areas where larval fish can be efficiently obtained in a safe and cost effective manner. We also believe that it will be necessary to test this technique from the perspective of insuring as good or better enhancement of genetic diversity within the Columbia River population, as compared to our existing efforts in obtaining juveniles through broodstock collection and fertilization within a hatchery environment.

The Yakama Nation proposes that we initiate these discussions with the state and tribal fisheries Co-Managers in year 2012, working closely with the Wells Aquatic Settlement Work Group, and if appropriate initiate a pilot fishing effort in the spring spawning season, 2013. The Yakama Nation is fully equipped to perform this potential pilot operation. During 2012 the Yakama Nation will develop a brief, but sufficient planning document describing a minimum of three areas where larval fishing can be accomplished safely and provide a relatively high probability of success. Also included in this plan will be (but not limited to) fishing methods and equipment, timing, safety considerations and means for obtaining genetic samples to determine the extent of maternal / paternal crosses within a representative sample of fish collected in this prototype effort.

*Coordination and Delivery with Wells Fish Hatchery*

The Yakama Nation will be responsible to remain in close communication and coordination during all important aspects of brood collection planning and implementation, during capture of brood and fertilization of eggs and particularly in determining specific dates and times for egg delivery to the Wells Fish Hatchery. DCPUD will be required to maintain a reasonable level of flexibility during egg fertilization and delivery so that eggs can be received at the Wells Hatchery and appropriately cared for within 12-18 hours after fertilization.

<u>Sturgeon Origin</u>: White Sturgeon broodstock will be collected from various sites within the mid- and lower Columbia River. Specific sites have not been chosen yet,

pending upcoming coordination meetings with the states of Oregon and Washington and member tribes of the CRITFC. However, it is very likely that collection will take place from three locations: 1) immediately below The Dalles Dam in what is known as "The Bucket", 2) in the John Day reservoir, near McNary Dam and 3) in the Wanapum and/or Priest Rapids reservoirs. Given time and depending upon fishing conditions, it is possible that fishing may also occur below Priest Rapids Dam in the Hanford Reach.

<u>Collection Methods</u>:
Over the past two pilot years of brood collection, the Yakama Nation has demonstrated reasonably good success with both hook and line and set-line fishing techniques. Similar efforts will be employed in the 2012 and 2013 brood collection season. Fishing is dependent upon weather and water temperature, but crews will be prepared to fish during a six- to eight-week window beginning in early-May and concluding late-June. Our efforts will be tightly coordinated with both Grant and Chelan PUD White sturgeon monitoring / collection efforts (undefined at this time) so that we will be able to maximize the potential for increased brood collection and potential male/female crosses.

Typically, set lines are employed in the late evening and are pulled the following morning. Lines are then re-set and fished for 2-5 hours throughout the day, depending upon conditions. Approximately 20 - 25 lines are set three times daily. Hook and line fishing will be employed as time is available. As in the 2011 brood collection, the Yakama Nation will provide opportunities for natural resource employees involved in Columbia Basin sturgeon management to help with brood collection via bank fishing during the main collection periods. This will be on a volunteer basis. In addition, the Yakama Nation is evaluating the use of two local guides over a 2-week period to assist in collection and to continue finding and evaluating pre-spawning adult "staging areas' where current and future brood collection efforts may be targeted.

Baits will continue to include use of squid, fresh hatchery reared salmonids and/or fresh shad upon availability.

Upon capture of reproductively capable adults, gonad maturation is determined at the site of capture via visual observation of the reproductive organs with an odoscope through a 1 cm incision on the ventral midline of the fish. The incision is made with a #10 scalpel. After observation the incision is closed with a cruciate suture pattern using a 2-0 chromic gut suture with a CP-2 reverse cutting needle.

The mature males will exhibit large white testes, mature females with 3.5- 4 mm black eggs are evaluated by removing a small sample of approximately 50 eggs. The eggs are then boiled in ringers solution for 5 minutes so that they can be dissected and measured under a microscope equipped with a digital camera and measuring software to determine the maturity of the fish. At this point in time, it is possible to estimate, approximately, when eggs will ripen to be fertilized. In general, staff can then begin planning towards synchronizing maturation rates to obtain highest certainty of multiple female to male crosses.

Adult Holding:
When fish are determined suitable (sexually viable) they are immediately transported to the Marion Drain hatchery and placed in appropriate holding tanks. Each female will be isolated (reducing stress) into its own 10' diameter tank and the males are pooled into an 20' diameter tank; tanks are covered and protected from direct sunlight. Depending on the maturation of the fish the water temperature will be manipulated with two heat pumps which are capable of heating or chilling water to synchronize spawning to achieve the desired spawning matrix.

Spawning and Release:
The female brood are examined in the hatchery as necessary in order to evaluate ripeness and schedule spawning. Once the female is determined suitable for spawning with an egg polarization index of .1 or less spawning is scheduled accordingly.

Artificial spawning is induced using LHRHa which is a synthetic luteinizing releasing hormone. The males are injected first to ensure that milt is available, once milt is obtained the females injections are administered. Males receive a single injection of 10 ug/kg body weight. The milt is extracted approximately 12 hours after the injection. The quality and motility of the milt is evaluated with a 40X microscope. Viable milt is placed in ziplock bags and filled with pure oxygen, the milt is then placed in a cooler on ice for storage.

After viable milt is obtained the female brood are induced with a total dose of 20 ug/kg body weight of LHRHa. The dosage is administered in two injections, an initial dose of 2 ug/kg and a resolving dose 12 hours later of 18 ug/kg, at 14-15C. The females will ovulate within 14-20 hours after the 2$^{nd}$ injection.

Egg extraction begins within 2 hours after the fish begins to expel eggs into the tank. The fish is placed in a stretcher and the desired number of eggs are massaged out of the fish.

The eggs are then fertilized, de-adheased and disinfected before they are placed in hatching jars. The eggs are then monitored visually for development until hatching begins in 6-8 days.

Brood are allowed to recover in the tank for 1-2 days to observe a healthy post-spawn recovery before it is returned to the Columbia River at the place of origin.

Juvenile Rearing:
Juveniles are reared in 8- 12 foot circular tanks supplied with well water at temperatures ranging between 55 - 60 Degrees Fahrenheit. Once feeding has been established, juveniles are fed once per day upon release. Juveniles remain in these tanks until release. Minimal handling and sorting is performed so that to minimize stress and un-necessary risk of disease and elevated mortality.

Transportation and Delivery:
Eggs supplied to DCPUD will be transported in coordination with Wells Hatchery within 12 hours of fertilization. The eggs will be stored in plastic bags filled with water and oxygen and securely placed in coolers for transport. The Yakama Nation will notify DCPUD sufficiently in advance of delivery to insure that adequate preparation for egg delivery is made at the Wells Hatchery.

Experience, Qualifications and Facilities:
The Yakama Nation has successfully fulfilled the White Sturgeon mitigation obligations of CCPUD and GCPUD over the past two years.

Over the past several years the Yakama Nation has constructed the Marion Drain Sturgeon Hatchery which is located on an 11 acre site 10 miles west of Toppenish, Washington.

The fish are reared with single pass ground water in circular rearing tanks. The water supply to the hatchery consists of one 195' deep 600 GPM primary well and one 320' deep backup well with an automatic transfer switch in case of pump failure. Well water temperature remains relatively stable throughout the year and ranges from 55 to 60 degrees F.

The hatchery is equipped with a 600 Kw backup generator with an automatic transfer switch in case of power failure. The hatchery is also equipped with an auto dialer alarm with a flow sensor and power supply monitor.

The adult holding area consists of eight 10’ diameter by 4’ deep tanks to house the female brood and two 20’ diameter by 4’ deep tanks to house the male brood. Two 30 Horse Power heat pumps are available to manipulate water temperatures, heat and chill, in order to synchronize maturation and spawning.

The incubation facility contains 32 incubation jars and eight hatching troughs to segregate the family groups created in a factorial spawning matrix. Adequate space exists to expand these incubation facilities as needed. The fish are brought onto feed in the hatching troughs before they are moved out into eight 10’ diameter circular rearing tanks for grow out. The brood tanks are available for grow out as necessary.

<u>Committed Staff and Resources</u>:
The Yakama Nation Fisheries Management Program (FRMP) has been exploring sturgeon culture requirements by rearing small numbers of White sturgeon in tribal hatchery facilities since the 1990s. Fish were obtained from various sources including the private Pelfrey sturgeon hatchery operating downstream from Bonneville Dam and mid-Columbia hatchery research by CRITFC and the USFWS.

The Yakama Nation hatchery program has successfully spawned captive broodstock in 2007 and 2008 and is currently rearing sturgeon of various ages. This work and expertise provides an opportunity to facilitate implementation of appropriate hatchery measures at such time as needs and objectives are clearly established under the concurrent comprehensive strategic and master planning effort for mid-Columbia White sturgeon.

The FRMP has constructed a sturgeon hatchery at the Marion Drain Facility which operates under funding from Grant County Power Sale Revenue, Bureau of Indian Affairs Cyclical Maintenance Funds, Columbia River Fish Accords and mitigation contracts from the Mid-Columbia Public Utility Districts (PUD) of Grant and Chelan Counties. The Yakama Nation hatchery program has successfully spawned broodstock in 2007, 2008, 2010 and 2011. The Yakama Nation is currently rearing approximately 8,000 juvenile fish which will be released into the PUD project areas in 2012, which includes the Priest Rapids, Wanapum and Rocky Reach reservoirs. The Yakama Nation successfully reared and released 13,000 fish into the PUD project areas in 2011.

The hatchery is staffed by a project manager, three fulltime regular, one part-time and one seasonal culturist. Additional staffs are available on an "as needed" basis from other Yakama Nation fisheries projects. Donella Miller, YN White Sturgeon Project Manager, will serve as the lead biologist on the project. The primary duties of the project manager are oversight of the broodstock collection, spawning and rearing of hatchery fish as well as project reporting, communication and coordination with DCPUD staff.

Donella has a Bachelor of Science degree in Fishery Resources from the University of Idaho and over 18 years of fish culture experience working with various species of salmonids and white sturgeon. Thomas Dittentholer, Fish Culturist V, has an Associate's Degree in Fisheries Science from Mt Hood Community College and over 20 years of fisheries experience. Alex Azure, Fish Culturist II, has 3 years of sturgeon culture and broodstock collection experience. Nathan Patterson, Fish Culturist II, has 2 years of sturgeon culture and brood stock collection experience. Dustin Yallup, Fish Culturist II, has 2 years of sturgeon culture experience.

Timelines, Schedules, Tasks, Descriptions:
The general timelines for planning, fishing and delivery of fertilized eggs will be consistent with the past two broodstock collection seasons and similar in both 2012 and 2013 contract years.

**January**: Co-Manager / PUD meetings to discuss, coordinate and conclude upcoming broodstock fishing efforts and juvenile release strategies. At this time all elements of regulatory compliance are determined and schedules for completion are determined.

**February - March**: Coordination with U.S. Army Corps of Engineers for boat access in The Dalles tailrace or other sensitive areas where brood collection activities may occur. All necessary permits secured.

**April**: All required broodstock collection, transportation, spawning and fertilization equipment and supplies purchased, maintained, and set up in fully operational condition. Develop and implement release plan for previous years sub-yearling hatchery reared juveniles.

**May**: Depending upon weather and water temperature conditions initiate broodstock collection activities.

**June**: Continue brood collection activities and initiate spawning and fertilization efforts, as appropriate.

**July**: Conclude all broodstock collection activities and develop draft reports for Aquatic Settlement Work Group.

**September**: Finalize broodstock collection report and convene Co-Manager led, regionally coordinated meeting concerning "lessons learned" and improvements for next year's collection efforts.

Regulatory Compliance:
Having been involved with broodstock collection, transportation, fertilization and rearing of juveniles over the past two years, the Yakama Nation is well aware and capable of obtaining all appropriate regulatory permits in a timely manner. The following lists relevant permits and potential considerations towards obtaining permits for these activities.

1.) *WA State Scientific Collectors Permit*: Required for any entity to sample/collect fish and wildlife for research/study purposes. As a Co-Manager, YN is exempt from obtaining this permit and/or can issues these permits as needed. The Yakama Nation will coordinate closely with both Oregon and Washington to insure states prior knowledge of these activities.

2.) *WA State Fish Transport Application/Permit*: YN is required to obtain a FTAP from WDFW to transport brood stock from Columbia River to Marion Drain and vice versa. A FTAP is also required if YN intends to perform fish stocking activities in the Wells Pool on behalf of DPUD. The FTAP only applies if YN are transporting and/or stocking fish off reservation. These permits typically require less than two weeks to obtain and can be processed through WDFW Region 2 office in Ephrata.

Oregon will also require a similar permit if any transport occurs within that state. This permit and process are essentially identical for both Oregon and Washington. The Yakama Nation will coordinate closely with both Oregon and Washington to insure states prior knowledge of these activities and appropriate permits are secured in a timely manner.

3.) Co-Manager Fish Health Policy: This policy essentially requires disease screen of fish being cultured at a particular facility including brood stock, eggs, and/or juveniles. In 2011, the Dworshak National Fish Hatchery (USFWS) performed disease screens under the request of the WDFW. Upon initiation of contracted services with DCPUD, the Yakama Nation will work closely with WDFW, USFWS and DCPUD to determine the best manner in which to operate within these policy guidelines during the DCPUD contract period (2012 -2013) and over the longer term, as determined.

4.) USFWS/NOAA ESA Permitting: The Yakama Nation brood collection or juvenile release activities do not require ESA consultation.

5.) Co-Manager Future Brood Document: The Yakama Nation has maintained adult sturgeon and / or broodstock for over 10 years and plans to maintain these stocks throughout the foreseeable future. As such, we recognize the need and are in consultation with WDFW in the development of a Co-Manager Future Brood Document which simply outlines to intent and operation of the Marion Drain White Sturgeon Hatchery. This documentation does not have either direct or indirect affect on the Yakama Nations capabilities to perform the terms of a contract with DCPUD concerning brood collection and egg delivery, as addressed in this Proposal.

**Cost Section**
The Yakama Nation estimates a total contracted cost to Douglas County Public Utility District of $80,649.25.

Provided below in Table 1 are total estimated costs for all activities associated with brood collection, spawning, incubation and deliver of final products to DCPUD, including local and regional coordination and final reporting to the ASWG. Following, in Table 2 is a summary of estimated contracted costs to DCPUD for these services.

It is important to note that total estimated costs to the Yakama Nation are specifically focused solely on Conservation efforts associated with the use of our hatchery facilities (operation, maintenance and equipment) and staff time. Conservation efforts in this context refers specifically to the capture of wild Columbia River broodstock, and all subsequent activities associated with the propagation of eggs, larval or juvenile progeny. Additionally, these total costs are being divided amongst both Chelan and Grant county PUDs as they have similar regulatory mitigation obligations that the Yakama Nation is supporting. Providing this cost-share opportunity offers DCPUD the highest level of assurance of cost-efficiency, that an appropriate number of broodstock are collected during the contract period, there is sufficient genetic diversity in the delivered fertilized eggs and that this effort will occur under the regulatory purview of the regional fisheries Co-Management agencies.

**Conclusion**
As illustrated in this Proposal to provide services to Douglas County Public Utility District, supporting conservation and mitigation obligations as outlined in both the DCPUD White Sturgeon Management Plan and the Brood Stock Collection and Breeding Plan, the Yakama Nation has demonstrated a high level of competence and capacity to accommodate these needs in supplying to DCPUD sufficient and high quality fertilized White sturgeon eggs in a timely and reliable manner.

We look forward to continuing our work with DCPUD and in our continued support towards these important activities.

**Table 1: Total Yakama Nation White Sturgeon Operations and Maintenance Budget for Conservation Measures (Brood collection, spawning, incubation and fertilized egg delivery).**

| Description | No. Postions | Quantity | Units | Rate | Itemized Amount | Estimated Budget |
|---|---|---|---|---|---|---|
| Fish Biologist | 1 | 350 | hrs | 30.17 | | **$10,559.50** |
| Fish Biologist (Overtime) | | 80 | hrs | 45.26 | | **$3,620.40** |
| Fish Culturist V | 1 | 350 | hrs | 29.49 | | **$10,321.50** |
| Fish Culturist V (Overtime) | | 80 | hrs | 44.24 | | **$3,538.80** |
| Fisheries Tech II | 1 | 300 | hrs | 16.49 | | **$4,947.00** |
| Fisheries Tech II (Overtime) | | 80 | hrs | 24.74 | | **$1,978.80** |
| Fisheries Tech II | 1 | 300 | hrs | 15.24 | | **$4,572.00** |
| Fisheries Tech II (Overtime) | | 80 | hrs | 22.86 | | **$1,828.80** |
| Fisheries Tech II | 1 | 300 | hrs | 15.24 | | **$4,572.00** |
| Fisheries Tech II (Overtime) | | 80 | hrs | 22.86 | | **$1,828.80** |
| YN FRMP Senior Staff Coordination | 3 | 100 | | 40.00 | | **$4,000.00** |
| Merit/Annual Leave | | $47,768 | base | 6.00% | | **$2,866.06** |
| **Total Wages** | | | | | | **$54,633.66** |
| Fringe | | | 22.00% | 54,634 | | **$12,019.40** |
| **Total Personnel** | | | | | | **$66,653.06** |
| | | | | | | |
| **Small Contract: Professional Guide-Exploratory Staging and Spawning Areas** | | 1 | 1 | 5,000 | 5,000 | **5,000** |
| | | | | | | |
| **Office Supplies** | | Quantity | Units | Rate | Amount | **$500.00** |
| Misc Office Supplies (paper, pens, etc) | | 2 | mo | 250 | 500 | |
| **Repairs & Maintenance** | | Quantity | Units | Rate | Amount | **$1,000.00** |
| Equipment Repairs | | 2 | mo | 500 | 1,000 | |
| **Operating Supplies** | | Quantity | Units | Rate | Amount | **$38,050.00** |
| Rope | | 1 | ea | 500 | 500 | |
| Buoy | | 10 | ea | 100 | 1,000 | |
| Anchor | | 10 | ea | 100 | 1,000 | |
| Fishing Lines | | 1 | ea | 500 | 500 | |
| Hooks | | 1 | ea | 250 | 250 | |
| Bait | | 1 | ea | 5,000 | 5,000 | |
| Poles & Reels | | 5 | ea | 250 | 1,250 | |
| Weights | | 1 | ea | 250 | 250 | |
| Pit Tag Detector | | 1 | ea | 3,500 | 3,500 | |
| Equipment Storage (containers, coolers, etc) | | 1 | ea | 500 | 500 | |
| Misc Materials ( hoses, etc) | | 1 | ea | 500 | 500 | |
| Transport Stretcher | | 2 | ea | 250 | 500 | |
| Oxygen Cylinder | | 2 | mo | 100 | 200 | |
| Sampling/Broodstock Collection supplies | | 1 | misc | 5,000 | 5,000 | |
| Truck Crane | | 1 | ea | 5,000 | 5,000 | |
| Set Line Hauler (Boat) | | 1 | ea | 2,000 | 2,000 | |
| On Board Handling (Boat) | | 1 | ea | 2,000 | 2,000 | |
| Boat Repairs | | 2 | ea | 3,000 | 6,000 | |
| Spawning/ Incubation Supplies | | 1 | misc | 3,000 | 3,000 | |
| Oxygen Regulator | | 1 | ea | 100 | 100 | |
| **Rental** | miles | Quantity | Units | Rate | Amount | **$5,704.00** |
| GSA Vehicle-Mileage (Pers & Equip Transport) | 1200 | 2 | mo | 0.26 | 624 | |
| GSA Monthly Lease | | 2 | mo | 500.00 | 1,000 | |
| GSA Vehicle-Mileage (Boat Transport) | 1200 | 2 | mo | 0.26 | 624 | |
| GSA Monthly Lease | | 2 | mo | 500.00 | 1,000 | |
| GSA Vehicle-Mileage (Fish Transport) | 2800 | 2 | mo | 0.26 | 1,456 | |
| GSA Monthly Lease | | 2 | mo | 500.00 | 1,000 | |
| **Cellular Phones** | Phones | Quantity | Units | Rate | Amount | **$0.00** |
| Cell Phone | 0 | 2 | mo | 100 | - | |
| **Utilities** | Phones | Quantity | Units | Rate | Amount | **$2,200.00** |
| electrical | | 2 | mo | 1,000 | 2,000 | **$2,000.00** |
| garbarge | | 2 | mo | 100 | 200 | **$200.00** |
| **Telephone** | Phones | Quantity | Units | Rate | Amount | **$0.00** |
| office phone | 1 | 0 | mo | 75 | - | |
| **Insurance** | | Quantity | Units | Rate | Amount | **$202.00** |
| General Liability vehicles | | 2 | mo | 65 | 130 | |
| Building | | 2 | mo | 36 | 72 | |
| **Travel Expenses** | | Quantity | Units | Rate | Amount | **$6,960.00** |
| 2. Travel Per Diem | | 48 | ea | 50 | 2,400 | |
| Lodging | | 60 | ea | 76 | 4,560 | |
| **Vehicle Gas & Oil** | | | | | | **$10,200.00** |
| Fuel for Equipment (Boat, pump, generator) | | 2 | mo | 5,000.00 | 10,000 | |
| Oil | | 2 | mo | 100 | 200 | |
| **Subtotal** | | | | | | **$136,469.06** |
| | | | | | | |
| **Yakama Nation Indirect Cost** | | **131,469.06** | | 18.85% | | **$24,781.92** |
| | | | | | | |
| | | | **Total Sturgeon Conservation Budget** | | | **$161,250.98** |

**Table 2: Summary of Estimated Cost-Shared Contracted Costs for Douglas County PUD.**

| Itemized Description | Total Costs to Yakama Nation | DCPUD Contracted Cost Share Contribution |
|---|---|---|
| Total Personnel | $66,653.06 | $33,326.53 |
| Small Contract: Professional Guide-Exploratory Staging and Spawning Areas | 5,000 | $2,500.00 |
| Office Supplies | $500.00 | $250.00 |
| Repairs & Maintenance | $1,000.00 | $500.00 |
| Operating Supplies | $38,050.00 | $19,025.00 |
| Rental | $5,704.00 | $2,852.00 |
| Utilities | $2,200.00 | $1,100.00 |
| Insurance | $202.00 | $101.00 |
| Travel Expenses | $6,960.00 | $3,480.00 |
| Vehicle Gas & Oil | $10,200.00 | $5,100.00 |
| **Subtotal** | **$136,469.06** | **$68,234.53** |
| Yakama Nation Indirect Cost (18.66%) | $24,781.92 | $12,390.96 |
| **Total Sturgeon Conservation Budget** | **$161,250.98** | **$80,625.49** |

Confederated Tribes and Bands
of the Yakama Nation

Established by the
Treaty of June 9, 1855

November 30, 2011

To: Douglas County Public Utility District
1151 Valley Mall Parkway
East Wenatchee, WA 98802

From: Paul Ward
Yakama Nation
Fisheries Resources Management Program
P.O. Box 151
Toppenish, WA 98948

**RE: Statement of Qualifications: White Sturgeon Population Supplementation, Proposal # 11-19-W**

The Yakama Nation has long been involved with the management and rebuilding of White sturgeon populations within the Columbia River Basin. These sturgeon populations have seen considerable decline since the development of Columbia River hydroelectric facilities and from over fishing. Not only are they an important food and commercial resource for the Yakama Nation, they are an important ecological component to this great river system.

Over the past 10-plus years, the Yakama Nation has been substantially involved with each of the three mid-Columbia Public Utility Districts (PUD) re-licensing efforts as regulated by the Federal Energy Regulatory Commission (FERC). During this time we have contributed significantly to the development of the White Sturgeon Management Plans (Plans) in common to each of these entities, including Douglas County PUD (DCPUD). Over the past two years the Yakama Nation, in close partnership with the Washington Department of Fish and Wildlife, has provided leadership and a central role for both Chelan County and Grant County PUD's in the implementation of these Plans by collecting sexually viable wild-caught White sturgeon from appropriate locations within the Columbia River, successfully transporting, spawning and returning fish back to their location of capture and have successfully reared their offspring for release into the Columbia River. During this time our staff have also developed a competent and fully functional White sturgeon hatchery that has demonstrated great success though basic measures such as very low incidence of disease and mortality and very high levels of fish health and biological productivity.

In short, our qualifications to continue to carry this work forward for the benefit of DCPUD, and for the resource are strong and many. Our White Sturgeon Project Manager is well educated as a graduate from the University of Idaho. During this time she has been able, and continues to participate in activities with many existing sturgeon hatcheries and facilities throughout the west coast region gaining broad and academically sound training as well as a high degree of respect from her professional peers. Her staff has demonstrate outstanding commitment and competence through the building of our White Sturgeon production and rearing facility at Marion Drain, near Toppenish. WA., which is now fully operational and continues to expand as we increase tank capacity for adult and juvenile holding, increase water availability and operational safety through multiple wells and power sources and improve our ability to synchronize adult spawning activities through water temperature control.

Post Office Box 151, Fort Road, Toppenish, WA 98948 (509) 865-5121

Over the past couple years, the Yakama Nation has reliably and safely demonstrated our commitment and ability to fish for and collect sexually viable adult White sturgeon in a professional manner consistent with best management practices and species conservation objectives. In addition, we offer to Douglas PUD the ability to become fully integrated with an ongoing regional program towards White sturgeon supplementation in which the Yakama Nation is providing substantial leadership and coordination with other Co-management authorities, specifically the States of Oregon, Washington and the Federally recognized tribes of the Columbia River Basin.

Sincerely,
Paul Ward

Yakama Nation
Program Manager
YN FRMP

---

**List of Completed Projects:**

2008: Marion Drain Sturgeon Hatchery initiated.

2010: Primary holding tanks and core facilities for adult holding, spawning and juvenile rearing at Marion Drain established. White sturgeon adults and juveniles brought on site. First season successfully completed for wild brood stock collection (from the Columbia River), spawning and juvenile rearing.

2011: Marion Drain facility expansion including additional tanks, back-up well and water temperature control for adult spawning. Second season successfully completed for wild brood stock collection (from the Columbia River), spawning and juvenile rearing. Juveniles from 2010 year-class successfully released in the Columbia River.

2012: Anticipated third season for contracted sturgeon brood stock collection and spawning to support Grant and Chelan County PUD White sturgeon mitigation. Anticipated release of second (sub-yearling) juvenile year-class into the Columbia River.

**References:**

Mr: Blain Parker. Columbia River Inter-Tribal Fish Commission.
White Sturgeon Project Manager. 503-731-1286

Mr. Keff Korth. Washington Department of Fish and Wildlife.
Region 2 Fisheries Program Manager. 509-754-4624

Mr. Tom Dresser. Grant County Public Utility District.
Fishery Program Manager. (509) 754-0500

Mr. Joe Miller. Chelan County Public Utility District.
Fishery Program Manager. (509) 663-8121

PROPOSAL FOR

# JUVENILE COLUMBIA RIVER WHITE STURGEON (ACIPENSER TRANSMONTANUS) FOR POPULATION SUPPLEMENTATION IN THE WELLS RESERVOIR, COLUMBIA RIVER, WASHINGTON (RFP #11-19-W)

November 30, 2011

Submitted By:

Colville Confederated Tribes, and
Golder Associates Ltd.

Contact: Jason McLellan, CCT
64A School House Loop Rd
Nespelem, WA 99155
Tel: (509) 209-2418
Fax: (509) 209-2421
e-mail: jason.mclellan@colvilletribes.com

Submitted To:

Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, WA 98802

## TABLE OF CONTENTS

## LIST OF TABLES



## LIST OF FIGURES

# SECTION 1 – TECHNICAL

## INTRODUCTION

A small population of white sturgeon *Acipenser transmontanus* inhabits Wells Reservoir on the Columbia River (Jerald 2007). While the catch was distributed over a wide range of lengths (60 – 210 cm FL), the low abundance in all size and age classes was suggestive of an absence of natural recruitment except in rare instances. Other populations of white sturgeon in the Columbia River basin have experienced similar reductions in abundance and lack of natural recruitment (Hildebrand et al., *in review*; UCWSRI 2002; Howell and McLellan 2011).

Natural resource managers have responded to the persistent lack of natural recruitment of white sturgeon in the upper Columbia (Washington and British Columbia) and Kootenai/Kootenay (Idaho, Montana, and British Columbia) rivers with conservation aquaculture programs (UCWSRI 2002). These programs were developed to preserve genetic diversity and restore population demographics, while concurrently investigating factors limiting natural production. These programs also included population monitoring/indexing and telemetry programs to evaluate the effectiveness of the aquaculture programs and investigate dispersal, seasonal movements, and seasonal habitat use of both hatchery and wild origin white sturgeon.

The Wells Hydroelectric Project White Sturgeon Management Plan goal and objectives are similar to those for the upper Columbia and Kootenai programs, particularly the use of aquaculture to supplement the population and evaluation of the supplementation program. The project proponents (Jason McLellan, Colville Confederated Tribes [CCT], and Larry Hildebrand, Golder Associates Ltd.[Golder]) played principal roles in the development and implementation of the Upper Columbia White Sturgeon Recovery Initiative's (UCWSRI) conservation aquaculture program and subsequent evaluation in Washington and British Columbia. Larry Hildebrand was the principal developer of the Grant County White Sturgeon Management Plan and also developed similar management programs for Chelan and Douglas Counties. The CCT and Golder are partnering to offer Public Utility District No. 1 of Douglas County (Douglas PUD) our extensive expertise with sturgeon supplementation to provide white sturgeon larvae for supplementation in the Wells Reservoir.

## PURPOSE

The purpose of this project is to fulfill requirements of the Aquatic Settlement Agreement (ASA) for the Wells Hydroelectric Project (FERC No. 2149). The ASA requires the implementation of the Wells White Sturgeon Management Plan (WSMP), which includes the Wells White Sturgeon Broodstock Collection and Breeding Plan (hereafter Breeding Plan).

## APPROACH

### *NATURALLY PRODUCED LARVAE*

Our approach to provide white sturgeon for supplementation in the Wells Reservoir is to deliver wild early larvae (up to 14 days post-hatch [dph]) captured from Wells Reservoir, Wanapum Reservoir, and the upper Columbia River (Lake Roosevelt) to the Wells Fish Hatchery for rearing. We are proposing that the Douglas PUD and the Wells Aquatic Settlement Working Group (ASWG) use naturally produced larvae as the source of fish for the supplementation program. This option, as opposed to the more traditional approach that involves collection of adult broodstock, has been proposed for the following reasons:

1. **Decreased broodstock selection.** Due to various factors, relatively small numbers of broodstock are typically collected and crossed under most sturgeon aquaculture programs. In addition, broodstock collection is often limited spatially and temporally, to the first ripe fish captured, and to the sizes of fish that recruit to the collection gear and can be safely handled by field and hatchery staff. Therefore, the largest and arguably the most fit adults may not be represented in an adult broodstock program. This "artificial" selection is eliminated using wild caught larvae that result from wild adult sturgeon that have selected their own mates, spawn timing, and spawning location. We propose to passively capture these wild larvae as they disperse to nursery habitats to begin exogenous feeding and rear them in a hatchery facility.
2. **Increased genetic diversity.** By utilizing larvae captured throughout the majority of the larval dispersal period (up to 1.5 months), the number of spawners represented would be substantially greater than could be achieved under a typical broodstock collection program. Presumably, including genetic input from graeter numbers of spawner will increase the amount of genetic diversity represented in the subsequent aquaculture program. In a study comparing the genetic diversity of lake sturgeon *Acipenser fulvescens* offspring derived from hatchery spawned adult broodstock to those from naturally produced eggs and larvae, the naturally produced offspring had the highest genetic diversity, lowest relatedness, and the greatest number of parents contributing (Crossman et al. 2011). The Breeding Plan calls for a partial factorial mating strategy with two 3x3 crosses, which will result in two sets of nine mated crosses of three females and three females (18 total crosses). In comparison, collections of wild larvae completed over the majority of the larval emergence period at three locations in the upper Columbia River, could theoretically represent dozens of mated crosses and contributing adults. This has important implications for the Wells Breeding Plan considering that to date, a single 3x3 cross has not been achieved in the middle Columbia sturgeon aquaculture efforts being conducted by the Grant and Chelan PUD's. Recently, the Washington component of the UCWSRI made a successful transition to the exclusive use of wild caught larvae as the source of fish for their conservation aquaculture needs. This program was conceived, designed, and implemented by members of the proposed team.
3. **Decreased stress on wild broodstock.** The sturgeon populations in the middle Columbia River reservoirs primarily consist of a small number of large, old adults. Handling can be very stressful for these fish and due to their low abundance it is desirable to limit handling.
4. **Increased likelihood of Wells Reservoir sturgeon contributing to the program.** As indicated in the Breeding Plan, it is unlikely that sufficient numbers of adult broodstock will be captured in Wells Reservoir due to their low abundance; however, female sturgeon are highly fecund (>100,000 eggs per female) and in all reservoirs where they are present, spawning and successful hatch have been recorded (Hildebrand et al., *in*

*review*). In our opinion, likelihood of capturing drifting larvae in Wells Reservoir are much greater than the likelihood of collecting sufficient numbers of local broodstock to achieve the target breeding matrix. In addition, the best possibility for locally adapted Wells origin sturgeon to contribute to the supplementation program is through the capture and rearing of naturally produced larvae.

5. **Allows for determination of natural reproduction potential in Wells Reservoir.** A secondary benefit of a larval collection program in Wells Reservoir is that it will allow for the evaluation of the natural reproduction potential in Wells Reservoir, which is consistent with Objective 3 and the Phase I Monitoring and Evaluation Program of the WSMP. Successful collection of larvae will confirm the occurrence and spatial and temporal characteristics of spawning in the Wells Reservoir.

The use of naturally produced larvae is becoming increasingly more common in sturgeon conservation aquaculture programs to address concerns about genetic conservation. The strategy has been used by several lake sturgeon aquaculture programs (Holtgren et al. 2007; Smith and Hobden 2011). Due to concerns about the genetic effects of the conservation aquaculture program, the Lake Roosevelt Sturgeon Recovery Project has shifted from a wild-caught adult broodstock based program to one that is solely comprised of naturally produced larvae. There were >10,000 larvae captured and transferred to the Sherman Creek Hatchery for rearing in eight nights of sampling in 2011 (WDFW, unpublished data). The survival rate to 4 months was approximately 35% (M. Combs, WDFW Sherman Creek Hatchery, personal communication). This is the first known use of wild-caught larvae for white sturgeon conservation aquaculture that we are aware of and it demonstrates the feasibility of this approach for other white sturgeon aquaculture programs.

### Origin

The first priority collection location is the Wells Reservoir, which is consistent with the WSMP and Breeding Plan. Due to the relatively low abundance of white sturgeon in the Wells Reservoir, it will likely be difficult to obtain enough larvae to provide for the release numbers of juveniles deemed acceptable by the ASWG. To supplement the collection efforts, we propose to capture white sturgeon larvae from the Wanapum Reservoir and the upper Columbia River (Lake Roosevelt).

Collection of larvae from the Wanapum Reservoir is also consistent with the WSMP and Breeding Plan. We selected Wanapum Reservoir because it has the greatest potential of the “middle” Columbia River reservoirs to produce relatively large numbers of larvae. Wanapum Reservoir possesses the largest population (n=551; 95% CI 314-1,460) of white sturgeon of any the reservoirs between Priest Rapids and Grand Coulee dams (Devore et al. 2000; Golder 2003a, 2003b). White sturgeon spawning has also been documented in Wanapum Reservoir in each year it was investigated (Golder 2003a). In fact, there were multiple spawning events detected in two of three years when monitoring was conducted, >2,300 eggs were captured, and experiments indicated that conditions were conducive for successful incubation. Collectively this information indicates the high potential for the collection of white sturgeon larvae in Wanapum Reservoir for use in supplementation programs. We are also submitting a concurrent proposal to conduct similar white sturgeon research in the Priest Rapids Project area for Grant County PUD. The proposal includes an experimental D-ring plankton net sample program to capture white sturgeon larvae, if we are awarded both contracts there will be an opportunity for cost sharing.

Despite the great potential, there is still some uncertainty as to the number of sturgeon larvae that can be successfully captured in Wanapum Reservoir. We also propose to collect white sturgeon larvae from the upper Columbia River in case the collection goals cannot be reached at the Wells and Wanapum collection sites. The upper Columbia sturgeon population is listed as a potential source of juveniles in both the WSMP and Breeding Plan albeit at a lower priority than the sources previously mentioned. The current scientific information indicates that upper Columbia River white sturgeon would be appropriate for supplementing the population in Wells Reservoir. The reason for the lower priority of the upper Columbia River fish was not explicitly stated in either the WSMP or Breeding Plan, but was likely due to management concerns related to their availability, impacts to the upper Columbia recovery effort, and potential impacts on downstream stocks if substantial entrainment occurs. Based on our experience working on the upper Columbia recovery effort, upper Columbia River white sturgeon larvae should be available and the capture of a few thousand (approximately 6,000) for the program in Wells Reservoir should not impact recovery efforts over the next two years. There is a high likelihood that some hatchery white sturgeon planted into the Wells Reservoir will leave the reservoir. Although not yet documented, Upper Columbia River sturgeon also have the opportunity to be entrained into downstream reservoirs which may be a concern for some managers. However, we suggest that having the entire cohort of white sturgeon in the Columbia River between Chief Joseph and Priest Rapids dams derived from a handful of parents (<6 in recent years) is a greater management and conservation concern than having some fish of upper Columbia origin within the middle Columbia River. In addition, recent genetic (nuclear DNA) analysis indicate that, generally speaking, upper and middle Columbia River white sturgeon are genetically more similar to each other than to those in the lower Columbia River (A. Schreier, UC Davis, geneticist, personal communication). Results of preliminary genetic analysis also indicated that there was genetic differentiation between the lower Columbia sturgeon population and those in the middle and upper, but more analysis was needed (Drauch Schrier et al. 2010). From a genetic perspective, there appears to be little risk in using white sturgeon from the upper Columbia to supplement Wells Reservoir. In fact, using upper Columbia sturgeon collected as larvae likely provides substantially better genetic benefits than the adult broodstock based program proposed to date.

There are several other benefits of collecting larvae from the upper Columbia to supplement the Wells Program. First, the Lake Roosevelt Sturgeon Recovery Project already collects sturgeon larvae for use in their conservation aquaculture program. By partnering with the Lake Roosevelt Project, we can supplement the collection efforts and ensure both programs achieve the target collection goals at lower costs for both programs. We have already discussed partnering on this effort with the Spokane Tribe of Indians, the lead on the Lake Roosevelt Sturgeon Recovery Project, and they have agreed to participate (D. Pavlik-Kunkel, Spokane Tribe of Indians, personal communication). An additional benefit is that there are a substantial number of wild larvae captured on an annual basis for use in the conservation aquaculture program, thus the probability of successfully capturing enough larvae for additional supplementation in Wells Reservoir is high. For example, in 2011 the Lake Roosevelt Sturgeon Recovery Project captured and transferred >10,000 sturgeon larvae to the Sherman Creek Hatchery for rearing in eight days of effort (WDFW, unpublished data). We believe that the Wells Fish Hatchery provides the best option for rearing white surgeon juveniles for supplementation of Wells Reservoir and our proposal has been developed as such. Nonetheless, a potential benefit of capturing naturally produced sturgeon larvae from the upper Columbia River is that at least some of the larvae could initially be transported to Sherman Creek Hatchery and raised until they have established exogenous feeding. Feed training is probably the most difficult part of sturgeon culture. By cost sharing with the Lake Roosevelt Project, we can take advantage of staff expertise at the Sherman Creek Hatchery, which have two years of experience feed training and rearing wild caught sturgeon larvae. Once the larvae have successfully made the conversion to exogenous foods they could be transferred to Wells Fish Hatchery for rearing to release size. In addition, feed training some larvae at Sherman Creek Hatchery, at least during the early years of the Wells Program will provide a failsafe. As previously indicated, our proposal assumes that all rearing will be conducted at Wells Fish Hatchery, so the feed training of larvae at Sherman Creek Hatchery would have to be negotiated separately.

### Collection Method

We will capture naturally produced white sturgeon early larvae at three separate locations: 1) Wells Reservoir, downstream of Chief Joseph Dam; 2) Wanapum Reservoir, downstream of Rock Island Dam; and 3) upper Columbia River (Lake Roosevelt), downstream of Northport, WA (Figure 1). We will sample 30 nights over a six week period, between July 1 and August 15, at Wells Reservoir. The level of effort is relatively large due to the fact that white sturgeon spawning in the middle and upper Columbia River occurs over at least a six to eight week period. We believe this level of effort is necessary to improve our understanding of how to sample this area in order to maximize efficiency in future years and is comparable to the level of effort completed during the initial larval sampling conducted on the upper Columbia River. We have allocated 20 nights of sampling at the Wanapum Reservoir location because it will be conducted concurrent with spawn monitoring per the Grant PUD sturgeon monitoring RFP. We will work cooperatively with whoever is conducting the Grant PUD work to identify when spawning occurs and then conduct targeted sampling for drifting larvae. The timing of larval drift following spawning is very predictable (Howell and McLellan, *in review*). We have allocated 10 nights of sampling to the upper Columbia location to augment their current program so that the Wells supplementation needs can also be accommodated. Our collection goal, assuming 35% survival, to achieve approximately 5,000 yearling juveniles for release in Wells Reservoir is 14,000 early larvae, with 6,000 coming from both Wanapum Reservoir and the upper Columbia River and 2,000 from Wells Reservoir. We will cease all collection activities once we achieve our total collection goal if it occurs prior to completing the allocated level of effort.

Drifting larvae will be captured using the same D-ring plankton net and mooring configuration utilized by the Lake Roosevelt Sturgeon Recovery Project (Figures 2 and 3). This D-ring plankton net system was developed by Jason McLellan (CCT) and Matt Howell (WDFW) specifically for unattended long duration sets to maximize capture rates and efficiency, as well as increase survival of captured larvae. The specific sites where D-rings will be fished will be selected after an initial reconnaissance. Ideal sites will have near-bottom water velocities of 0.25 to 0.5 m/s and relatively level bottom topography. We will fish six frames (12 nets) per location per night, beginning at dusk and continuing until dawn. The nets will be checked once every two hours to maximize larval survival. The nets will be affixed with flowmeters to allow for calculation of catch rate (number of larvae per volume of water filtered). All larvae will be sorted by size, tallied, and placed in 18.9 L (5 gallon) cylindrical insulated water coolers filled with river water. The water in the coolers will be partially replaced (approximately one quarter of the volume) every 15 minutes and dissolved oxygen levels will be monitored at 15 minute intervals using a handheld meter.

### Transportation and Delivery

At the completion of sampling in the morning, all captured larvae will be immediately delivered to the appropriate fish hatchery (Wells Fish Hatchery – Wells and Wanapum reservoirs; Sherman Creek Fish Hatchery – upper Columbia). The larvae will be transported in 18.9 L (5 gallon) cylindrical insulated water coolers. The water in the coolers will receive a complete exchange of river water prior to transport. During transport, the dissolved oxygen and temperature will be checked once every half hour. We will have additional coolers filled with river water for partial water exchanges during transport, as well as oxygen available if necessary. Larvae captured in the upper Columbia River will be held at Sherman Creek and delivered to Wells Hatchery once per week; however, the transfer interval could be modified based on how larvae respond to handling. For example, if handling mortality appears to be resulting in excessive mortality, we may deliver upper Columbia larvae to Wells Hatchery on a daily basis. Adjustments to the delivery and transport interval will be made in consultation with Wells Hatchery staff, Douglas PUD, and the Wells ASWG, as appropriate. Loading densities will be approximately 1,000 early larvae per transport vessel. Loading densities for later stage larvae (feed trained) will be 3.3 g $L^{-1}$ (M. Combs, WDFW Sherman Creek Hatchery, personal communication).

### Disease

Disease concerns have been raised in relation to the use of naturally produced sturgeon larvae in an aquaculture setting. The primary pathogens known to affect white sturgeon in aquaculture environments are white sturgeon iridovirus (WSIV) and white sturgeon herpesvirus (WSHV) (Watson et al. 1995; LaPatra et al. 1999). The WSIV is the pathogen of greatest concern for white sturgeon aquaculture due to its wide distribution (LaPatra et al. 1999). Although the risk of disease is a concern, there is an equal risk regardless of the fish source. There have been outbreaks of WSIV in cultured white sturgeon that originated from wild-caught parents, including from eggs that were treated with iodophor disinfectant (LaPatra et al. 1999; Drennan et al. 2006). Factors generally mediating WSIV outbreaks are rearing density, handling stress, and water source (LaPatra et al. 1999; Drennan et al. 2005). The incidence of WSIV appears to be greater at higher densities, when there is greater handling stress, and when the water source is river water. Wells Fish Hatchery, which uses river water for some of its production, would require the same considerations in husbandry and design to minimize the risk of a disease outbreak regardless of the source of the sturgeon being cultured. River water has been used successfully for rearing white sturgeon in both the Kootenai River and Lake Roosevelt programs, but the facilities in those areas are careful to maintain low densities and minimize handling. Columbia River water is routed through ultraviolet (UV) filters prior to entering the sturgeon rearing tanks at the Sherman Creek Hatchery. In addition, the Sherman Creek Hatchery uses periodic prophylactic salt treatments (1% concentration by weight) to reduce stress and prevent infection (M. Combs, WDFW Sherman Creek Hatchery, personal communication). The Sherman Creek Hatchery has avoided outbreaks of WSIV and WSHV while rearing naturally produced white sturgeon larvae on Columbia River water to date.

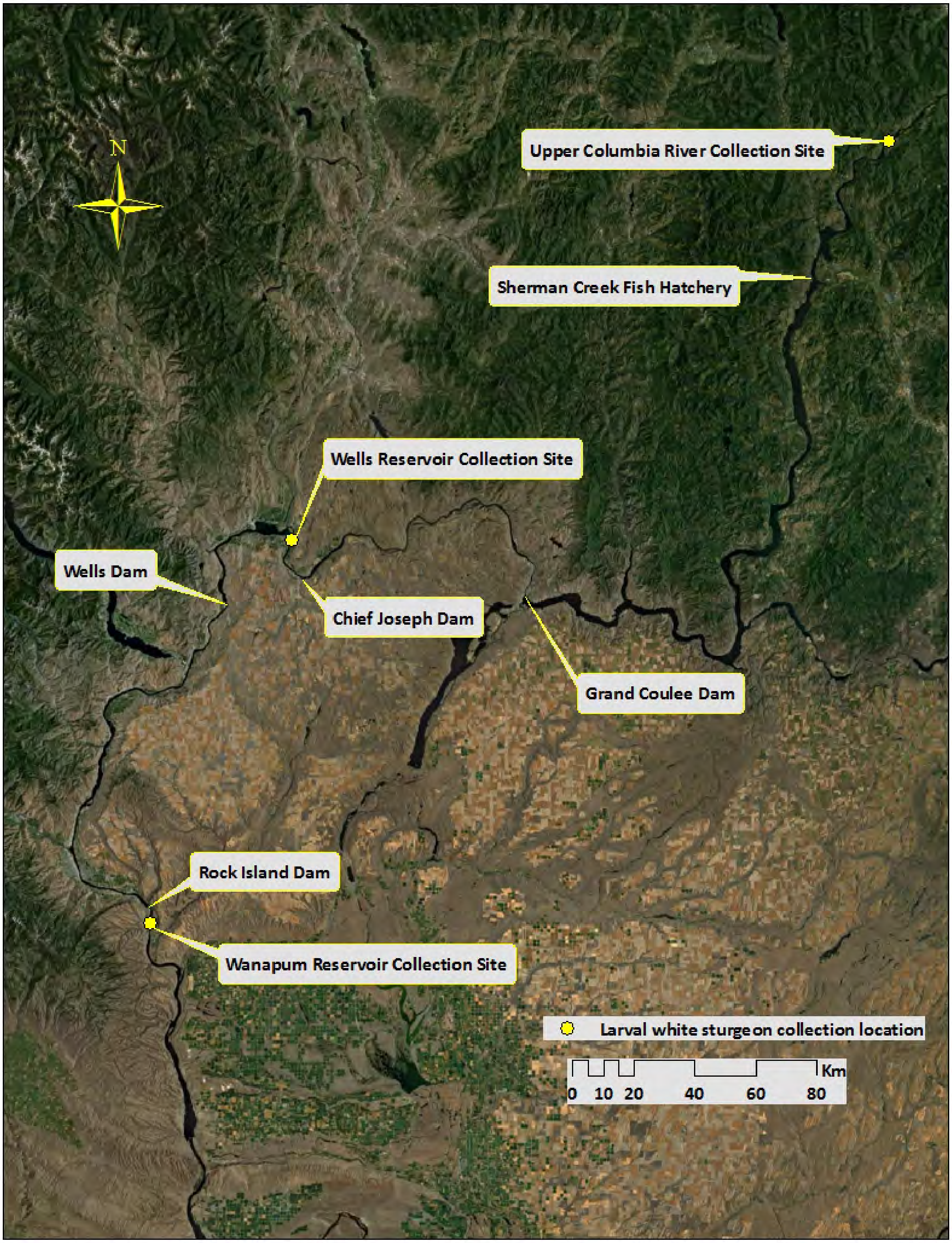



Figure 1. Map of proposed larval white sturgeon collection locations.

Figure 2. D-ring plankton nets and modified collection buckets. Photos from Howell and McLellan, *in review*.

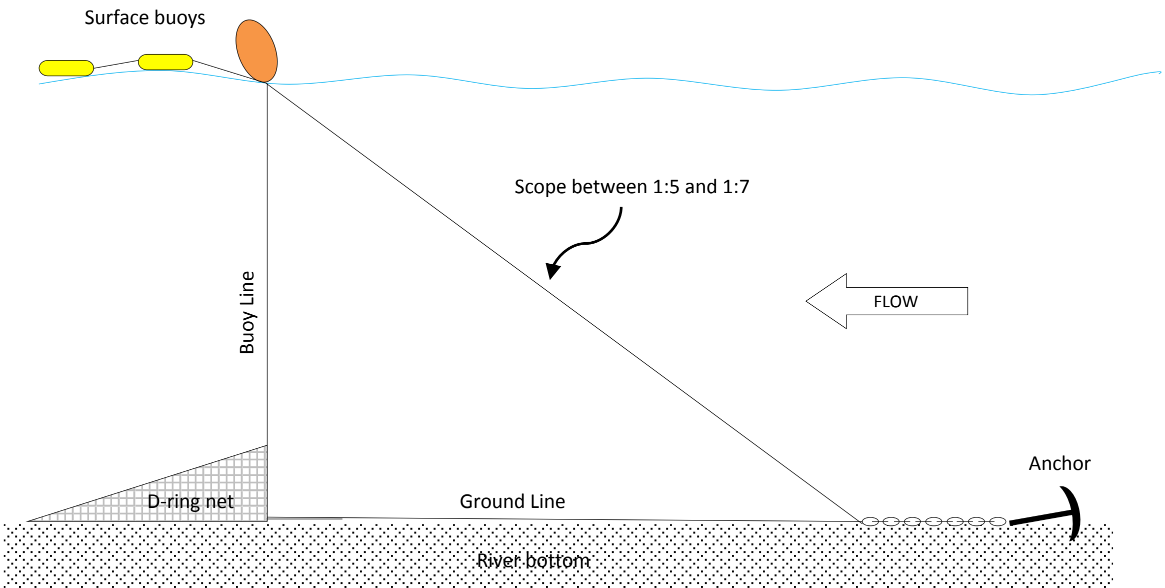



Figure 3. Mooring system used for extended deployments of D-ring plankton nets. Figure from Howell and McLellan, *in review*.

## EXPERIENCE

To deliver this project, CCT proposes an integrated team of specialists who have extensive white sturgeon monitoring experience, have previously worked for Douglas County, have direct experience in sturgeon management and recovery planning in the middle Columbia River (and the Project area), and have proven project management capabilities. The team will have the guidance of Mr. Larry Hildebrand as Project Director and Mr. Jason McLellan as Project Manager. Experience and proven track record of performance of the key project team is provided below. Curricula vitae of key personnel are provided in Appendix A.

### Larry Hildebrand, B.Sc., R.P. Bio. – Project Director, Senior Fisheries Biologist (Golder)

As project director, Larry's responsibilities will include input to project management and technical supervision, senior review of reports, oversight to ensure the study plan is meeting the objectives of the program, review of field data collected and data analysis results, and report writing, review, and editing. He will also provide input into the adaptive management aspects of the monitoring program based on past experience and his continued involvement in white sturgeon recovery programs throughout the Columbia River Basin. Larry will devote approximately 0.5% of his annual time to this project.

Larry is a Principal and senior owner within Golder with over 35 years of experience as a fisheries biologist. He has directed over 100 studies involving sturgeon since the late 1980s. Since 1990, Larry has directed annual studies related to all aspects of white sturgeon biology and ethology in the upper Columbia River in British Columbia. From 1995 to 1999, he directed studies in the lower Fraser River on white sturgeon spawning, recruitment, and population characteristics and from 1999 to 2003, developed and directed similar studies on white sturgeon in the middle Columbia River for the Public Utility Districts of Grant County and Chelan County. As a member of the Upper Columbia White Sturgeon Recovery Initiative, Larry co-authored the original draft of the white sturgeon population stabilization plan for the SARA listed white sturgeon population in the upper Columbia River basin and since that time has been actively involved in conducting research and monitoring programs related to the implementation of that plan. He has also drafted white sturgeon management plans for white sturgeon populations in the middle Columbia River for Grant, Chelan, and Douglas PUDs. These plans included the development of supplementation programs (using conservation aquaculture) to initiate the restoration and subsequent monitoring and evaluation programs that included fish capture, population assessments, and monitoring fish movements through tagging and sonic telemetry.

### Jason McLellan, M. Sc. – Project Manager, Senior Fisheries Biologist (CCT)

Jason will be the project manager for the Wells White Sturgeon Supplementation project. He will be the primary contact for all issues related to project contracting, study design, study implementation, coordination, analysis, and reporting. Jason will devote 2% of his annual time to this project.

Jason has more than 13 years in the Inland Northwest, with more than 12 of those years as the project manager on one or more fish research or monitoring projects. He recently accepted a Resident Fish Biologist position with the CCT, where he is responsible for managing Bonneville

Power Administration (BPA) resident fish research, monitoring, and evaluation projects related to redband trout, white sturgeon, and burbot. Jason is the CCT's technical lead for white sturgeon projects and is the Tribes representative on the UCWSRI Technical Working Group. Prior to his employment with the CCT, Jason was employed by the Washington Department of Fish and Wildlife (WDFW). He was the WDFW representative on the UCWSRI TWG from 2003 until his move to the CCT in June 2011. While at WDFW, Jason was responsible for managing and conducting research and monitoring projects focused on resident fish conservation and management in the upper Columbia River basin. Projects included the Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams (BPA Project No. 1997-004-00), Lake Roosevelt White Sturgeon Recovery (BPA Project No. 1995-027-00), Redband Trout Spawning and Fry Emergence Study: Abundance and Year-Class Strength (Avista Corp.), Middle Spokane River Baseline Fish Population Assessment (Avista Corp.), and the Upper Columbia River White Sturgeon Fine-Scale Movement and Habitat Study (Washington Department of Ecology). Jason managed all aspects of the projects listed above including development of proposals, scopes of work, budgets, study design, and coordination with collaborators.

Jason and his colleagues on the Lake Roosevelt Sturgeon Recovery project initiated the Lake Roosevelt white sturgeon conservation aquaculture program. The program started with fish and eggs provided from the Kootenay Sturgeon Hatchery in British Columbia in 2003, became self-sufficient in 2006 (collected and spawned own broodstock), and transitioned to naturally produced larvae in 2011 just prior to Jason's move to the CCT. Jason was principally involved in all aspects of the conservation aquaculture program, including the development of marking and tagging strategies, conducting marking and tagging, broodstock collection, spawning, developing release strategies (location, timing, numbers), adaptive management (breeding strategies, use of wild larvae), evaluation of release program success, and assisting with holding/rearing facility modifications.

### Paul Grutter, B.Sc., R.P.Bio. Fisheries Biologist (Golder)

Paul Grutter will be a Project Biologist for the Wells White Sturgeon Supplementation project. He will be responsible for coordinating and conducting field activities. Paul has worked as a project biologist for many studies and has been responsible for study design and implementation, data collection, QA/QC review, data analysis, and report writing. Paul is currently the Project Manager for the telemetry and population assessment studies of white sturgeon populations in the Priest Rapids Project area for Grant PUD. Paul will devote approximately 7% of his annual time to this project.

### Additional Staff

The CCT intends to hire a lead Fisheries Biologist with >5 years' experience in sturgeon research to coordinate and lead field studies and assist with permitting, analysis, and reporting on all of the CCT's sturgeon related projects. The CCT lead biologist will devote 4% of his annual time to this project and will direct the field sampling and assist with permitting and reporting. In the event that we do not find an adequate candidate, Jason McLellan will coordinate all of the field activities for the project.

The CCT and Golder also have several other biologists and technicians with extensive experience working with white sturgeon that will be available to participate on the project (CV's provided upon request). Due to the long-term nature of the project we cannot guarantee the consistency of all staff and we retain the right to substitute technical staff as needed but we would not substitute senior staff without prior discussions with Douglas PUD.

### QUALIFICATIONS

Staff from CCT and Golder Associates have designed, planned, implemented and reported on white sturgeon conservation aquaculture programs and supplementation evaluation programs in the upper Columbia River since their inception in both Washington (2003) and British Columbia (2001). From the information provided in the RFP, Wells WSMP, and Breeding Plan it is evident that the UCWSRI, the Kootenai River White Sturgeon Recovery program, and the Grant County WSMP were the foundation for the program being implemented by Douglas PUD in Wells Reservoir. All of these programs employ conservation aquaculture to supplement the limited natural recruitment of white sturgeon until such time as sufficient levels of natural recruitment can be achieved. These aquaculture and supplementation programs all require evaluation and the use of adaptive management based on the results of the monitoring programs. Our team's key role in all phases of the UCWSRI and the Grant County programs combined with our familiarity or involvement in all of the other white sturgeon research and recovery programs on the Columbia, Kootenay, and Fraser river systems make us uniquely suited to assist with the development and implementation of an analogous program in the Wells Reservoir. This experience will allow the rapid incorporation of any data developed from other sturgeon recovery programs into the present study. Based on past examples, this familiarity with other recovery programs has allowed members of the study team to help fast-track the recovery process in other areas and aided the development and implementation of scientifically defensible and cost-effective monitoring programs.

The CCT and Golder staffs have extensive experience capturing, measuring, tagging, and monitoring all life stages of white sturgeon in riverine and reservoir environments using a variety of sampling gears, including D-ring plankton nets designed to capture white sturgeon larvae. Jason McLellan was the former WDFW project leader on the Lake Roosevelt Sturgeon Recovery project and utilized D-ring plankton nets to study early life history of white sturgeon annually from 2005 through 2010. As previously described, Jason and his colleague, Matt Howell, designed a modified D-ring plankton net system that allowed for long duration, consistent sets with high survival of captured larvae. Golder conducted the early life history studies utilizing D-ring plankton nets in the BC reach of the upper Columbia River from 2007 to 2011.

Members of our team regularly present study results at professional meetings, workshops, and symposia. Team members have produced numerous primary journal articles, project completion reports, and technical reports as a result of research and monitoring conducted on projects similar to the one outlined in the RFP. A large number were reports of research and monitoring projects detailing the monitoring of juvenile white sturgeon released from of the Upper Columbia conservation aquaculture program.

## FACILITIES AND EQUIPMENT

The CCT will have 26'x8'6" and 27'x10' Almar landing craft boats that are customized for sturgeon research. They are equipped with specialized equipment for the rapid and safe deployment of sampling equipment, such as the large anchors and D-ring plankton nets and frames. The specialized equipment consists of a hydraulic pot hauler, davit arm, dive door, bow door, VHF marine radio, GPS, radar, and sonar.

Other field equipment that CCT will have available for the project include 4x4 pickup trucks, field computers, tools, safety equipment (radios, cell phones, Personal Protective Equipment, fire extinguishers, flares, and first aid kits. Golder also has a large inventory of river and lake boats and all of the specialized equipment required for sampling white sturgeon. This equipment would be available for use on the study program or as back-up.

Both CCT and Golder maintain data management and analysis tools that include work station computer systems interconnected through a local area network and the Internet. Staff are trained on a full range of software packages required for word processing, document production, data manipulation and compilation, statistical data analysis, scientific graphics, presentation, document distribution, digital mapping, and operating systems. Software available for this project will include (but not be limited to) SQL Server or MS Access, MS Office Suite, SigmaPlot 12, R, Systat, and ArcGIS.

### Safety Program

Both CCT and Golder have strict safety programs. The CCT abides by all Tribal Occupational Safety and Health Act (TOSHA) standards and regulations. Both CCT and Golder have exemplary safety records due to their high emphasis on staff training and safe work practices. If we are selected as the successful bidder, we will develop a detailed study specific safety plan and submit it to Douglas PUD for review and acceptance.

## STAFF AND RESOURCES

The CCT has an established Fish and Wildlife Department (FWD) with >100 staff. Qualified staff can be rotated between projects as needed. Project planning and development will be conducted to ensure that the obligations of all of our contracts are met. The CCT has offices, equipment storage, and technical staff based in Omak, WA, which is a short drive from the Wells project area. With project field staff based out of Omak, most work can be completed within a normal work day (8-10) hrs. Additional staff are based in Spokane, which is only a 2-2.5 hour drive from the Wanapum and upper Columbia River sampling locations. The PM will spend 2% of his annual time on the project. The lead biologist will spend 4% of his annual time on the project. Two field biologists will spend 8% and 12% of their annual time, respectively, on the project. The CCT Fish and Wildlife Department employs its own administration staff that includes purchasing, accounting, and contracting staff and has strict purchasing policies to ensure cost control. Work quality is maintained through Division Manager review of contract deliverables and annual employee performance evaluations.

Golder has access to staff and equipment resources from a variety of offices in southern BC (i.e., from Castlegar approximately 4 h travel time) and western Washington (Redmond approx 3h travel) to conduct the project. Present assignments of key staff on other projects will not affect our ability to meet our commitments to the present study program. Golder has stringent policies related to work quality and has project management and accounting systems in place for effective contract management and cost control. As defined in the previous section, the relatively small annual proportion of time our staff are required for this project can be easily accommodated within our present workload.

The CCT and Golder have a wealth of relevant experience in conducting white sturgeon sampling, assessment and monitoring projects. Through lessons learned over the years collaborating with other technical study teams in the area, advances in data collection and analysis, extensive local knowledge regarding logistics (boat launching/operation), and efficiencies developed to benefit schedule, budget, and health & safety, we are confident that we can successfully achieve the Project's objectives. The CCT and Golder have worked collaboratively on other white sturgeon projects in the past.

## TASKS AND DELIVERABLES

**Task 1. Obtain permits.** We will submit the necessary federal and state permit applications for the collection of white sturgeon from the Wells and Wanapum reservoirs and the upper Columbia River and to transport the fish to Wells Fish Hatchery.

**Deliverable:** Federal and state permits that will authorize the collection of white sturgeon larvae from the three proposed locations and the transport of the larvae to Wells Fish Hatchery.

**Task 2. Prepare sampling equipment.** We will acquire, construct, and prepare all equipment necessary for the capture of white sturgeon larvae from the Wells and Wanapum reservoirs and the upper Columbia River and to transport the fish to Wells Fish Hatchery.

**Deliverable:** Equipment necessary for the efficient and safe capture and transport of white sturgeon larvae.

**Task 3. Capture white sturgeon larvae and transport to Wells Fish Hatchery.** We will deploy D-ring plankton nets and associated moorings in the Wells Reservoir (downstream of Chief Joseph Dam), Wanapum Reservoir (downstream of Rock Island Dam), and upper Columbia River (downstream of Northport) and capture white sturgeon early larvae. After collection, larvae will be transported to the Wells Fish Hatchery for rearing.

**Deliverable:** White sturgeon early larvae delivered to the Wells Fish Hatchery. The collection goal is approximately 14,000 larvae, with 2,000 from Wells Reservoir, 6,000 from Wanapum Reservoir, and 6,000 from the upper Columbia River.

**Task 4. Reporting.** We will prepare an annual progress report for submission to Douglas PUD and complete all reporting as required to comply with the federal and state sampling and transport permits.

**Deliverable:** Annual progress report that includes a brief introduction, description of methods, results (number of larvae captured by location and delivered to Wells Fish Hatchery), conclusions, and a list of recommendations. Federal and state permit compliance.

## TIMELINE/SCHEDULE/DESCRIPTIONS

Table 1. Timeline, schedule, and description of activities for the collection of naturally produced white sturgeon early larvae and transport to Wells Fish Hatchery for supplementation of the Wells Reservoir. Assumes contract awarded by February 1, 2012.

| Timeframe | Description of Activity |
|---|---|
| **2012** | |
| February 1 – February 15 | Task 1 – Submit all permit applications to appropriate agencies. |
| February 1 – April 30 | Task 2 – Work with Douglas PUD to acquire all components necessary to construct D-ring plankton net systems and acquire transport vessels. |
| May 1 – May 31 | Task 2 – Construct D-ring plankton net systems and prepare sampling equipment. |
| June 1 – June 30 | Task 3 – Deploy D-ring plankton nets moorings at all three locations. |
| July 1 – August 15 | Task 3 – Conduct sampling with D-ring plankton nets to capture naturally produced white sturgeon early larvae and transport them to Wells Fish Hatchery. |
| August 16 – August 31 | Task 3 – Retrieve D-ring plankton nets moorings at all three locations. |
| September 1 – October 31 | Task 4 – Prepare and submit annual progress report and data to Douglas PUD. Prepare reports in compliance with all permits and submit to permitting agencies. |
| November 1 – December 15 | Task 1 – Submit all permit applications to appropriate agencies for sampling in 2013. |
| **2013** | |
| February 1 – April 30 | Task 2 – Work with Douglas PUD to acquire all components necessary to complete maintenance on D-ring plankton net systems. |
| May 1 – May 31 | Task 2 – Prepare D-ring plankton net systems and sampling equipment. |
| June 1 – June 30 | Task 3 – Deploy D-ring plankton nets moorings at all three locations. |
| July 1 – August 15 | Task 3 – Conduct sampling with D-ring plankton nets to capture naturally produced white sturgeon early larvae and transport them to Wells Fish Hatchery. |
| August 16 – August 31 | Task 3 – Retrieve D-ring plankton nets moorings at all three locations. |
| September 1 – October 31 | Task 4 – Prepare and submit annual progress report and data to Douglas PUD. Prepare reports in compliance with all permits and submit to permitting agencies. |

### REGULATORY COMPLIANCE

We are assuming that we will be working under Douglas PUD's Section 10(a)(1)(A) permit for scientific research for larval sturgeon collection using D-ring plankton nets in the Wells Reservoir, otherwise we will obtain a Section 10 permit. As previously mentioned, we are also submitting a proposal to Grant PUD that includes larval sturgeon collection using D-ring plankton nets in Wanapum Reservoir. If we are awarded both of these contracts, we will conduct the sampling in Wanapum under Grant PUD's Section 10(a)(1)(A) permit. In the event we do not receive the Grant PUD contract, we will obtain our own Section 10 permit. No Section 10 permits are required for sampling in Lake Roosevelt. The D-ring plankton net sampling poses virtually no risk to fish species listed under the Endangered Species Act that are within the proposed sampling areas. We are unaware of juvenile salmonids being captured in D-ring plankton net gear.

Larval sturgeon collection at all three locations will require a Scientific Collection Permit issued by the Washington Department of Fish and Wildlife (WDFW) that we will obtain. In addition, the transport of sturgeon larvae will require a WDFW Fish Transport Permit, which we will also obtain.

We will comply with all permit requirements, including reporting.

## SECTION 2 – COST

### FINANCIAL RESPONSIBILITY/SOUNDNESS

The CCT will serve as the lead consultant and will partner with sub-consultant Golder Associates Ltd.

#### Colville Confederated Tribes

The CCT will be the prime consultant for this project, with direct responsibility to Douglas County. The CCT will be responsible for overall project coordination, management, and communication.

The CCT has elected to include Golder as a sub-consultant to augment our experience and capacity in white sturgeon collection in the Wanapum Reservoir Project area and provide continuity among white sturgeon recovery programs in the Columbia River Basin.

#### Golder Associates Ltd.

Golder Associates is an international group of consulting companies specializing in ground engineering and environmental services. Employee-owned since our formation in 1960, we have experienced steady growth, now employing nearly 7,000 people who operate from more than 160 offices located throughout Africa, Asia, Australasia, Europe, North and South America. Our Canadian operations, Golder Associates Ltd., have more than 2,800 employees in over 30 offices. Our BC and Washington offices work collaboratively and collectively, sharing resources and expertise. Our team has the technical, financial, and project management capabilities necessary to assist in the delivery of this project.

## LINE ITEM BUDGET

Below is the CCT projected line item budget, including contract total cost, broken down by task (Table 2), followed by the Golder line item budget (Table 3). Additional budget detail is provided in Appendix B. The proposed budget assumes that Douglas PUD will: 1) obtain the Federal sampling permits for Wells Reservoir, 2) supply the D-ring plankton net system (frames, nets, flowmeters, and moorings) for sampling in Wells and Wanapum reservoirs (6 per location; approximately $2,000 each system), 3) supply the 18.9 L (5 gallon) transport vessels (5 per location; approximately $40 each), and 4) all rearing will be conducted at Wells Fish Hatchery. If it is determined that the Douglas PUD would prefer to have a portion of the upper Columbia River larvae feed trained at Sherman Creek Hatchery, the associated costs will be negotiated at that time.

Table 2. Colville Tribes line item budget with subcontractor and grand totals.

| | | | Task 1 | | Task 2 | | Task 3 | | Task 4 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Personnel** | units | cost | units | cost | units | cost | units | cost | units | cost | units | cost |
| Jason McLellan, Project Manager | $58 | hr | 16 | $928 | 8 | $464 | 48 | $2,784 | 16 | $928 | 88 | $5,104 |
| Fish Biologist III, Lead Biologist | $50 | hr | 16 | $800 | 16 | $800 | 96 | $4,800 | 48 | $2,400 | 176 | $8,800 |
| Fish Biologist I | $36 | hr | 0 | $0 | 24 | $864 | 480 | $17,280 | 0 | $0 | 504 | $18,144 |
| Fish Biologist I | $36 | hr | 0 | $0 | 24 | $864 | 320 | $11,520 | 0 | $0 | 344 | $12,384 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 24 | $864 | 480 | $17,280 | 0 | $0 | 504 | $18,144 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 24 | $864 | 480 | $17,280 | 0 | $0 | 504 | $18,144 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 24 | $864 | 320 | $11,520 | 0 | $0 | 344 | $12,384 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 24 | $864 | 320 | $11,520 | 0 | $0 | 344 | $12,384 |
| **Travel** | | | | | | | | | | | | |
| Mileage | $0.54 | mile | 0 | $0 | 400 | $216 | 20,560 | $11,102 | 0 | $0 | 20,960 | $11,318 |
| Lodging (field work) | $79 | night | 0 | $0 | 0 | $0 | 16 | $1,264 | 0 | $0 | 16 | $1,264 |
| Lodging (RV site - field work) | $45 | night | 0 | $0 | 0 | $0 | 16 | $720 | 0 | $0 | 16 | $720 |
| Per diem (field work) | $47 | day | 0 | $0 | 0 | $0 | 48 | $2,256 | 0 | $0 | 48 | $2,256 |
| **Supplies/Equipment** | | | | | | | | | | | | |
| Misc. office supplies | | | | $50 | | $0 | | $0 | | $50 | | $100 |
| Misc. field equipment | | | | $0 | | $200 | | $1,200 | | $0 | | $1,400 |
| Permits | | | | $234 | | $0 | | $0 | | $0 | | $234 |
| **Rental Fees** | | | | | | | | | | | | |
| RV rental | $100 | day | 0 | $0 | 0 | $0 | 20 | $2,000 | 0 | $0 | 20 | $2,000 |
| Boat/trailer O&M (fuel, oil, maint.) | $209 | day | 0 | $0 | 0 | $0 | 100 | $20,900 | 0 | $0 | 100 | $20,900 |
| Subtotal | | | | $2,012 | | $6,864 | | $133,426 | | $3,378 | | $145,680 |
| Admin.Expenses (21.41% Personnel) | | | | $370 | | $1,381 | | $20,122 | | $713 | | $22,585 |
| **Total** (Subtotal+Administrative) | | | | **$2,382** | | **$8,245** | | **$153,548** | | **$4,091** | | **$168,265** |
| | | | | | | | | | | | | |
| **Subcontracts** | | | | | | | | | | | | |
| Golder Associates Ltd | | | | $2,228 | | $4,592 | | $93,100 | | $3,988 | | $103,988 |
| | | | | | | | | | | | | |
| **Grand Total** | | | | **$4,610** | | **$12,837** | | **$246,648** | | **$8,079** | | **$272,173** |

Table 3. Golder Associates Ltd. line item budget.

| Personnel | units | cost | Task 1 units | Task 1 cost | Task 2 units | Task 2 cost | Task 3 units | Task 3 cost | Task 4 units | Task 4 cost | Total units | Total cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Larry Hildebrand, Project Director C7 | $197 | hr | 4 | $788 | 4 | $788 | 8 | $1,576 | 8 | $1,576 | 24 | $4,728 |
| Paul Grutter, Fish Biologist C3 | $109 | hr | 8 | $872 | 16 | $1,744 | 248 | $27,032 | 16 | $1,744 | 288 | $31,392 |
| Fisheries Technician T3 | $87 | hr | 0 | $0 | 16 | $1,392 | 240 | $20,880 | 0 | $0 | 256 | $22,272 |
| Fisheries Technician T3 | $87 | hr | 0 | $0 | 0 | $0 | 240 | $20,880 | 0 | $0 | 240 | $20,880 |
| Administrative Assistant B3 | $71 | hr | 8 | $568 | 8 | $568 | 0 | $0 | 8 | $568 | 24 | $1,704 |
| **Travel** | | | | | | | | | | | | |
| Mileage | $0.54 | mile | 0 | $0 | 0 | $0 | 6,000 | $3,240 | 0 | $0 | 6,000 | $3,240 |
| Lodging (field work) | $76 | night | 0 | $0 | 0 | $0 | 66 | $5,016 | 0 | $0 | 66 | $5,016 |
| Per diem (field work) | $46 | day | 0 | $0 | 0 | $0 | 66 | $3,036 | 0 | $0 | 66 | $3,036 |
| **Supplies/Equipment** | | | | | | | | | | | | |
| Misc. office supplies | | | | $0 | | $100 | | $0 | | $100 | | $200 |
| Misc. field equipment | | | | $0 | | $0 | | $1,300 | | $0 | | $1,300 |
| TN Visa fee | | | | $0 | | $0 | | $840 | | $0 | | $840 |
| **Rental Fees** | | | | | | | | | | | | |
| Field equipment rentals | | | | $0 | | $0 | | $1,900 | | $0 | | $1,900 |
| Truck rental | $50 | day | 0 | $0 | 0 | $0 | 24 | $1,200 | 0 | $0 | 24 | $1,200 |
| Boat/trailer O&M (fuel, oil, maint.) | $310 | day | 0 | $0 | 0 | $0 | 20 | $6,200 | 0 | $0 | 20 | $6,200 |
| **Total** | | | | **$2,228** | | **$4,592** | | **$93,100** | | **$3,988** | | **$103,908** |

## LITERATURE CITED

Beamesderfer, R. and C. Justice. 2008. Sturgeon hatchery release targets. Unpublished report to the Upper Columbia White Sturgeon Recovery Initiative Technical Working Group. Cramer Fish Sciences, Portland, OR.

Crossman, J.A., K.T. Scribner, D.T. Yen, C.A. Davis, P.S. Forsythe, and E.A. Baker. 2011. Gamete and larval collection methods and hatchery rearing environments affect levels of genetic diversity in early life stages of lake sturgeon (*Acipenser fulvescens*). Aquaculture 310:312-324.

DeVore, J.D., B.W. James, D.R. Gilliland, and B.J. Cady. 2000. Report B. Evaluate the success of developing and implementing a management plan for white sturgeon in reservoirs between Bonneville and McNary dams in enhancing production and Describe the life history and population dynamics of subadult and adult white sturgeon upstream of McNary Dam and downstream from Bonneville Dam. Pages 41 to 74 in D. L. Ward, editor. White sturgeon mitigation and restoration in the Columbia and Snake rivers upstream from Bonneville Dam. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 198605000. Contract No. DE-AI79-86BP63584.

Drauch Schreier, A., B. Mahardja, and B. May. 2010. Investigation of white sturgeon population structure in the Transboundary Reach of the Columbia River using polysomic microsatellite markers. Unpublished technical report to the Spokane Tribe of Indians, Wellpinit, WA.

Drennan, J.D., S. Ireland, S.E. LaPatra, L. Grabowski, T.K. Carrothers, and K.D. Cain. 2005. High-density rearing of white sturgeon *Acipenser transmontanus* (Richardson) induces white sturgeon iridovirus disease among asymptomatic carriers. Aquaculture Research 36:824-827.

Drennan, J.D., S.E. LaPatra, J.T. Siple, S. Ireland, and K.D. Cain. 2006. Transmission of white sturgeon iridovirus in Kootenai River white sturgeon *Acipenser transmontanus*. Diseases of Aquatic Organisms 70:37-45.

Golder Associates Ltd. 2003a. White sturgeon investigations in Priest Rapids and Wanapum reservoirs on the Middle Columbia River, Washington, U.S.A. Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington. Golder Associates Ltd. Report No. 002-8817F.

Golder Associates Ltd. 2003b. Rocky Reach white sturgeon investigations 2002 study results. Report prepared for Public Utility District No. 1of Chelan County, Wenatchee, WA.

Hildebrand, L.R., A. Drauch-Schrier, K. Lepla, S. McAdam, J. McLellan, M.J. Parsley, V.L. Paragamian. *In review*. Current knowledge of White Sturgeon (*Acipenser* *transmontanus*) life history, status, threats to survival, and prognosis for the future. Paper submitted to the Journal of Applied Ichthyology.

Holtgren, J.M., S.A. Ogren, A.J. Paquet, and S. Fajfer. 2007. Design of a portable streamside rearing facility for lake sturgeon. North American Journal of Aquaculture 69:317-323.

Howell, M. D., and J. G. McLellan. 2011. Lake Roosevelt white sturgeon recovery project. Annual Progress Report (2007) to Bonneville Power Administration, Portland, Oregon. Project No. 199502700. BPA Document No. P122055.

Howell, M. D., and J. G. McLellan. *In review*. Lake Roosevelt white sturgeon recovery project. Annual Progress Report (2008) to Bonneville Power Administration, Portland, Oregon. Project No. 199502700.

Jerald, T. 2007. White sturgeon (Acipenser transmontanus) population assessment in Wells Reservoir. M.S. Thesis. Central Washington University, Ellensburg, WA.

LaPatra, S.E., S.C. Ireland, J.M. Groff, K.M. Clemens, and J.T. Siple. 1999. Adaptive disease management strategies for the endangered population of Kootenai River white sturgeon. Fisheries 24:6-13.

Porto, L. and L. Hildebrand. 2001. White Sturgeon Studies In The Rocky Reach Project Area On The Columbia River, Washington, U.S.A. 2001 Investigations. Report prepared for Public Utility District No. 1 of Chelan County, Wenatchee, Washington. R.L. & L. Report No. 957F: 52 p. + 2 app.

Smith, A.L. and D. Hobden. 2011. A synopsis of lake sturgeon (*Acipenser fulvescens*) culture, marking, and stocking techniques. Biodiversity Branch. Ontario Ministry of Natural Resources. Peterborough, Ontario.

UCWSRI. 2002. Upper Columbia River white sturgeon recovery plan, November 28, 2002. Upper Columbia White Sturgeon Recovery Initiative. http://uppercolumbiasturgeon.org/RecoveryEfforts/Recovery.html.

Watson, L.R., S.C. Yun, J.M. Groff, R.P. Hedrick. 1995. Characteristics and pathogenicity of a novel herpesvirus isolated from adult and subadult white sturgeon *Acipenser transmontanus*. Diseases of Aquatic Organisms 22:199-210.

## SIGNATURE PAGE

<table>
<tr><td colspan="3">Proposer Company Name: Colville Confederated Tribes</td></tr>
<tr><td colspan="3">Address: 64A School House Loop Rd, Nespelem, WA 99155</td></tr>
<tr><td colspan="2">Person Signing RFP (Print): Jason McLellan</td><td>Title: Resident Fish Habitat Sub-Division Lead</td></tr>
<tr><td colspan="3">Signature:</td></tr>
<tr><td>Telephone: (509) 209-2418</td><td>Fax: (509) 209-2421</td><td>Email: jason.mclellan@colvilletribes.com</td></tr>
</table>

# APPENDIX A

Curricula Vitae

# APPENDIX B

Additional Budget Detail

Table B-1. The CCT line item budget for Task 1 – permitting.

| Personnel | cost/unit | units | 2012 units | 2012 cost | 2013 units | 2013 cost | Total units | Total cost |
|---|---|---|---|---|---|---|---|---|
| Jason McLellan, Project Manager | $58 | hr | 8 | $464 | 8 | $464 | 16 | $928 |
| Fish Biologist III, Lead Biologist | $50 | hr | 8 | $400 | 8 | $400 | 16 | $800 |
| Fish Biologist I | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fish Biologist I | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (field work) | $79 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (RV site - field work) | $45 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Per diem (field work) | $47 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $25 | | $25 | | $50 |
| Misc. field equipment | | | | $0 | | $0 | | $0 |
| Permits | | | | $117 | | $117 | | $234 |
| **Rental Fees** | | | | | | | | |
| RV rental | $100 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Boat/trailer O&M (fuel, oil, maint.) | $209 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Subtotal | | | | $1,006 | | $1,006 | | $2,012 |
| Admin.Expenses (21.41% Personnel) | | | | $185 | | $185 | | $370 |
| **Total** (Subtotal+Administrative) | | | | **$1,191** | | **$1,191** | | **$2,382** |

Table B-2. The CCT line item budget for Task 2 – sampling equipment construction and preparation.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | cost/unit | unit | units | cost | units | cost | units | cost |
| Jason McLellan, Project Manager | $58 | hr | 4 | $232 | 4 | $232 | 8 | $464 |
| Fish Biologist III, Lead Biologist | $50 | hr | 8 | $400 | 8 | $400 | 16 | $800 |
| Fish Biologist I | $36 | hr | 16 | $576 | 8 | $288 | 24 | $864 |
| Fish Biologist I | $36 | hr | 16 | $576 | 8 | $288 | 24 | $864 |
| Fisheries Technician IV | $36 | hr | 16 | $576 | 8 | $288 | 24 | $864 |
| Fisheries Technician IV | $36 | hr | 16 | $576 | 8 | $288 | 24 | $864 |
| Fisheries Technician IV | $36 | hr | 16 | $576 | 8 | $288 | 24 | $864 |
| Fisheries Technician IV | $36 | hr | 16 | $576 | 8 | $288 | 24 | $864 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 200 | $108 | 200 | $108 | 400 | $216 |
| Lodging (2 people - field work) | $47 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (RV site - field work) | $45 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Per diem (2 people- field work) | $0 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $0 | | $0 | | $0 |
| Misc. field equipment | | | | $100 | | $100 | | $200 |
| Permits | | | | $0 | | $0 | | $0 |
| **Rental Fees** | | | | | | | | |
| RV rental | $100 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Boat/trailer O&M (fuel, oil, maint.) | $209 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Subtotal | | | | $4,296 | | $2,568 | | $6,864 |
| Admin.Expenses (21.41% Personnel) | | | | $875 | | $505 | | $1,381 |
| **Total** (Subtotal+Administrative) | | | | **$5,171** | | **$3,073** | | **$8,245** |

Table B-3. The CCT line item budget for Task 3 – collection and transport of naturally produced white sturgeon early larvae from Wells Reservoir.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | cost/unit | unit | units | cost | units | cost | units | cost |
| Jason McLellan, Project Manager | $58 | hr | 8 | $464 | 8 | $464 | 16 | $928 |
| Fish Biologist III, Lead Biologist | $50 | hr | 16 | $800 | 16 | $800 | 32 | $1,600 |
| Fish Biologist I | $36 | hr | 240 | $8,640 | 240 | $8,640 | 480 | $17,280 |
| Fish Biologist I | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 240 | $8,640 | 240 | $8,640 | 480 | $17,280 |
| Fisheries Technician IV | $36 | hr | 240 | $8,640 | 240 | $8,640 | 480 | $17,280 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 3,840 | $2,074 | 3,840 | $2,074 | 7,680 | $4,147 |
| Lodging (2 people - field work) | $79 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (RV site - field work) | $45 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Per diem (2 people- field work) | $47 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $0 | | $0 | | $0 |
| Misc. field equipment | | | | $200 | | $200 | | $400 |
| Permits | | | | $0 | | $0 | | $0 |
| **Rental Fees** | | | | | | | | |
| RV rental | $100 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Boat/trailer O&M (fuel, oil, maint.) | $209 | day | 30 | $6,270 | 30 | $6,270 | 60 | $12,540 |
| Subtotal | | | | $35,728 | | $35,728 | | $71,455 |
| Admin.Expenses (21.41% Personnel) | | | | $5,820 | | $5,820 | | $11,640 |
| **Total** (Subtotal+Administrative) | | | | **$41,548** | | **$41,548** | | **$83,095** |

Table B-4. The CCT line item budget for Task 3 – collection and transport of naturally produced white sturgeon early larvae from Wanapum Reservoir.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | cost/unit | unit | units | cost | units | cost | units | cost |
| Jason McLellan, Project Manager | $58 | hr | 8 | $464 | 8 | $464 | 16 | $928 |
| Fish Biologist III, Lead Biologist | $50 | hr | 16 | $800 | 16 | $800 | 32 | $1,600 |
| Fish Biologist I | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fish Biologist I | $36 | hr | 80 | $2,880 | 80 | $2,880 | 160 | $5,760 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 80 | $2,880 | 80 | $2,880 | 160 | $5,760 |
| Fisheries Technician IV | $36 | hr | 80 | $2,880 | 80 | $2,880 | 160 | $5,760 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 3,900 | $2,106 | 3,900 | $2,106 | 7,800 | $4,212 |
| Lodging (2 people - field work) | $79 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (RV site - field work) | $45 | night | 8 | $360 | 8 | $360 | 16 | $720 |
| Per diem (2 people- field work) | $47 | day | 10 | $470 | 10 | $470 | 20 | $940 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $0 | | $0 | | $0 |
| Misc. field equipment | | | | $200 | | $200 | | $400 |
| Permits | | | | $0 | | $0 | | $0 |
| **Rental Fees** | | | | | | | | |
| RV rental | $100 | day | 10 | $1,000 | 10 | $1,000 | 20 | $2,000 |
| Boat/trailer O&M (fuel, oil, maint.) | $209 | day | 10 | $2,090 | 10 | $2,090 | 20 | $4,180 |
| Subtotal | | | | $16,130 | | $16,130 | | $32,260 |
| Admin.Expenses (21.41% Personnel) | | | | $2,120 | | $2,120 | | $4,241 |
| **Total** (Subtotal+Administrative) | | | | **$18,250** | | **$18,250** | | **$36,501** |

Table B-5. The CCT line item budget for Task 3 – collection and transport of naturally produced white sturgeon early larvae from the upper Columbia River.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | cost/unit | unit | units | cost | units | cost | units | cost |
| Jason McLellan, Project Manager | $58 | hr | 8 | $464 | 8 | $464 | 16 | $928 |
| Fish Biologist III, Lead Biologist | $50 | hr | 16 | $800 | 16 | $800 | 32 | $1,600 |
| Fish Biologist I | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fish Biologist I | $36 | hr | 80 | $2,880 | 80 | $2,880 | 160 | $5,760 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 80 | $2,880 | 80 | $2,880 | 160 | $5,760 |
| Fisheries Technician IV | $36 | hr | 80 | $2,880 | 80 | $2,880 | 160 | $5,760 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 2,540 | $1,372 | 2,540 | $1,372 | 5,080 | $2,743 |
| Lodging (2 people - field work) | $79 | night | 8 | $632 | 8 | $632 | 16 | $1,264 |
| Lodging (RV site - field work) | $45 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Per diem (2 people- field work) | $47 | day | 10 | $470 | 18 | $846 | 28 | $1,316 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $0 | | $0 | | $0 |
| Misc. field equipment | | | | $200 | | $200 | | $400 |
| Permits | | | | $0 | | $0 | | $0 |
| **Rental Fees** | | | | | | | | |
| RV rental | $100 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Boat/trailer O&M (fuel, oil, maint.) | $209 | day | 10 | $2,090 | 10 | $2,090 | 20 | $4,180 |
| Subtotal | | | | $14,668 | | $15,044 | | $29,711 |
| Admin.Expenses (21.41% Personnel) | | | | $2,120 | | $2,120 | | $4,241 |
| **Total** (Subtotal+Administrative) | | | | **$16,788** | | **$17,164** | | **$33,952** |

Table B-6. The CCT line item budget for Task 4 – reporting.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | cost/unit | unit | units | cost | units | cost | units | cost |
| Jason McLellan, Project Manager | $58 | hr | 8 | $464 | 8 | $464 | 16 | $928 |
| Fish Biologist III, Lead Biologist | $50 | hr | 24 | $1,200 | 24 | $1,200 | 48 | $2,400 |
| Fish Biologist I | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fish Biologist I | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician IV | $36 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (2 people - field work) | $79 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (RV site - field work) | $45 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Per diem (2 people- field work) | $47 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $25 | | $25 | | $50 |
| Misc. field equipment | | | | $0 | | $0 | | $0 |
| Permits | | | | $0 | | $0 | | $0 |
| **Rental Fees** | | | | | | | | |
| RV rental | $100 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Boat/trailer O&M (fuel, oil, maint.) | $209 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Subtotal | | | | $1,689 | | $1,689 | | $3,378 |
| Admin.Expenses (21.41% Personnel) | | | | $356 | | $356 | | $713 |
| **Total** (Subtotal+Administrative) | | | | **$2,045** | | **$2,045** | | **$4,091** |

Table B-7. The Golder line item budget for Task 1 – permitting.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | units | cost | units | cost | units | cost | units | cost |
| Larry Hildebrand, Project Director C7 | $197 | hr | 2 | $394 | 2 | $394 | 4 | $788 |
| Paul Grutter, Fish Biologist C3 | $109 | hr | 4 | $436 | 4 | $436 | 8 | $872 |
| Fisheries Technician T3 | $87 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician T3 | $87 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Administrative Assistant B3 | $71 | hr | 4 | $284 | 4 | $284 | 8 | $568 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (field work) | $76 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Per diem (field work) | $46 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $0 | | $0 | | $0 |
| Misc. field equipment | | | | $0 | | $0 | | $0 |
| TN Visa fee | | | | $0 | | $0 | | $0 |
| **Rental Fees** | | | | | | | | $0 |
| Field equipment rentals | | | | $0 | | $0 | | $0 |
| Truck rental | $50 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Boat/trailer O&M (fuel, oil, maint.) | $310 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Total** | | | | **$1,114** | | **$1,114** | | **$2,228** |

Table B-8. The Golder line item budget for Task 2 – sampling equipment construction and preparation.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | units | cost | units | cost | units | cost | units | cost |
| Larry Hildebrand, Project Director C7 | $197 | hr | 2 | $394 | 2 | $394 | 4 | $788 |
| Paul Grutter, Fish Biologist C3 | $109 | hr | 8 | $872 | 8 | $872 | 16 | $1,744 |
| Fisheries Technician T3 | $87 | hr | 8 | $696 | 8 | $696 | 16 | $1,392 |
| Fisheries Technician T3 | $87 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Administrative Assistant B3 | $71 | hr | 4 | $284 | 4 | $284 | 8 | $568 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (field work) | $76 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Per diem (field work) | $46 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $50 | | $50 | | $100 |
| Misc. field equipment | | | | $0 | | $0 | | $0 |
| TN Visa fee | | | | $0 | | $0 | | $0 |
| **Rental Fees** | | | | | | | | $0 |
| Field equipment rentals | | | | $0 | | $0 | | $0 |
| Truck rental | $50 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Boat/trailer O&M (fuel, oil, maint.) | $310 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Total** | | | | **$2,296** | | **$2,296** | | **$4,592** |

Table B-9. The Golder line item budget for Task 3 – collection and transport of naturally produced white sturgeon early larvae from Wanapum Reservoir.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | units | cost | units | cost | units | cost | units | cost |
| Larry Hildebrand, Project Director C7 | $197 | hr | 4 | $788 | 4 | $788 | 8 | $1,576 |
| Paul Grutter, Fish Biologist C3 | $109 | hr | 124 | $13,516 | 124 | $13,516 | 248 | $27,032 |
| Fisheries Technician T3 | $87 | hr | 120 | $10,440 | 120 | $10,440 | 240 | $20,880 |
| Fisheries Technician T3 | $87 | hr | 120 | $10,440 | 120 | $10,440 | 240 | $20,880 |
| Administrative Assistant B3 | $71 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 3,000 | $1,620 | 3,000 | $1,620 | 6,000 | $3,240 |
| Lodging (field work) | $76 | night | 33 | $2,508 | 33 | $2,508 | 66 | $5,016 |
| Per diem (field work) | $46 | day | 33 | $1,518 | 33 | $1,518 | 66 | $3,036 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $0 | | $0 | | $0 |
| Misc. field equipment | | | | $650 | | $650 | | $1,300 |
| TN Visa fee | | | | $420 | | $420 | | $840 |
| **Rental Fees** | | | | | | | | |
| Field equipment rentals | | | | $950 | | $950 | | $1,900 |
| Truck rental | $50 | day | 12 | $600 | 12 | $600 | 24 | $1,200 |
| Boat/trailer O&M (fuel, oil, maint.) | $310 | day | 10 | $3,100 | 10 | $3,100 | 20 | $6,200 |
| **Total** | | | | **$46,550** | | **$46,550** | | **$93,100** |

Table B-6. The Golder line item budget for Task 4 – reporting.

| | | | 2012 | | 2013 | | Total | |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | units | cost | units | cost | units | cost | units | cost |
| Larry Hildebrand, Project Director | $197 | hr | 4 | $788 | 4 | $788 | 8 | $1,576 |
| Fish Biologist III, Field Biologist | $109 | hr | 8 | $872 | 8 | $872 | 16 | $1,744 |
| Fisheries Technician III | $87 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Fisheries Technician III | $87 | hr | 0 | $0 | 0 | $0 | 0 | $0 |
| Aministration Assistant | $71 | hr | 4 | $284 | 4 | $284 | 8 | $568 |
| **Travel** | | | | | | | | |
| Mileage | $0.54 | mile | 0 | $0 | 0 | $0 | 0 | $0 |
| Lodging (field work) | $76 | night | 0 | $0 | 0 | $0 | 0 | $0 |
| Per diem (field work) | $46 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Supplies/Equipment** | | | | | | | | |
| Misc. office supplies | | | | $50 | | $50 | | $100 |
| Misc. field equipment | | | | $0 | | $0 | | $0 |
| TN Visa fee | | | | $0 | | $0 | | $0 |
| **Rental Fees** | | | | | | | | |
| Field equipment rentals | | | | $0 | | $0 | | $0 |
| Truck rental | $50 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| Boat/trailer O&M (fuel, oil, maint.) | $310 | day | 0 | $0 | 0 | $0 | 0 | $0 |
| **Total** | | | | **$1,994** | | **$1,994** | | **$3,988** |

## Education

*B.Sc. Zoology, University of Alberta, Edmonton, Alberta, 1974*

# Golder Associates Ltd. – Castlegar

## Employment History

### ***Golder Associates Ltd. – Castlegar, BC***

*Principal and Senior Fisheries Biologist (2001 to Present)*

Aquatic resources specialist involved with fisheries research and aquatic environmental assessments of water resource, waterpower, and linear development projects. Services provided include study design and management, collection and reporting of field investigations, input to multi-disciplinary environmental impact assessments, preparation of environmental monitoring plans, development of mitigation and fish habitat compensation programs, and providing expert testimony at hearings.

### ***R.L.&L. Environmental Services Ltd. – Castlegar, BC***

*Regional Manager/Senior Fisheries Biologist (1978 to 2001)*

Carried out fisheries and aquatic environmental investigations throughout western and northern Canada; project experience in the northwestern United States. Managed programs related to the identification, assessment, and mitigation of impacts from hydroelectric power developments on anadromous and resident fish populations. Involved in coal and gas thermal power projects and screening/diversion studies for hydroelectric and thermal power intakes. Directed and completed aquatic environmental studies for the construction and monitoring of pipelines and bridges on watercourses; developed habitat compensation and reclamation plans; managed forestry fish and habitat inventory programs; and managed research studies on threatened fish or fish species of concern.

### ***Renewable Resources Consulting Services Ltd. – Edmonton, AB***

*Field Crew Leader (1977 to 1977)*

Field crew leader for fisheries and parasitological investigations associated with McGregor River diversion studies (BC Hydro).

### ***Alberta Fish and Wildlife – Edmonton, AB***

*Project Biologist (1975 to 1977)*

Participated in aerial big game surveys and was employed as a project biologist for the Carson Lake improvement project. Duties included conducting limnological surveys of Carson Lake, determination of effective means of removing northern pike populations, and co-ordination of lake treatment with toxicant.

## PROJECT EXPERIENCE – STURGEON

Larry Hildebrand’s sturgeon experience extends back to the late 1980s, when he assisted in the design and implementation of studies directed at lake sturgeon in the South Saskatchewan River in Alberta. These studies involved the determination of life history characteristics, status, and movements of this population.

Since the early 1990s, Larry has directed annual studies related to all aspects of white sturgeon biology and ethology in the upper Columbia River in British Columbia. From 1995 to 1999, he also directed studies in the lower Fraser River on white sturgeon spawning, recruitment, and population characteristics. Since 1999, Larry has expanded his knowledge of white sturgeon recruitment, movements, and population dynamics in the Columbia River system to include populations in the middle Columbia, between Wells Dam and Priest Rapids Dam. These studies are related to re-licencing requirements of the U.S. Federal Energy Review Commission (FERC).

Recently, Larry has been involved in the development of a white sturgeon population stabilisation plan for the SARA-listed white sturgeon population in the upper Columbia River basin. He is a member of the Upper Columbia White Sturgeon Recovery Team, an international team of biologists responsible for the development and implementation of studies to identify bottlenecks to natural reproduction and to the development of a Recovery Plan through which sustainable levels of natural reproduction can ultimately be achieved. One component of the plan is the use of conservation aquaculture as a short-term measure to supplement recruitment until such time as natural recruitment can be achieved.

**Status of White Sturgeon in the Columbia River**
British Columbia, CANADA

Determined white sturgeon movements in the Columbia River using mark-recapture techniques (conventional Floy and PIT tags) and radio telemetry. Successfully collected white sturgeon eggs and larvae. Presented estimates of growth rates, survival, and exploitation of white sturgeon. Mark-recapture data were used to derive population estimates for each study section of the Columbia River. Habitats used by white sturgeon for spawning, holding, feeding, and overwintering were described and related to habitat variables. Factors influencing white sturgeon recruitment in the study area were described in detail, and recommendations for future studies were presented.

**Priest Rapids Hydroelectric FERC Re-licencing No.2145**
Washington, USA

Intensive studies were conducted to assess white sturgeon population status, movements, preferred habitats, and spawning success in the Wanapum and Priest Rapids (the Project) reservoirs from 2000 to 2003. In 2009, a "White Sturgeon Management Plan was prepared for the Project Area, Mid Columbia River" was prepared for agency and First Nations review and submitted to FERC as an initial step towards achieving Grant County's objectives related to supplementation and recovery of the white sturgeon population within the Rocky Reach Project area. This plan was accepted by FERC and the Priest Rapids Fisheries Forum and will be implemented commencing in 2010.

**Rocky Reach Hydroelectric FERC Re-licencing No. 2145**
Washington, USA

This project involved the collection of data on benthic invertebrates, fish rearing and habitat use, and white sturgeon population characteristics as part of the environmental investigations leading up to an application for the FERC Re-licencing of the project. Sampling was conducted within the Rocky Reach reservoir and from the tailwater zone of Rocky Reach and Wells dams project area. This project involved the habitat use information as part of the environmental investigations leading up to an application for the FERC Relicencing of the project. This project involved the collection of baseline information on white sturgeon population status and habitat use within the Rocky Reach reservoir and from the tailwater zones of Rocky Reach and Wells dams project area. In addition, a document entitled "Proposed Methodology for White Sturgeon Enhancement in Rocky Reach Reservoir" was prepared for agency and First Nations review and submitted to FERC as an initial step towards Chelan County's objective of achieving and sustaining a white sturgeon population within the Rocky Reach Project area through a comprehensive white sturgeon management plan.

**Fraser River White Sturgeon Monitoring**
British Columbia, CANADA

Involved in a large-scale, five-year program to investigate the status of white sturgeon in the Fraser River drainage in British Columbia. Work was completed for BC Fisheries and BC Ministry of Environment, Lands and Parks. Annual reports were prepared, along with a final comprehensive report summarising the findings of the five-year study. Results of the studies were presented at the 4th International Sturgeon Symposium, with current research being applied to recovery efforts for white sturgeon in the Nechako River watershed.

**Population Stabilisation Plan for White Sturgeon**
Columbia River Basin, BC, CANADA

This document summarised both historical and present knowledge of white sturgeon distribution and population dynamics. The data deficiencies and prioritisation of future data requirements in the lower Columbia River, upstream of the Grand Coulee Dam, were also discussed. Limiting factors to the population success and proposed methods of maintaining a viable stock of white sturgeon in the Columbia River in BC were assessed, along with limitations of available options.

**Columbia River White Sturgeon Studies**
British Columbia, CANADA

Carried out an investigation of the status of white sturgeon in the Columbia River, between Hugh Keenleyside Dam and the American border. Watersheds included the Kootenay, Columbia, and Pend d'Orielle rivers. Conducted research for BC Hydro as part of environmental assessments for proposed dam expansions and upgrades. Studies also were completed for the BC Ministry of Environment, Lands and Parks as part of ongoing stock status investigations.

**White Sturgeon Genetics Workshop**
Boise, ID, USA

Attended workshop on behalf of BC Hydro. Geneticists and fisheries managers were invited to participate in a working group to help interpret findings by the Aquaculture Research Institute (ARI) at the University of Idaho regarding genetic variation and stock structure among white sturgeon populations in the Columbia Basin. Results from this workshop were intended to provide information needed to assist in the restoration of productive white sturgeon populations throughout the Basin.

**Aquatic Inventories**
Alberta and British Columbia, CANADA

Involved in a series of studies and reports that examined various aspects of the fish and aquatic communities in rivers and lakes in western Canada. Designed and implemented projects that assessed impacts and mitigative options associated with operation and expansion of hydroelectric facilities. These projects included investigations of the status of endangered white sturgeon stocks in the Columbia River, studies of reservoir aquatic communities, instream surveys of fish species assemblages and aquatic habitat use, and assessments of productive capacity in regulated systems. Many of these programs also involved detailed assessments of the movement patterns and behaviour of resident and migratory fish species, as well as computerised water quality, temperature, and dissolved gas monitoring; and the evaluation, classification, and quantification of aquatic habitats in rivers, lakes, and reservoirs.

**Fisheries and Fish Habitat Inventories**
South Saskatchewan River Basin, CANADA

Conducted fish and habitat inventories during fall 1995 and spring 1996 at 16 index sites in the South Saskatchewan River basin (Bow, Oldman, and South Saskatchewan rivers) to provide bases for the development of appropriate fisheries management and habitat protection strategies that may assist in future water management decisions.

**Study of Lake Sturgeon Movements**
South Saskatchewan River, CANADA

Lake sturgeon distribution in Alberta is confined to the North and South Saskatchewan rivers. This study was initiated in 1985 to provide further information to aid in management of the species in the South Saskatchewan River. A creel survey, mark-recapture study, and long-term radio telemetry investigations were carried out. Critical habitats (spawning and overwintering) were identified as a result of the telemetry program.

**Investigations of Lake Sturgeon**
South Saskatchewan River, CANADA

To provide information on angler effort and harvest, a stratified random angler census was undertaken at major access points along the South Saskatchewan River. In addition to on-site data collection, Alberta Fish and Wildlife Division mail-out questionnaire returns (indicating individual catch) were examined. The combined results will aid fishery managers in evaluating present harvest levels and future management options

**Management of Lake Sturgeon Sport Fisheries**
Alberta, CANADA

This report described the biology and habitat preferences of sturgeon. Information also was provided on harvest and habitat status. A management plan was presented, which discussed options such as creel limits, minimum and slot limits, seasonal closures, and registration/enforcement. Also provided an annotated bibliography of lake sturgeon literature, focussed primarily on Alberta, Saskatchewan, and Manitoba.

## PROFESSIONAL AFFILIATIONS

Association of Professional Biologists of BC

Canadian Society of Environmental Biologists

American Fisheries Society

World Sturgeon Conservation Society

Upper Columbia White Sturgeon Recovery Team - Technical Writing Group

## PUBLICATIONS

**Other**

PRESENTATIONS

M. Hildebrand and L. Hildebrand. 2010. White sturgeon spawning at Waneta, 2009 investigations. Data Report prepared for Columbia Power Corporation, Castlegar, B.C. Golder Report No. 09-1480-0034F: 20 p. + 1 app.

Editor: 2009. Interim Report: Post-Project white sturgeon monitoring on the Brilliant Expansion Tailwater area. Report prepared for Columbia Power Corporation, Castlegar, B.C. Golder Report No. 08-1480-0059F: 26 p.

M. Hildebrand and L. Hildebrand. 2010. Middle Columbia River juvenile white sturgeon monitoring: 2009 investigations. Report prepared for BC Hydro, Castlegar, B.C. Golder report No. 09-1480-0045F: 47 p. + 3 app.

M. Hildebrand and L. Hildebrand. 2010. Middle Columbia River white sturgeon spawn monitoring: 2009 investigations data report. Report prepared for BC Hydro, Castlegar, B.C. Golder Report No. 09-1480-0044F: 20 p. + 2 app

L. Hildebrand and J. Powell. 2009. Priest Rapids Project – FERC P-2114 White Sturgeon Management Plan. Prepared for Public Utility District No. 2 of Grant County, Ephrata, WA. Prepared by Golder Associates Ltd., Castlegar, BC, and Freshwater Fisheries Society of BC, Victoria, BC. 97 p + 4 app.

B. Hildebrand and L. Hildebrand. 2009. Observations of white sturgeon behaviour in Waneta eddy during a zero flow event at Waneta Dam. Report prepared for BC Hydro, Castlegar, B.C. Golder Report No. 08-1480-0029F: 9 p. + 1 app.

L. Hildebrand. 2010. Follow-up report on the effectiveness of the Environmental Assessment Process for the Keenleyside Powerplant Project. Report prepared for Columbia Power Corporation, Castlegar, B.C. Golder Report No. 08-1480-0059F: 26 p.

M. Hildebrand. B. Hildebrand, and L. Hildebrand. 2009. Lower Columbia River adult white sturgeon monitoring: 2008 investigations data report. Report prepared for BC Hydro, Castlegar, B.C. Golder Report No. 08-1480-0032F: 32 p. + 2 app.

M. Hildebrand and L. Hildebrand. 2009. Middle Columbia River white sturgeon spawn monitoring study: 2008 investigations. Report prepared for BC Hydro, Revelstoke, B.C. Golder Report No. 08-1480-0029F: 24 p. + 2 app.

M. Hildebrand and L. Hildebrand. 2009. Lower Columbia River juvenile white sturgeon detection: 2008 investigations data report. Report prepared for BC Hydro, Castlegar, B.C. Golder Report No. 08-1480-0040F: 24 p. + 2 app.

M. Hildebrand and L. Hildebrand. 2009. Monitoring of juvenile white sturgeon habitat use and movements of sonic-tagged sturgeon: 2008 investigations. Report prepared for BC Hydro, Revelstoke, B.C. Golder Report No. 08-1480-0030F: 34 p. + 3 app.

B. Hildebrand and L. Hildebrand. 2009. Mica Dam Tailwater Mountain Whitefish Spawning and Egg Stranding Assessment. Report prepared for BC Hydro, Burnaby, B.C. Golder Report No. 08-1480-0009F: 13 p. + 4 app.

Contributing author. 2008. Working document: IFC Review on Environment, Health, and Safety Guidelines for hydropower issues. Report prepared for BC Hydro, Revelstoke, B.C. Golder Report No. 05-1422-0013F: 46p.

M. Hildebrand and L. Hildebrand. 2008. Lower Columbia River white sturgeon early life history sampling: 2007 investigations. Report prepared for BC Hydro, Revelstoke, B.C. Golder Report No. 07-1480-0036F: 13 p. + 1 app.

M. Hildebrand and L. Hildebrand. 2008. Middle Columbia River monitoring of juvenile white sturgeon and habitat use and monitoring movements of sonic-tagged sturgeon, 2007 - 2008. Data report prepared for BC Hydro, Revelstoke, B.C. Golder Report No. 07-1480-0069F: 25 p. + 3 app.

Editor. 2008. Large River Fish Indexing Program - Lower Columbia River - 2007 Phase 7 Investigations. Report prepared for BC Hydro, Burnaby, B.C. Golder Report No. 07-1480-0067F: 78 p. + 6 app

B. Hildebrand and L. Hildebrand. 2007. White sturgeon spawning at Waneta, 2007 investigations. Report prepared for Teck Cominco Metals Ltd. Trail Operations. Golder Report No. 07-1480-0031F: 28p. + 1 app.

M. Hildebrand and L. Hildebrand. 2007. Upper Columbia River juvenile white sturgeon monitoring: Phase 5 investigations, November 2006. Report prepared for BC Hydro, Revelstoke, B.C. Golder Report No. 06-1480-049D: 64 p. + 6 app.

M. Hildebrand and L. Hildebrand. 2007. Upper Columbia River juvenile white sturgeon monitoring: Phase 4 investigations, 2005 – 2006. Report prepared for BC Hydro, Castlegar, B.C. Golder Report No. 05-1480-058F: 70 p. + 6 app.

Project Leader and Editor. 2007. Large River Fish Indexing Program – Middle Columbia River 2006 Phase 6 Investigations. Report prepared for BC Hydro, Revelstoke, B.C. Golder Report No. 06-1480-032D: 56 p. + 6 app

Editor. 2007. Large River Fish Indexing Program – Lower Columbia River 2006 Phase 6 Investigations. Report prepared for BC Hydro, Burnaby, B.C. Golder Report No. 06-1480-031F: 70 p. + 6 app

Irvine, R., D. Schmidt, and L. Hildebrand. 2007. Population Status of white sturgeon in the lower Columbia River, Canada. Transactions of the American Fisheries Society: 136, 1472-1479

P. Grutter and L. Hildebrand. 2006. White sturgeon spawning at Waneta, 2005 investigations. Report prepared for Teck Cominco Metals Ltd. and BC Hydro. Golder Report No. 05-1480-030F: 40p. + 1 app.

L. Westcott and L. Hildebrand. 2006. Brilliant Expansion Project: White Sturgeon Monitoring Program 2005-2006 Instream Works Window. Report prepared for Skanska-Chant Joint Venture, Castlegar, B.C. Golder Report No. 05-1480-055F: 23 p. + 4 app.

Editor. 2006. Large River Fish Indexing Program – Lower Columbia River 2005 Phase 5 Investigations. Report prepared for BC Hydro, Burnaby, B.C. Golder Report No. 05-1480-034F: 56 p. + 6 app.

Contributing author. 2006. Waneta Hydroelectric Expansion Project, Environmental Assessment Certificate Application. Volume 1 (Assessment Report), Volume II (Background Reports – Land Use Investigations and Other) and Volume 3 (Background Reports – Aquatic and Terrestrial Resources and Modeling). Prepared by Waneta Expansion Power Corporation for the British Columbia Environmental Assessment Office. May, 2006.

Project Leader and editor. 2006. Large River Fish Indexing Program: Middle Columbia River - 2004 Phase 4 Investigations. Report prepared for B.C Hydro Power Supply Environmental Services, Burnaby, B.C. Golder Report No. 041480048F 66p. + 5 app.

L. Hildebrand, M. Hildebrand, and L. Porto. 2005. A synthesis of white sturgeon investigations in Arrow Lakes Reservoir B.C., 1995 – 2003. Report prepared for BC Hydro, Castlegar, B.C. Golder Report No. 04-1480-016: 57 p. + 11 app.

Project Leader and editor. 2005. Large River Fish Indexing Program – Lower Columbia River 2004 Phase 4 Investigations. Report prepared for BC Hydro, Burnaby, B.C. Golder Report No. 04-1480-047F: 57 p. + 6 app.

Project Advisor and editor. 2005. White sturgeon spawning in relation to the White Sturgeon Flow Augmentation Program. Report prepared for Teck Cominco Metals Ltd., Trail Operations, Trail, B.C. Golder Report No. 04-1480-068F: 33 p. + 4 app.

M. Hildebrand and L. Hildebrand. 2005. Waneta Expansion Project: Examination of velocity characteristics in Waneta Eddy in relation to overwintering use by juvenile white sturgeon, March 2004. Report prepared for Waneta Expansion Power Corporation, Castlegar, B.C. Golder Report No. 04-1480-019: 19 p. + 1 app.

M. Hildebrand and L. Hildebrand. 2005. Upper Columbia White Sturgeon Stock Monitoring and Data Management Program: Annual Report No. 2, 1 April 2004 - 31 March 2005. Prepared for British Columbia Ministry of Water, Land and Air Protection, Nelson, B.C. Golder Report No. 03-1480-078A2F: 22 p. + 2 app.

M. Hildebrand and L. Hildebrand. 2005. Upper Columbia River juvenile white sturgeon monitoring: Phase 2 investigations, fall 2003 – spring 2004. Report prepared for BC Hydro, Castlegar, B.C. Golder Report No. 03-1480-034F: 44 p. + plates + 2 app.

Contributing Author. 2004. Waneta Hydroelectric Expansion Project: Terms of Reference for Environmental Assessment Certificate Application. Prepared for Columbia Power Corporation.

Contributing Author and Editor. 2004. Rocky Reach Reservoir White Sturgeon Comprehensive Management Plan. Rocky Reach Hydroelectric Project. FERC Project No. 2145. Prepared for Chelan County Public Utility District by Golder Associates Ltd., Castlegar, BC. Golder Report No. 03-1480-069F: 51 p. + 1 app.

Project Leader and editor. 2004. White sturgeon spawning at Waneta, 2003 investigations. Data Report prepared for Teck Cominco Metals Ltd. and BC Hydro. Golder Report No. 03-1480-032D: 19 p. + 1 app.

Project Leader and editor. 2004. Large River Fish Indexing Program – Lower Columbia River 2003 Phase 3 Investigations. Report prepared for BC Hydro, Burnaby, B.C. Golder Report No. 03-1480-021F: 54 p. + 6 app.

M.A.H. Webb, J. E. Williams, and L.R. Hildebrand. (2004). Review of the Recovery Program for the Endangered Pallid Sturgeon in the Upper Missouri River Basin. Report prepared for the Western Division of the American Fisheries Society.

M. Hildebrand and L. Hildebrand. 2003. Upper Columbia River juvenile white sturgeon monitoring, Phase I investigations, fall 2002. Report prepared for BC Hydro, Castlegar, B.C. Golder Report No. 0228046F: 33 p. + 2 app.

P. Grutter and L. Hildebrand. 2003. White sturgeon spawning at Waneta, 2002 investigations. Data report prepared for Columbia Power Corporation, Castlegar, B.C. by Golder Associates Ltd. Golder Report No. 0228016F: 23pp. + 1 app.

Lewis, B., L. Hildebrand, and D. Schmidt. 2002. Lower Columbia River Fish Community Indexing Program – 2001 Phase 1 Investigations. Report prepared for B.C Hydro, Burnaby, B.C. Golder Report No. 012-8007 F: 54 p. + 6 app

L. Hildebrand and B. Chapman. 2002. White Sturgeon Monitoring: Brilliant Dam Upper Tailrace Area, Winter 2001 - 2002. Report prepared for Brilliant Expansion Power Corporation, Victoria, B.C. R.L. & L. Report No. 012-8010F: 10 p.

Porto, L. and L. Hildebrand. 2002. White sturgeon investigations in Priest Rapids and Wanapum reservoirs on the Middle Columbia River, Washington, U.S.A. Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington. Golder Associates Ltd. Report No. 002-8817F: 82p. + 5 app.

Hildebrand, M. and Hildebrand L. 2002. Waneta Expansion Project: Assessment of fish use in the Waneta area, 2001 investigations. Report prepared for Columbia Power Corporation, Castlegar, B.C. Golder Report No. 0128967F: 43 p. + 3 ap

Porto, L. and L. Hildebrand. 2002. Upper Columbia River White Sturgeon Broodstock Investigations, 2001 study results. Report prepared for B.C. Ministry of Environment, Lands and Parks, Nelson, B.C. Golder Associates Ltd. Report No. 012-8920D:52p. + 7app.

Contributing author. 2002. White sturgeon spawning at Waneta, 2001 investigations and historical data summary. Report prepared for Columbia Power Corporation, Castlegar, BC. Golder Report No. 0128966D: 46 p. + 7 app.

Porto, L. and L. Hildebrand. 2001. White Sturgeon Studies In The Rocky Reach Project Area On The Columbia River, Washington, U.S.A. 2001 Investigations. Report prepared for Public Utility District No. 1 of Chelan County, Wenatchee, Washington. R.L. & L. Report No. 957F: 52 p. + 2 app.

Hildebrand, L. and P. Grutter. "Columbia River white sturgeon spawning studies, 2000 investigations." Data report prepared for B.C. Ministry of Environment, Lands and Parks, Nelson, BC by R.L. & L. Environmental Services Ltd., R.L. & L. Report No. 853F, 2001.

Hildebrand, L., L. Porto, and B. Chapman. "White sturgeon investigations in Arrow Reservoir and the Columbia River, B.C., 2000 study results." Data report prepared for B.C. Ministry of Environment, Lands and Parks, Nelson, BC by R.L. & L. Environmental Services Ltd., R.L. & L. Report No. 840F, 2001.

Hildebrand, L. and L. Porto. "White sturgeon investigations in Priest Rapids and Wanapum reservoirs on the Columbia River in Washington, U.S.A., 2000 data

report." Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington by R.L. & L. Environmental Services Ltd., R.L. & L. Report No. 2000-817D, 2001.

Vandenbos, R. and L. Hildebrand. "Fraser River White Sturgeon Monitoring Program, Region 2 (Lower Mainland), 1998 data report." Report prepared for B.C. Fisheries and Fraser River Sturgeon Conservation Society by R.L. & L. Environmental Services Ltd., R.L. & L. Report No. 671F, 1999.

Vandenbos, R. and L. Hildebrand. "White sturgeon investigations in Arrow Reservoir, B.C., 1998 study results." Report prepared for B.C. Ministry of Environment, Lands and Parks by R.L. & L. Environmental Services Ltd., R.L. & L. Report No. 634F, 1999.

Hildebrand, L., C. McLeod, and S. McKenzie. "Status and management of white sturgeon in the Columbia River in British Columbia, Canada: an overview." Journal of Applied Icthyology, 15(1999): 164-172, 1999.

McLeod, C., L. Hildebrand, and D. Radford. "A synopsis of lake sturgeon management in Alberta, Canada." Journal of Applied Icthyology, 15(1999): 173-179, 1999.

Hildebrand, L. "Working criteria to determine the effects of the Waneta Dam flow program on white sturgeon spawning." Prepared for Cominco Ltd. by R.L. & L. Environmental Services Ltd., 1998.

Vandenbos, R. and L. Hildebrand. "Columbia River white sturgeon spawning studies, 1998 investigations." Report prepared for Cominco Ltd. by R.L. & L. Environmental Services Ltd., R.L. & L. Report No. 641, 1998.

Hildebrand, L. and G. Birch. "Canadian Columbia River white sturgeon: Stock stabilization plan (discussion document)." Prepared for B.C. Ministry of Environment, Lands and Parks by R.L. & L. Environmental Services Ltd. and BC Hydro, 1996.

Hildebrand, L. (contributing author). "Fraser River white sturgeon monitoring program, 1995 data report." Prepared for B.C. Ministry of Environment, Lands and Parks by R.L. & L. Environmental Services Ltd., 1996.

Prince, A. and L. Hildebrand. "The distribution and status of white sturgeon in isolated waterbodies within the Columbia Basin in B.C., 1995 study results." Prepared for B.C. Ministry of Environment, Lands and Parks by R.L. & L. Environmental Services Ltd., 1996.

McKenzie, J.S., and L. Hildebrand. "Columbia River white sturgeon investigations, 1995 Study Results." Prepared for BC Hydro by R.L. & L. Environmental Services Ltd., 1996.

Hildebrand, L. (principal author). "Columbia River Development - Lower Columbia River fisheries inventory: 1990 to 1994 Studies." Prepared for BC Hydro by R.L. & L. Environmental Services Ltd., 1995.

Hildebrand, L. and J.S. McKenzie. “White sturgeon in the Columbia River, B.C., 1994 study results.” Prepared for BC Hydro by R.L. & L. Environmental Services Ltd., 1995.

Hildebrand, L., G. Ash, and G. Birch. “Impacts of Waneta powerplant construction and operation on white sturgeon populations in the Columbia River. Preliminary scoping document and discussion paper.” Prepared for BC Hydro by R.L. & L. Environmental Services Ltd., 1994.

Hildebrand, L. and J.S. McKenzie. “Status of white sturgeon in the Columbia River, B.C.” Prepared for BC Hydro by R.L. & L. Environmental Services Ltd., 1994.

Hildebrand, L. (contributing author). “A study of lake sturgeon (Acipenser fulvescens) movements, abundance, and harvest in the South Saskatchewan River, Alberta.” Report prepared for Alberta Recreation, Parks and Wildlife Foundation and Alberta Fish and Wildlife Division. 56pp + app., 1994.

Hildebrand, L. “Lower Columbia River Fisheries Inventory. 1990 Studies. Vol. I and II.” Report prepared for BC Hydro by R.L. & L. Environmental Services Ltd., 1991.

**PRESENTATIONS, CONFERENCES, AND WORKSHOPS RELATED TO STURGEON**

2011 Meeting Chair of the 4th Annual North American Sturgeon Conservation Society meeting in Nanaimo, BC.

2011 Participant in the 2nd Annual Lower Columbia River workshop in Boardman OR. River

2001-2010 Participation in bi-annual meetings/workshops as a member of the Transboundary Upper Columbia White Sturgeon Recovery Team, Technical Working Group.

2009 Presentation of a talk entitled “Status of White Sturgeon” at the 5th International Sturgeon Symposium in Wuhan, China.

2009 Co-organizer and presenter at the North American Chapter of the World Sturgeon Conservation Society Sturgeon Symposium held in conjunction with the 139th American Fisheries Society meeting in Nashville, TN.

2008 Presentation of a talk entitled “Status of White Sturgeon” at the 138th American Fisheries Society Meeting in Ottawa, ON.

2007 Presentation of a talk entitled “Upper Columbia white sturgeon recovery: Monitoring the effectiveness of the hatchery supplementation program” at the 137th American Fisheries Society Meeting in San Francisco, CA.

2006 Presentation of a talk entitled “White Sturgeon In The Canadian Columbia River ” at the Columbia Basin - A Cultural Environment and an Environmental Culture symposium in Spokane, WA.

2000 Public presentation concerning the proposed Upper Columbia White Sturgeon Recovery Program, Castlegar, BC.

2000 Presentation of a talk entitled “White Sturgeon Stock Assessment and Management in the Mid-Columbia” at the 2000 White Sturgeon Research Coordination Meeting in Clarkston, Idaho.

2000 Presentation of a proposed white sturgeon research program to the Commissioners of Grant County PUD, Moses Lake, Washington.

1999 Participant in an Upper Columbia River White Sturgeon Researchers workshop, Vancouver, Washington.

1999 Participant in a white sturgeon genetics workshop, Boise, Idaho.

1998 Participant in Adaptive Environmental Assessment Modelling Workshop for the Columbia River, Vancouver, BC.

1998 Current status of white sturgeon research and management in the Columbia River, British Columbia. Paper presented to the Towards Ecosystem-Based Management in the Upper Columbia River Basin, Castlegar, BC.

1997 Participant in a white sturgeon genetics workshop, Vancouver, Washington.

1997 Participant in the Adaptive Environmental Assessment Modelling Workshop for the Kootenay River white sturgeon, Spokane, Washington.

1997 Hosted an international workshop to develop suitability criteria to assess effects of flow augmentation on white sturgeon spawning success in Castlegar, BC.

1997 Status and management of white sturgeon in the Columbia River, BC. Paper presented to the 3rd International Sturgeon Symposium, Piacenza, Italy.

1996 Columbia River white sturgeon investigations downstream of Hugh L. Keenleyside Dam, BC. Paper presented to the International Congress on the Biology of Fishes, San Francisco, California.

1994 Status of white sturgeon in the Columbia River, BC. Poster-paper presented at the International Conference on Sturgeon Biodiversity and Conservation, New York, NY.

1994 Status of white sturgeon in the Columbia River, BC. Paper presented at the Canada-U.S. Technical Workshop on the Upper Columbia River Basin - International Dialogue, Spokane, Washington.

1990 Participant in the North American Sturgeon Workshop, Milwaukee, Wisconsin.

**Jason G. McLellan**
**25 W Main St, Suite 434**
**Spokane, WA 99201**
**(509) 209-2419 (office); (509) 263-1082 (cell)**
**work: jason.mclellan@colvilletribes.com**


Mr. McLellan has been employed as a fisheries biologist for over 12 years in the Inland Northwest. During this time he has conducted a variety of research with an emphasis on native fishes, primarily white sturgeon, burbot, and redband trout. He is the author of over 35 peer reviewed journal articles and technical reports. Through his work, he has contributed to the management and conservation of resident fish populations in the upper Columbia River basin.

## EDUCATION:

| | | |
|---|---|---|
| Eastern Washington University, Cheney | M.S. Biology | 1998 |
| The University of Montana, Missoula | B.A. Biology | 1995 |

## PROFESSIONAL EXPERIENCE:

**Confederated Tribes of the Colville Reservation**

*Resident Fish Biologist 4 (June 2011 -current)*: Lead biologist responsible for managing and conducting research and monitoring projects (described below) focused on resident fish conservation and management in the upper Columbia River.

*Responsibilities include:*

- working cooperatively with tribal staff, co-managers, BPA staff, and other project cooperators to develop project goals, objectives, and proposals for funding,
- developing detailed study plans, schedules for implementation, and budgets with input from professional staff,
- supervising professional staff (2 biologists),
- managing contract budgets,
- overseeing and actively conducting project field sampling activities and data analysis,
- project reporting, including quarterly reports, PISCES reports, annual technical reports, and peer-reviewed journal articles
- presenting study results at professional meetings/conferences, to citizens groups, and at public meetings,
- providing technical review/advise and field support to Tribal staff involved in fish management, and
- serve as the Tribes technical representative on the Upper Columbia White Sturgeon Recovery Initiative Technical Working Group (formerly Recovery Team).

*Projects:*

*Lake Roosevelt Rainbow Trout Habitat/Passage Improvement Project (BPA Project No. 1990-018-00).* The goal of the project is to increase the abundance of migratory rainbow trout to levels that provide for sustainable Tribal recreational and subsistence fishing opportunities. The objectives of the project are to identify stream habitat conditions that may limit rainbow trout production, implement improvement projects, and evaluate improvement effectiveness.

*White Sturgeon Enhancement Project (BPA Project No. 2008-116-00).* The White Sturgeon Enhancment Project will begin in early 2012, but development of the project study design is underway. It will be part of an international initiative to restore natural recruitment of white sturgeon *Acipenser transmontanus* in the upper Columbia River (upstream of Grand Coulee Dam). Project activities will be stock assessment surveys and research to identify factors limiting recruitment.

**Washington Department of Fish and Wildlife, Spokane, Washington**

*Fish and Wildlife Biologist 3 (May 2002-June 2011)*: Lead biologist responsible for managing and conducting research and monitoring projects (described below) focused on resident fish conservation and management in the upper Columbia River.

*Responsibilities include:*

- working cooperatively with agency staff, tribal co-managers, BPA staff, and other project cooperators to develop project goals, objectives, and proposals for funding,
- developing detailed study plans, schedules for implementation, and budgets with input from professional staff,
- supervising professional (3 biologists) and technical (1 career seasonal, 1-2 non-permanent, seasonal) staff,
- managing contract budgets,
- overseeing and actively conducting project field sampling activities and data analysis,
- project reporting, including quarterly reports, PISCES reports, annual technical reports, and peer-reviewed journal articles
- managing the contracting process (entry into contracting software applications [PISCES, CAPS Production, and CAPS Financial]) for both receivable and payable contracts in coordination with contracts and budget staff,
- presenting study results at professional meetings/conferences, to citizens groups, and at public meetings,
- providing technical review/advise and field support to Agency staff involved in fish management and major projects,

- serve as the agency technical representative on the Upper Columbia White Sturgeon Recovery Initiative Technical Working Group (formerly Recovery Team), and
- coordinate initial development of the eastern Washington component of the Draft Washington Department of Fish and Wildlife Statewide White Sturgeon Management Plan.

*Projects:*

*Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams (BPA Project No. 1997-004-00).* The Resident Fish Stock Status project goal is to assess the status of resident fish stocks and their limiting factors in the upper Columbia River in Washington above Chief Joseph Dam (blocked area). Project components included studies of fish populations, habitat, productivity, and limnology in streams, lakes, and reservoirs with in the blocked area.

*Lake Roosevelt White Sturgeon Recovery (BPA Project No. 1995-027-00).* The Lake Roosevelt Sturgeon Recovery Project is part of an international initiative to restore natural recruitment of white sturgeon *Acipenser transmontanus* in the upper Columbia River (upstream of Grand Coulee Dam). Project components include stock assessment surveys, research to identify factors limiting recruitment, an acoustic telemetry study, and an interim conservation aquaculture program.

*Redband Trout Spawning and Fry Emergence Study: Abundance and Year-Class Strength*. The project was funded by Avista Corporation in partial fulfillment of the Federal Energy Regulatory Commission (FERC) license requirement for their Spokane River Hydroelectric Development (HED) project. The objective of this study was to determine the abundance and year class strength of redband trout *Oncorhynchus mykiss gairdneri* in an index area of the Spokane River.

*Middle Spokane River Baseline Fish Population Assessment*. The project was funded by Avista Corporation in partial fulfillment of the FERC license requirement for their Spokane River HED project. The objective of this study was to conduct a baseline assessment of the fish community between Upper Falls and Upriver dams.

*Upper Columbia River White Sturgeon Fine-Scale Movement and Habitat Study*. The objective of this project was to use a Vemco acoustic telemetry VR2W Positioning System (VPS) to determine fine-scale movements of white sturgeon juveniles, sub-adults, and adults within the Marcus area of the upper Columbia River.

*Pend Oreille River White Sturgeon Investigation*: The objective of the study was to determine the presence or absence of white sturgeon in Box Canyon and Boundary reservoirs using setlines.

*Fish and Wildlife Biologist 2 (August 1999 – May 2002):* Lead biologist responsible for managing and implementing the Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams project (described above). This position was reclassified to a Biologist 3 in 2002 due to increases in the number of projects managed and responsibilities. The duties of this position were similar to those of the Biolgist 3 position, as described above.

**Eastern Washington University, Cheney, Washington**

*Research Associate (July 1998 – August 1999)*: A professional level biologist position conducting research on walleye *Sander vitreus* and kokanee *Oncorhynchus nerka* in Lake Roosevelt. The purposes of these projects were to estimate walleye abundance and growth for use in estimating consumption of stocked salmonids and evaluate hatchery kokanee release strategies.

*Responsibilities included:*

- developing detailed study plans to determine walleye abundance and population dynamics in Lake Roosevelt,
- implementation of field sampling activities for walleye and kokanee,
- conducting analysis of fish data, including capture-recapture estimates of abundance, age structure, growth rates, mortality, and movements,
- project reporting including quarterly reports, annual technical reports, and peer-reviewed journal articles,
- presenting study results at professional meetings/conferences, to citizens groups, and at public meetings, and
- assisting with fish population and limnological investigations on Rock and Sprague lakes, Washington.

*Graduate Research Assistant (October 1996 – June 1998)*: A graduate student position conducting research on walleye and kokanee in Lake Roosevelt. The purposes of the projects were to estimate walleye abundance and growth for use in estimating consumption of stocked salmonids and evaluate hatchery kokanee release strategies.

*Responsibilities included:*

- implementing a study to determine walleye abundance and population dynamics in Lake Roosevelt,
- conducting field sampling activities for walleye and kokanee,
- completing analysis of walleye data, including capture-recapture estimates of abundance, age structure, growth rates, mortality, and movements,
- developing the project annual technical report and M.S. Thesis,
- presenting study results at professional meetings/conferences, and
- experimentally culturing walleye, yellow perch *Perca flavescens*, pumpkinseed *Lepomis gibbosus*, carp *Cyprinus carpio*, largescale suckers *Catostomus macrocheilus*, brown trout *Salmo trutta*, and brook trout *Salvelinus fontinalis*, to initiate the development of a larval fish key for eastern Washington fishes.

## PRIMARY PUBLICATIONS:

Hildebrand, L.R., A. Drauch-Schrier, K. Lepla, S. McAdam, **J. McLellan**, M.J. Parsley, V.L. Paragamian. *In review*. Current knowledge of White Sturgeon (*Acipenser transmontanus*) life history, status, threats to survival, and prognosis for the future. Journal of Applied Ichthyology.

**McLellan, J.G.** 2009. Characteristics of the kokanee spawning run in Harvey Creek, Washington and its potential use as an egg source. Northwest Science 83:1-15.

Baldwin, C.M. and **J.G. McLellan**. 2008. Use of gill nets for target verification of a hydroacoustic fisheries survey and comparison with kokanee spawner escapement estimates from a tributary trap. North American Journal of Fisheries Management 28:1744-1757.

Small, M.P., **J.G. McLellan**, J. Loxterman, J. Von Bargen, A. Frye, and C. Bowman. 2007. Fine-scale population structure of rainbow trout in the Spokane River drainage in relation to hatchery stocking and barriers. Transactions of the American Fisheries Society 136:301-317.

McLellan, H.J., **J.G. McLellan**, and A.T. Scholz. 2004. Evaluation of release strategies for hatchery kokanee in Lake Roosevelt, Washington. Northwest Science 78:158-167.

Young, S.F., **J.G. McLellan**, and J.B. Shaklee. 2004. Genetic integrity and microgeographic population structure of westslope cutthroat trout, *Oncorhynchus clarki lewisi*, in the Pend Oreille Basin in Washington. Environmental Biology of Fishes 69:127-142.

Baldwin, C.M., **J.G. McLellan**, M.C. Polacek, and K. Underwood. 2003. Walleye predation on hatchery releases of kokanees and rainbow trout in Lake Roosevelt, Washington. North American Journal of Fisheries Management 23:660-676.

## TECHNICAL REPORTS:

**McLellan, J.G.**, M.D. Howell, S.G. Hayes, and R.K. Steinhorst. 2011. Seasonal use of channel and off-channel habitats and depth distribution of white sturgeon in the Marcus area of the upper Columbia River as determined using an acoustic telemetry array. Report submitted to the Toxics Cleanup Program, ERO, Washington Department of Ecology, Spokane, WA. Washington Department of Fish and Wildlife, Spokane, WA.

**McLellan, J.G.**, and S.G. Hayes. 2011. Burbot Stock Assessment in Bead and Sullivan Lakes, Pend Oreille County, Washington. Annual Progress Report (2010) to Bonneville Power Administration, Portland, Oregon. Project No. 199700400.

**McLellan, J.G.**, and S.G. Hayes. 2011. Burbot Stock Assessment in Bead and Sullivan Lakes, Pend Oreille County, Washington. Annual Progress Report (2009) to Bonneville Power Administration, Portland, Oregon. Project No. 199700400.

**McLellan, J.G.**, and L.C. King. 2011. Status of redband trout in the upper Spokane River, Washington. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199700400. BPA Document No. P121542.

Howell, M.D., and **J.G. McLellan**. *In review*. Lake Roosevelt white sturgeon recovery project, 2008-2009 Annual Report. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199502700.

Howell, M.D., and **J.G. McLellan**. 2011. Lake Roosevelt white sturgeon recovery project, 2007-2008 Annual Report. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199502700. BPA Document No. 122055.

**McLellan, J.G.**, and C.D. Lee. 2011. Redband trout spawning and fry emergence study: abundance and year class strength component, annual progress report 2010. Report prepared for Avista Corporation, Spokane, Washington (Contract No. R-36488) and Bonneville Power Administration, Portland, Oregon (Project No. 199700400).

Lee, C. D., and **J. G. McLellan**. 2011. Middle Spokane River baseline fish population assessment, annual progress report 2010. Report prepared for Avista Corporation, Spokane, Washington (Contract No. R-36488).

**McLellan, J.G.**, S.G. Hayes, and R.R. O'Connor. 2009. Burbot Stock Assessment in Bead and Sullivan Lakes, Pend Oreille County, Washington. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199700400. BPA Document No. P114269.

O'Connor, R. R., and **J. G. McLellan**. 2009. Stock status of redband trout and an estimate of smallmouth bass abundance in the upper Spokane River, Washington. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199700400. BPA Document No. P114270.

**McLellan, J.G.** and S.G. Hayes. 2008. Burbot stock assessment in Bead and Sullivan lakes, Pend Oreille County, Washington. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199700400. BPA Document No. P106615.

O'Connor, R.R., and **J.G. McLellan**. 2008. Baseline fish community assessment for the middle Spokane River. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199700400. BPA Document No. P106617.

O'Connor, R.R., and **J.G. McLellan**. 2008. Stock Status of redband trout in the upper Spokane River, Washington. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199700400. BPA Document No. P106616.

Howell, M.D., and **J.G. McLellan**. 2008. Lake Roosevelt white sturgeon recovery project, 2006-2007 Annual Report. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199502700. BPA Document No. 110097.

Howell, M.D., and **J.G. McLellan**. 2007. Lake Roosevelt white sturgeon recovery project, 2005-2006 Annual Report. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199502700. BPA Document No. P108776.

**McLellan, J.G.**, S.G. Hayes, and D. O'Connor. 2006. 2006 WDFW Annual Report for the Project Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams. *in*: Connor, J., and nine other authors. *In Prep*. Resident fish stock status above Chief Joseph and Grand

Coulee Dams. 2006 Annual Report. Report to Bonneville Power Administration, Project No. 199700400.

**McLellan, J.G.**, and D. O'Connor. 2006. 2005 WDFW Annual Report for the Project Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams. *in*: Connor, J., and nine other authors. *In Prep*. Resident fish stock status above Chief Joseph and Grand Coulee Dams. 2005 Annual Report. Report to Bonneville Power Administration, Project No. 199700400. (Submitted to Kalispel Tribe for inclusion in final report).

**McLellan, J.G.,** and D. O'Connor. 2005. 2004 WDFW Annual Report for the Project Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams. *in*: Connor, J., and nine other authors. *In Prep*. Resident fish stock status above Chief Joseph and Grand Coulee Dams. 2004 Annual Report, Report to Bonneville Power Administration. Project No. 199700400. (Submitted to Kalispel Tribe for inclusion in final report).

Howell, M.D., and **J.G. McLellan**. 2007. Lake Roosevelt white sturgeon recovery project, 2004-2005 Annual Report. Project No. 199502700. (BPA Report DOE/BP-00022571-1).

Howell, M.D., and **J.G. McLellan**. 2006. White sturgeon setlining efforts in the impoundments of the Pend Oreille River formed by Boundary and Box Canyon dams. Project completion report prepared for Kalipsel Tribe of Indians, Usk, WA and Seattle City Light, Seattle, WA.

**McLellan, J.G.**, and D. O'Connor. 2005. 2003 WDFW Annual Report for the Project Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams. Pages 134-323 *in*: Connor, J., and nine other authors. 2005. Resident fish stock status above Chief Joseph and Grand Coulee Dams. 2003 Annual Report. Report to Bonneville Power Administration, Project No. 199700400. (BPA Report DOE/BP-00004619-4).

Howell, M.D., and **J.G. McLellan**. 2005. Lake Roosevelt white sturgeon recovery project, 2003-2004 Annual Report. Annual Progress Report to Bonneville Power Administration, Portland, Oregon. Project No. 199502700. BPA Document No. 112493.

Baldwin, C.M. and **J.G. McLellan**. 2005. Fisheries assessment of the limnetic zone of Sullivan Lake, Washington, using hydroacoustics and gill nets, September 2003. Technical Report FPT 05-01. Washington Department of Fish and Wildlife, Olympia.

**McLellan, J.G.** and D. O'Connor. 2003. 2002 WDFW Annual Report for the Project Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams. Pages 149-296 *in*: Connor, J., and nine other authors. 2003. Resident fish stock status above Chief Joseph and Grand Coulee Dams. 2002 Annual Report. Report to Bonneville Power Administration, Project No. 199700400. (BPA Report DOE/BP-00004619-3).

**McLellan, J.G.** and D. O'Connor. 2003. 2001 WDFW Annual Report for the Project Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams. Pages 109-276 *in*: Connor, J. and three other authors. 2003. Resident fish stock status above Chief Joseph and Grand Coulee Dams. 2001 Annual Report. Report to Bonneville Power Administration, Project No. 199700400. (BPA Report DOE/BP-00004619-2).

**McLellan, J.G.**, H.J. McLellan, and A.T. Scholz. 2002. Lake Roosevelt Fisheries Evaluation Program; assessment of the Lake Roosevelt walleye population: compilation of 1997-1999 data. 1999 Annual Report. Project No. 199404300. (BPA Report DOE/BP-32148-10).

**McLellan, J.G.,** and D. O'Connor. 2001. 2000 WDFW Annual Report for the Project Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams. Pages 18-221 *in*: Lockwood Jr., N. and 3 other authors. 2003. Resident fish stock status above Chief Joseph and Grand Coulee Dams. 2001 Annual Report, Report to Bonneville Power Administration, Project No. 199700400. (BPA Report DOE/BP-00004619-1).

McLellan, H.J., A.T. Scholz, **J.G. McLellan**, M.B. Tilson. 2001. Lake Roosevelt Fisheries Evaluation Program; Lake Whatcom kokanee salmon (*Oncorhynchus nerka kennerlyi*)

investigations in Lake Roosevelt. 1999 Annual Report. Project No. 199404300. (BPA Report DOE/BP-32148-11).

**McLellan, J.G.**, H.J. Moffatt, A.T. Scholz. 1999. Lake Roosevelt Fisheries Evaluation Program, part D; assessment of the Lake Roosevelt Walleye population. 1998 Annual Report. Project No. 199404300. (BPA Report DOE/BP-32148-7).

**McLellan, J.G.** 1998. Assessment of walleye (*Stizostedion vitreum vitreum*) abundance, movements, and growth in Lake Roosevelt, Washington. M.Sc. Thesis. Eastern Washington University, Cheney, WA. 116 pp.

**PAPERS PRESENTED AT PROFESSIONAL MEETINGS:**

2010 McLellan, J.G., and M.D. Howell. Lake Roosevelt white sturgeon recovery. Lake Roosevelt Forum Conference, November 2010, Spokane, WA.

2010 McLellan, J.G., and M.D. Howell. Recovery efforts for white sturgeon *Acipenser transmontanus* in the upper Columbia River, Washington. Washington-British Columbia Chapter American Fisheries Society Annual Conference, March 2010, Nanaimo, British Columbia, Canada.

2009 McLellan, J.G., and M.D. Howell. White sturgeon population status in Lake Roosevelt. Washington State Lake Protection Association (WALPA) Conference, September 2009, Spokane, WA.

2009 McLellan, J.G., and R.R. O'Connor. Status of Columbia River redband trout in the upper Spokane River. Lake Roosevelt Forum Conference, April 2009, Spokane, WA.

2009 Baldwin, C., and J. McLellan. (poster). Use of gill nets for target verification of a hydroacoustics fishery survey and comparison with kokanee spawner escapement from a tributary trap. Washington-British Columbia Chapter American Fisheries Society Annual Conference, April 2009, Shelton, Washington.

2009 McLellan, J.G., and R.R. O'Connor. Status of Columbia River redband trout in the upper Spokane River. Spokane River Forum Conference, January 2009, Spokane, WA.

2008 O'Connor, R.R., and J.G. McLellan. An abundance estimate for redband trout *Oncorhynchus mykiss gairdneri* in the upper Spokane River, Washington. Idaho Chapter American Fisheries Society Annual Conference, March 2008, Post Falls, ID.

2007 McLellan, J.G. and M.D. Howell. White sturgeon population status in Lake Roosevelt. Lake Roosevelt Forum Conference, November 2007, Spokane, WA.

2006 Howell, M.D. and J.G. McLellan (*presenter*). White sturgeon research in Lake Roosevelt, WA. Columbia Basin Rivers Conference, October 2006, Castlegar, British Columbia, Canada.

2005 McLellan, J.G. An assessment of the Harvey Creek kokanee spawning run. Lake Roosevelt Forum Conference, April 2005, Spokane, WA.

2002 McLellan, J.G, H.J. McLellan, A.T. Scholz. The use of open and closed population models to estimate the size of the walleye population in Lake Roosevelt, Washington. Western Division American Fisheries Society Annual Conference, April 2002, Spokane, WA.

2002 Young, S.F., J.G. McLellan (*presenter*), and J.B. Shaklee. Population structure of cutthroat trout (*Oncorhynchus clarki*) in the Pend Oreille River drainage in Washington. Western Division American Fisheries Society Annual Conference, April 2002, Spokane, WA.

2002 Young, S.F., J.G. McLellan, and J.B. Shaklee. (poster). A microsatellite DNA-based analysis of population structure of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in the Pend Oreille basin in Washington. Genetics of Subpolar Fish and Invertebrates, 20th Lowell Wakefield Fisheries Symposium, May 2002, Juneau, Alaska.

1999 McLellan, J.G., H.J. Moffatt, and A.T. Scholz. Walleye (*Stizostedion vitreum vitreum*) population dynamics in Lake Roosevelt, Washington. Washington State Lake Protection Association (WALPA) Annual Conference, Spokane, WA.

1998 McLellan, J.G., A.T. Scholz, H.J. Moffatt (McLellan), and B.J. Tucker. (poster). Walleye (*Stizostedion vitreum vitreum*) population dynamics in Lake Roosevelt, Washington, 1997. International Conference on Ecosystem-Based Management in the Upper Columbia River Basin, April 1998, Castlegar, British Columbia, Canada.

1998 Moffatt (McLellan), H.J., J.G. McLellan, A.T. Scholz, and T.R. Nelson. (poster). A preliminary estimate of the largescale sucker (*Catostomus macrocheilus*) population in Lake Roosevelt, Washington, 1997. International Conference on Ecosystem-Based Management in the Upper Columbia River Basin, April 1998, Castlegar, British Columbia, Canada.

1998 Scholz, A.T. (presenter), J.G. McLellan, and H.J. Moffatt (McLellan). Incidence of gas bubble trauma in Lake Roosevelt fishes in 1997. International Conference on Ecosystem-Based Management in the Upper Columbia River Basin, April 1998, Castlegar, British Columbia, Canada.

## PRESENTATIONS TO COMMUNITY GROUPS:

2010 McLellan, J.G. Spokane River redband trout – native or not? Spokane Falls Chapter Trout Unlimited, October 2010, Spokane, Washington.

2008 McLellan, J.G., and R.R. O'Connor. Redband trout in the Spokane River drainage. Spokane Falls Chapter Trout Unlimited, March 2008, Spokane, Washington.

2006 McLellan, J.G., M. Polacek, and M. Divens. Fish population assessment of Loon Lake, Stevens County, Washington. Loon Lake Property Owners Association, April 2006, Deer Lake, Washington.

2006 McLellan, J.G., M. Polacek, and M. Divens. Fish population assessment of Deer Lake, Stevens County, Washington. Deer Lake Property Owners Association, February 2006, Deer Lake, Washington.

2003 McLellan, J.G. Spokane River wild rainbow trout genetics project. Spokane Falls Chapter Trout Unlimited, December 2003, Spokane, Washington.

## CERTIFICATIONS AND TRAINING:

Department of Interior Motorboat Operator Certification Course. Washington Department of Fish and Wildlife, Spokane, Washington. April 2010.

Basic First Aid/CPR. Washington Department of Fish and Wildlife, Spokane, Washington. November 2009.

ArcGIS Desktop II: tools and functionality. Juniper GIS Services. Spokane, Washington. December 2006.

Introduction to ArcGIS I. ESRI, Olympia, Washington. February 2004.

U.S. Coast Guard Auxiliary (USCGAUX) Boating Skills and Seamanship Course. USCGAUX, Spokane, Washington. February 1998.

## HONORS AND AWARDS:

2009 Best Science Award, Region One. Washington Department of Fish and Wildlife, Spokane, Washington.

2004 Esprit de Corp Award, Region One. Washington Department of Fish and Wildlife, Spokane, Washington.

## REFERENCES:

References provided upon request.

## Education

*B.Sc. Ecology, University of Calgary, Alberta, Canada, 1993*

*B.Sc. Zoology, University of Calgary, Alberta, Canada, 1991*

# Golder Associates Ltd. – Castlegar

***Intermediate Biologist***

Mr. Grutter has pursued a career in environmental biology since 1987. Prior to joining Golder, Mr. Grutter gained substantial experience in the identification of Pacific coast salmonids and conducted fish habitat assessments on coastal streams on Vancouver Island, the mid-coast region of British Columbia, and the Queen Charlotte Islands. Since joining Golder/RL&L Environmental Services Ltd. in 1996, Mr. Grutter has participated in numerous fisheries studies and environmental assessments and was certified as a registered professional biologist with the Association of Professional Biologists of British Columbia in 2001.

Mr. Grutter has experience with a variety of fish sampling techniques including boat electroshocking, backpack electrofishing, minnow traps, fyke nets, vertical and horizontal gill nets, fish fences, Nordic nets, sturgeon setlines, and beach seining. From 2000 to 2005, Mr. Grutter has conducted white sturgeon spawning studies on the Columbia River and compiled a summary of all existing lower Columbia River (Canada) spawning data from 1993 to 2001 in an interpretative report and a poster-presentation at the 2004 World Fisheries Congress in Vancouver. Paul has conducted salmonid, white sturgeon, and lamprey studies on the Columbia River and its tributaries and served in the role as project biologist responsible for the surgical implantation of sonic and/or radio transmitters during these studies. Specific to fisheries research, Mr. Grutter is experienced with application of acoustic and telemetry monitoring equipment and has a good understanding of the strengths and limitations of both systems. From 2007 to 2008, Paul was responsible for planning and implementing the telemetry study component as part of Boundary Dam FERC relicensing for Seattle City Light.

From 1996 to 2008, Mr. Grutter gained considerable experience in conducting total dissolved gas studies of hydroelectric facilities on the Columbia, Kootenay, Pend d'Oreille rivers. Recent work includes the 2003 and 2004 reports that summarize TDG monitoring conducted for Avista as part of their FERC relicensing process. In 2007 and 2008, Mr. Grutter was responsible for design and deployment of dissolved gas monitoring arrays and TDG data collection in the tailrace and forebay reaches of Boundary Dam for the total dissolve gas component as part of Boundary Dam FERC relicensing for Seattle City Light.

# Employment History

***Golder Associates Ltd./R.L.&L. Environmental – Castlegar, BC***

*Biological Technician 1996 to 2000, Fisheries Biologist 2001 to current (1996 to PRESENT)*

Initial tasks involved monitoring dissolved gas levels, participating in whitefish population assessments, rainbow trout and lamprey telemetry studies, and conducting fish and fish habitat inventory assessments. Later duties included

## Certifications

*Small Vessel Operators Permit (SVOP), West Coast Powerboat Handling, 2009*

*MED A3 Basic Safety for Small Non-Pleasure Vessels, West Coast Powerboat Handling, 2008*

*Columbia Mountain Institute, Statistics for Biologists – a refresher course, 2005*

*Occupational First Aid (Level 1) and Transportation Endorsement , 2011)*

*Golder U Communications Course , 2002*

*Swiftwater Safety Operations , Certified June 2011*

*Malaspina University College, BC Backpack Electrofishing Course (M.O.E. approved) Crew Supervisor certification, 1998*

*BC Watershed Restoration Program Channel Conditions and Prescriptions Assessment Course, 1997*

*Gully Assessment Course , 1995*

*NAUI Open Water Diving Certification , 1993*

## Languages

*English – Fluent*

white sturgeon and lamprey studies, designing and installing instream habitat enhancement structures, and environmental monitoring at dam construction sites. Also involved in report writing and data analysis.

### *Strathinnes Forestry Consultants – Nelson BC*

*Forestry Technician (1996)*

Primary role in the company involved timber cruising and determining the feasibility of pursuing road deactivation contracts.

### *Coast Forest Management Ltd. – Victoria, BC*

*Ecologist (1994 to 1995)*

Initially involved in learning block layout, road design, surveying, timber cruising, and fish stream surveys. Later work involved participating in a Marbled Murrelet study and conducting a Level 1 and Level 2 FRBC stream inventory on two TFLs on the Queen Charlotte Islands.

### *Forestry Canada – Edmonton, AB*

*Forestry Technician (1992 to 1992)*

This position involved conducting ecosystem survey plots as part of the Boreas program. Later work included aging trees using TRIM analysis and identifying pollen samples retrieved from lake sediment cores.

## PROJECT EXPERIENCE – FISHERIES INVESTIGATIONS

**White Sturgeon Necropsy**
Castlegar, BC, CANADA

In certain years, a small number of Columbia River white sturgeon in the reach between HLK and the International Border are killed or mortally injured. On behalf of the Ministry of Environment, with funding provided by BC Hydro, Columbia Power Corporation, and FortisBC, autopies were conducted on these fish recovered from the Columbia and Kootenay rivers to determine the likely cause of death. During the autopsies, allometric measurements of physical attributes, the condition of internal organs, evidence of internal and external damage, and the extent of decomposition were recorded. The presence of external and internal identifying marks was determined to determine whether the fish had been previously captured during biological sampling. Upon completion of the autopsy, otoliths were removed and sent to Ministry of Environment for archiving. A written autopsy summary was provided to BC Hydro, DFO, and the Ministry of Environment.

**White Sturgeon Spawn Monitoring Investigation**
Waneta, BC, CANADA

Investigations were conducted from 1993 to 2005 to assess white sturgeon spawning activity in the tailrace area of Waneta Dam. The primary objectives of these studies were to assess effect of dam operations and other environmental variable on spawn frequency and intensity. Sampling involved the deployment of egg collection mat at specific locations within the known spawning area. These mats were routinely inspected and all eggs recovered were either preserved for developmental staging or were incubated in situ to hatch for later DNA analysis. For the spawn monitoring investigations conducted from 2000 to 2005, duties included project management, sampling design, crew supervisor, data analysis, and report writing.

**Brilliant Expansion Project: White Sturgeon Monitoring Program: Castlegar, BC, CANADA**

The construction phase of the monitoring program involved installation of three underwater cameras in the Brilliant Dam plungepool. Also included was boat-based monitoring using a mobile underwater camera to look for the presence of sturgeon and other fish species within an eddy that formed downstream of a rockfill workpad that was used to dampen the effects of blasting into the bedrock of the riverbed. The boat-based monitoring, along with sonic telemetry information and other field observations, formed part of an intensive monitoring program conducted during the first five days of instream blasting. The results from the intensive monitoring phase, coupled with interpretation of data from a hydrophone/seismograph system deployed by the client to monitor blast overpressures, were used to develop recommendations for a final monitoring plan that could be implemented during the remainder of the 2003/2004 instream works window and during subsequent instream windows in 2004/2005 and 2005/2006. A semi-permanent underwater video camera was deployed in the eddy downstream of the workpad to provide on-going monitoring of fish activity during the instream blasting window.

**Priest Rapids and Wanapum White Sturgeon Studies**
Vantage, WA, CANADA

This three-year study in central Washington began in 2000. Grant County Public Utility District commissioned Golder Associates Ltd. (then R.L. & L. Environmental Services Ltd.) to conduct white sturgeon studies in Priest Rapids and Wanapum reservoirs. These studies included capturing white sturgeon using setlines and surgically implanting each fish with a sonic tag. These fish were then tracked to determine overwintering and spawning locations. Spawning studies were conducted using artificial substrate mats to determine time and location of spawning events. This study was conducted in both Wanapum and Priest Rapids Reservoirs. Duties included white sturgeon capture, surgical examination and tag implantation, boat operation, field crew supervision, and coordinating with the project lead. (2000-2002). A post-licensing re-assessment of white sturgeon populations was conducted in 2010, during which additional duties also included project management, data analysis, and report writing.

**Priest Rapids Lamprey Telemetry Studies**
Vantage, WA, CANADA

In conjunction with LGL, this two-year study in central Washington began in 2001. Grant County Public Utility District commissioned Golder Associates Ltd. (then R.L. & L. Environmental Services Ltd.) to conduct lamprey studies at Priest Rapids Dam. These studies included capturing lamprey from the fish ladder using dip nets and velocity-shelter traps. Lamprey of suitable size were surgically implanted with a radio tag. These fish were then tracked to determine overwintering and spawning locations. Duties included lamprey capture, surgical radio tag implantation, telemetry tracking, and coordinating with the project lead. (2001-2002)

**Rocky Reach White Sturgeon Studies**
Wenatchee, WA, CANADA

This two-year study in central Washington began in 2001. Chelan County Public Utility District commissioned Golder Associates Ltd. (then R.L. & L. Environmental Services Ltd.) to conduct white sturgeon studies in Rocky Reach reservoir. These studies included capturing white sturgeon using setlines and surgically implanting each fish with a sonic tag. These fish were then tracked to determine overwintering and spawning locations. Duties included white sturgeon capture, surgical examination and tag implantation, boat operation, field crew supervision, and coordinating with the project lead. (2001-2002)

**BEX White Sturgeon Monitoring in Brilliant Tailrace**
Castlegar, BC, CANADA

In order to determine the presence or absence of white sturgeon in the plunge pool area of Brilliant Dam, remotely operated video (ROV) surveys were conducted during periods of the year that coincided with the proposed tailrace work related to the Brilliant Dam expansion. Tasks included boat and equipment operation, crew supervision, and project coordination. (2001-2002)

**Rocky Reach Fisheries Inventory**
Wenatchee, WA, CANADA

Duke Engineering & Services, with the assistance of R.L.&L. Environmental Services, was contracted to assess the fish rearing and habitat utilization in Rocky Reach reservoir. The study area for the project includes the Rocky Reach hydroelectric project from Rocky Reach Dam to the tailrace of Wells Dam on the mainstem Columbia River in Washington State. Sampling consisted of fike netting, G-minnow traps, and beach seining. Tasks include field sampling, data collection, and boat operation. (2000)

**South Salmo Fish Habitat Enhancement**
Nelway, BC, CANADA

To compensate for rainbow trout entrainment losses at Waneta Dam, the Waneta Upgrade Project Mitigation and Compensation Plan was developed by Golder Associates for Teck Cominco. As part of the plan, eight instream structures were installed in the South Salmo River to provide holding and rearing for juvenile rainbow trout and spawning habitat for mature rainbow trout. Duties included candidate stream selection, preliminary structure design, structure installation, project management, and pre- and post-installation habitat and fish population assessments, report composition, and annual structural integrity assessments. (2000 pre-assessments and installation; 2002 & 2005 post assessment)

**White Sturgeon DNA Hook**
Castlegar, BC, CANADA

Funded in part by the Golder Innovation Award, the objective of this project was the development of a suitable DNA hook and a passive deployment method to obtain DNA samples from white sturgeon. The DNA hooks were developed by Rik Buckworth (Fisheries Group Department of Business in Berrimah, Australia) and consist of a shank made out of copper wire or tubing fitted with a stainless steel tissue retaining tip. When taken by a fish, the hooks were designed to straighten while retaining a small tissue sample. Based on a test deployment conducted in August 2005 and subsequent DNA analysis, DNA hooks were demonstrated as a cost-effective method to recover multiple viable DNA samples from adult white sturgeon in the Columbia River. Duties included project management, grant application, study design and field implementation, data analysis, and report writing.

**Seven Mile Reservoir and Tailrace Biotelemetry**
**Seven Mile Dam, BC, CANADA**

In conjunction with radio telemetry programs at both Boundary Dam and in the Salmo River, a solar-powered radio telemetry station was installed in the tailrace of Seven Mile Dam on the Pend d'Oreille River. The station was programmed to detected tags on the two frequencies used by the above studies. Mobile telemetry tracking of the upper Seven Mile Reservoir was conducted on a biweekly basis.

**Triploid Trout Management**
**Boundary Dam, WA, USA**

As part of the Boundary Dam FERC relicensing, data were collect to assess the survival, growth and potential biological effects of triploid trout releases in the Boundary Dam reservoir. A portion of the annual releases were marked with external t-bar anchor tags. Tags were recovered and turned in by anglers under a tag reward program. Tags were also recaptured during monthly fish sampling conducted under other Boundary relicensing studies. Data provided included movement and distribution, growth, and approximate estimates of survival. Forty new released triploid were radio tagged, these fish provided information on movement and habitat use. Upon completion of the study in 2008, the overall objective will be to develop a triploid release management plan. Responsibilities included data collection protocol, study and personnel coordination, data management, data analysis, report writing, and client liaison (2007-2008).

**Radio and Acoustic Biotelemetry**
**Boundary Dam, WA, USA**

As part of the Boundary Dam FERC relicensing, a radio and acoustic biotelemetry monitoring program was conducted in the Boundary Dam reservoir and tailrace reaches. In total, eleven fixed radio telemetry stations were installed throughout the study area. Target fish species were tagged with either radio tags, CART tags, or a dual radio/acoustic tag combination. The majority of tags were implanted throughout study year during regular monthly electrofishing sampling. Tagging implantation was also conducted during a fish derby, spring and fall triploid trout release, and during a one-week intensive capture and tagging session. Boat-based mobile tracking with radio and acoustic receivers was conducted on a biweekly basis. Biweekly servicing and downloading of the fixed telemetry station was also conducted. Responsibilities included development and implementation of fixed station servicing and mobile tracking protocol, data collection protocol, study and personnel coordination, data management, data analysis, report writing, and client liaison (2007-2008).

**Fish Population Assessment of the Lower Pend d'Oreille River**
**Castlegar, BC, CANADA**

This study was conducted in 1999 and 2000 for the City of Seattle, City Light Department, on the lower Pend d'Oreille River between Boundary and Seven Mile dams. The objectives of the study were to determine the species composition and relative abundance of fish species in the area with emphasis on native species of concern such as bull trout and white sturgeon; to assess the temporal and spatial distribution of fish; and to conduct a literature review and summarize available data to provide an overview of the status of bull trout and white sturgeon in the study area.

**Assessment of Fish Use in the Waneta Area**
**Trail, BC, CANADA**

This study was conducted in the late summer of 2001 for Colombia Power Corporation as part of the Waneta Expansion Project. The Waneta Expansion Project involves the construction of a new powerplant downstream of the existing dam. The new powerplant would generate electricity from water spilled from Waneta Dam under current operating conditions and bring Waneta Dam closer in power generation capacity with upstream plants (Seven Mile and Boundary dams). The two primary objectives of this study were to conduct a fisheries inventory of the Waneta area during the same time period as in past studies, using the same sample methods at the same locations in order to assess whether the fish species assemblage had changed; and to document, using remotely operated underwater video equipment, the species of fish that use Waneta Eddy during the fall, winter, and spring.

**Pre-project Monitoring in Brilliant Headpond and Tailwater Areas**
**Castlegar, BC, CANADA**

This study was conducted in 2000 and 2001 for Columbia Power Corporation as part of the Brilliant Expansion Project. The Brilliant Expansion Project involves the construction of an additional powerhouse adjacent to the existing Brilliant Dam on the lower Kootenay River to generate hydroelectric power from water that is currently spilled. The purpose of the Brilliant headpond excavated rock disposal portion of this study was to determine the seasonal fish species composition, relative abundance, and fish use patterns; and assess the habitat availability and suitability in the bank infill zone of Brilliant headpond; and through comparisons of pre and post-project results, to determine the effects of intake channel excavation and the placement of excavated rock on the existing habitat and fish uses of adjacent areas. The purpose of the Brilliant tailwater area portion of this study was to document the general fish use of this area and provide a baseline database against which post-project results could be compared and the effects of the tailwater excavation determined.

**BC Hydro General Fish & Egg Stranding**
**Columbia River, BC**

For each flow reduction in the Kootenay Generating Area (KGA), a specific protocol is followed involving querying the fish stranding database for historic results; assessing the current risk of fish stranding; and the mobilization and deployment of crews if necessary. Fish salvage activities include back-pack electrofishing; beach seining and visual assessments of shoreline habitats. Flow reduction responses have occurred on various rivers in the area including the lower Columbia, Kootenay, and Pend D'Oreille Rivers. (2002-Present)

**Duncan River Ramping Rate Study**
**Duncan River, BC, CANADA**

During the summer and fall of 2004-2009, a ramping study on the Duncan river was conducted in efforts to determine the ideal ramping rate to minimize the incidence of interstitial fish stranding. Two different sample methods were investigated, including a transect survey method and a net pen enclosure study. Flows from Duncan Dam were adjusted at different rates during day experiments.

## PROFESSIONAL AFFILIATIONS

Association of Professional Biologists of British Columbia

Ducks Unlimited Canada

## PUBLICATIONS

**Other**

TECHNICAL AND SCIENTIFIC REPORTS

Grutter, P. 2006. Assessment of fish habitat and fish populations associated with enhancement structures in the South Salmo River, 2005 investigations. Report prepared for Cominco Ltd., Trail, BC. Golder Report No. 051480042F: 35p. + 2 app.

Grutter, P. 2006. White sturgeon spawning at Waneta, 2005 investigations. Report prepared for Teck Cominco Metals and BC Hydro. Golder Report No. 05-1480-030F: 40p. + 1 app.

Grutter, P. 2005. Total Dissolved Gas Pressure (TGP) Monitoring at Waneta Dam, 2004 Investigations. Report prepared for Columbia Power Corporation, Castlegar, BC. Golder Report No. 04-1480-025F: 39 p. + CD Appendix.

Grutter, P. 2005 White sturgeon spawning at Waneta, 2004 investigations. Report prepared for Teck Cominco Metals and BC Hydro. Golder Report No. 04-1480-042D: 22 p. + 1 app.

Grutter, P. 2004. Total Dissolved Gas Pressure (TDG) Monitoring on the Spokane River, 2004 Final Data Report. Report prepared for Avista Corporation, Castlegar, BC. Golder Report No. 033-1363C2004F: 55 p. + 1 Appendix + plates.

Grutter, P. 2004. Total dissolved gas pressure monitoring of Arrow Lakes Generating Station (ALGS): 2002-2003. Data summary and final report. Report prepared for Columbia Power Corporation, Castlegar, BC. Golder Report No. 031480031F: p12 + 2 app.

Grutter, P. and B. Hildebrand. 2004. White sturgeon spawning at Waneta, 2003 investigations. Data Report prepared for Teck Cominco Metals Ltd. and BC Hydro. Golder Report No. 03-1480-032D: 19 p. + 1 app.

Grutter, P. 2003. Total Dissolved Gas Pressure (TDG) Monitoring on the Spokane River, 2003 Data Report. Report prepared for Avista Corporation, Castlegar, BC. Golder Report No. 033-1363CD: 48 p. + 2 appendices, 1 CD.

Grutter, P., Hildebrand, L., and Schmidt, D. 2004. Large River Fish Indexing Program: Middle Columbia River - 2003 Phase 3 Investigations. Report prepared for BC Hydro Power Supply Environmental Services, Burnaby, BC. Golder Report No. 031480022F 53p. + 4 app.

Grutter, P. 2003. White sturgeon spawning at Waneta, 2002 investigations. Report prepared for Columbia Power Corporation, Castlegar, BC. Golder Report No. 0228016F: 23 p. + 1 app.

Grutter, P. 2003. Assessment of fish habitat and fish populations associated with enhancement structures in the South Salmo River, 2002 investigations. Report prepared for Cominco Ltd., Trail, BC. Golder Report No. 0228015F: 28p. + 2 app.

Grutter, P. 2002. Total dissolved gas pressure database for the Columbia, Kootenay, and Pend d'Oreille rivers (Canada), 1995 to 2000. Database prepared for the Columbia River Integrated Environmental Monitoring Program, Victoria, BC. Golder Report No. 0128963D.

Hildebrand, L. and Grutter, P. 2002. White sturgeon spawning at Waneta, 2001 investigations and historical data summary. Report prepared for Columbia Power Corporation, Castlegar, BC. Golder Report No. 0128966D: 46 p. + & app.

Schmidt, D. and Grutter, P. 2002. Kootenay River total dissolved gas data compilation and simulation summary (1972 to 2000). Report prepared for Utilicorp Networks Canada, South Slocan, BC. Golder Report No.0128017D: 27 p.

Schmidt, D. and Grutter, P. 2002. Total dissolved gas modeling of Waneta Dam, pre-upgrade and post-upgrade operations. Report prepared for Acres International Ltd., Vancouver, BC. Golder Report No. 0228002F: 27 p. + 1 app.

Hildebrand, L. and Grutter, P. 2001. Columbia River white sturgeon spawning studies, 2000 investigations. Data report prepared for BC Ministry of Environment, Lands and Parks, Nelson, BC by R.L. & L. Environmental Services Ltd. R.L. & L. Report No. 853F.

Hildebrand, L., Grutter, P., and Zimmer, M. 2001. Rainbow trout habitat assessment and enhancement structure installation in the South Salmo River. Report prepared for Cominco, Trail, BC by R.L. & L. Environmental Services Ltd. R.L. & L. Report No. 851F.

Hildebrand, M. and Grutter, P. 2001. Brilliant Dam Expansion Project, pre-project biological monitoring of the Brilliant Reservoir spoils area and Brilliant Dam tailrace. Report prepared for Columbia Power Corporation by R.L. & L. Environmental Services Ltd. R.L. & L. Report No. 831/848D.

Grutter, P. 2000. Total gas pressure monitoring at Hugh L. Keenleyside Dam, 1999 investigations. Report prepared for Columbia River Integrated Environmental Monitoring Program, Nelson, BC by R.L. & L. Environmental Services Ltd. R.L. & L. Report No. 753F.

Grutter, P. 2000. Kootenay River total gas pressure monitoring, 1999

investigations. Report prepared for Columbia River Integrated Environmental Monitoring Program, Nelson, BC by R.L. & L. Environmental Services Ltd. R.L. & L. Report No. 739F.

PRESENTATIONS AND CONFERENCES

2004 Grutter, P., Schmidt, D., and Hildebrand, L. 2004 The challenge of conserving upper Columbia River white sturgeon: Evaluating temporal spawning trends. Poster presentation at the 4th World Fisheries Conference. Vancouver, British Columbia.

2004 Grutter, P. 2004 Large river indexing program, Middle Columbia River, 2003 Phase 3 investigations. Presentation for BC Hydro Large Rivers Seminar.

2003 Presentation on Investigations of White Sturgeon Spawning in the Upper Columbia River at AFS NPIC Annual General Meeting, Vancouver, BC.

2002 Presentation on total dissolved gas issues in the Canadian portion of the Columbia River Basin at Towards Ecosystem-based Management: Breaking down the barriers in the Columbia River and Beyond, Spokane, WA.

2001 Presentation on the fish habitat enhancement project on the South Salmo River at Salmo-Pend d' Oreille Watersheds Strategic Management Plan Project Update Meeting in Salmo, BC.

2001 Presentation on the fish habitat enhancement project on the South Salmo River at the Cominco Energy Group Seminar, Cominco, Trail, BC.

# APPENDIX B
# LIST OF AQUATIC SETTLEMENT WORK GROUP MEMBERS

## Aquatic Settlement Work Group Members

**Signatory Parties**

| Organization | Policy Representative | Technical Representative |
|---|---|---|
| Douglas PUD | Shane Bickford | Beau Patterson |
| Yakama Nation | Paul Ward | Steve Parker |
| U.S. Fish and Wildlife | Jessi Gonzales | Steve Lewis |
| U.S. Bureau of Land Management | Karen Kelleher | Karen Kelleher |
| Washington State Department of Ecology | John Merz | Pat Irle |
| Washington Department of Fish and Wildlife | Patrick Verhey | Bob Jateff |
| Colville Confederated Tribes | Joe Peone | Bill Towey |

**Technical Support**

| Organization | Representative | Expertise |
|---|---|---|
| Washington Department of Fish and Wildlife | Molly Hallock | Lamprey |
| Washington Department of Fish and Wildlife | Brad James | Sturgeon |
| Washington Department of Fish and Wildlife | Chad Jackson | Fisheries |
| Douglas PUD | Bao Le | Lamprey |
| Colville Confederated Tribes | Kirk Truscott | Fisheries |
| Colville Confederated Tribes | Brett Nine | Sturgeon |
| Yakama Nation | Patrick Luke | Lamprey |

# APPENDIX C
# AQUATIC SETTLEMENT WORK GROUP
# 2011 STUDY REPORTS

- White Sturgeon Broodstock Collection and Breeding Plan (Supplementation Plan)
- RFP #11-19-W Juvenile Columbia River White Sturgeon (*Acipenser Transmontanus*) for Population Supplementation in the Wells Reservoir, Columbia River, Washington (includes White Sturgeon Broodstock Collection and Breeding Plan)
- 2009 Assessment of Adult Pacific Lamprey Response to Velocity Reductions at Wells Dam Fishway Entrances (2009 DIDSON Study Report)
- Draft 2010 Assessment of Adult Pacific Lamprey Response to Velocity Reductions at Wells Dam Fishway Entrances (2010 DIDSON Study Report)
- 2011 Wells Dam Fishway Entrance Velocity Measurements Memo
- 2011Wells Project Total Dissolved Gas Abatement Plan (GAP) Annual Report
- 2011 Wells Project Gas Bubble Trauma Biological Monitoring Report (revised February 2012)
- 2010 Bull Trout Monitoring and Management Plan Annual Report
- 2011 Aquatic Nuisance Species Monitoring PowerPoint Presentation
- 2011 Aquatic Macrophyte Species Survey Letter to Ecology

# WHITE STURGEON BROODSTOCK COLLECTION AND BREEDING PLAN (SUPPLEMENTATION PLAN)

# WHITE STURGEON BROODSTOCK COLLECTION AND BREEDING PLAN

# WELLS HYDROELECTRIC PROJECT
# FERC PROJECT NO. 2149

Public Utility District No.1 of Douglas County
East Wenatchee, WA 98802

**September 2011**

# Table of Contents

# 1.0 INTRODUCTION

## 1.1 Wells Project Relicensing

As a component of the FERC relicensing of the Wells Hydroelectric Project (Wells Project), the Public Utility District No. 1 of Douglas County (Douglas) developed a White Sturgeon Management Plan (WSMP; Douglas PUD 2008) as one of six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement (Agreement). The WSMP was developed in close coordination with agency and tribal natural resource managers (Aquatic Settlement Work Group or Aquatic SWG). During the development of this plan, the Aquatic SWG focused on developing management priorities for resources potentially impacted by Project operations.

The WSMP for the Wells Project was based on similar plans that have been developed in other areas of the middle and upper Columbia River Basin, specifically the Kootenai White Sturgeon Recovery Plan, the Upper Columbia White Sturgeon Recovery Initiative (UCWSRI 2002), the Priest Rapids White Sturgeon Management Plan (Grant PUD 2009), and the Rocky Reach White Sturgeon Management Plan (Chelan PUD 2005). The Kootenai and Upper Columbia recovery programs were implemented in 1996 and 2001, respectively. The Priest Rapids WSMP was initiated in 2009 and the Rocky Reach WSMP was initiated in 2010.

## 1.2 Wells Project White Sturgeon Population Status

Research to determine the abundance, distribution, population dynamics, biophysical attributes of preferred habitat, seasonal movement patterns, and spawning characteristics of white sturgeon were conducted in Wells Reservoir from 2001 to 2003 (Jerald 2007). This information has been summarized below and where applicable, has been used to tailor the White Sturgeon Broodstock Collection and Breeding Plan to the Wells Project area.

A relatively small population of white sturgeon (estimated at 34 fish; 95% CI of 13 - 217 fish), primarily consisting of adults, is present in the Wells Reservoir. Based on set line capture and radio telemetry movement information, white sturgeon were found primarily near the confluence of the Okanogan and Columbia rivers and in the lower Okanogan River. White sturgeon were not documented during telemetry surveys or setline surveys that took place outside this area during the spawning period. The location of spawning areas and the occurrence of spawning in the reservoir have not been documented.

Sex ratios for white sturgeon captured in the Wells Reservoir were not determined. Captured sturgeon ranged in age from 6 to 30 years old demonstrating that all of these fish recruited to the Wells Reservoir after Wells Dam was completed in 1967 with strong year class recruitment between the years 1972 and 1978 and again between 1988 and 1996. The presence of fish within these age classes suggests that successful recruitment within or to the Wells Reservoir is occurring either through (1) spawning within the Wells Reservoir and/or (2) immigration into the Wells Reservoir from populations upstream.

Catches were dominated by white sturgeon from 60 to 135 cm fork length (FL), which represented fish between the 1988 to 1997 year-class and from 180 to 210 cm FL (1972 to 1978 year-class). These two groups accounted for all captures. The histogram showed a relatively low distribution of younger juvenile white sturgeon, with 15% of the total catch composed of juvenile fish less than 90 cm. However, the use of set lines with large circle hooks (11/0, 13/0 and 15/0) likely reduced the capture of smaller, younger fish.

Two white sturgeon were captured and subsequently recovered to provide growth rate information. One juvenile grew from 65 cm FL at capture on July 11, 2001 to 87 cm FL on September 26, 2002, a growth rate of 22 cm in 14 months. One adult fish caught on August 9, 2001 measured 197 cm FL and when recaptured on September 6, 2002 measured 199 cm FL, a 2 cm growth over approximately 13 months. This fish was subsequently found deceased in October of 2006 and was 228.5 cm FL, which represented an increase of 29.5 cm FL over an approximate four year period (average of 7.4 cm per year).

In total, six white sturgeon were radio-tagged and monitored throughout the study period using mobile and fixed telemetry. Telemetry data along with set line capture data verified that white sturgeon congregated in the Columbia River near the Okanogan River confluence during the summer, fall, and winter months with none of the six fish being detected downstream from Brewster (RM 530) or upstream of Park Island (RM 538). Very little movement of tagged sturgeon was observed during winter months. In the spring of 2002, one adult made an upstream migration into the Okanogan River; in 2003, two different adults undertook movements into the Okanogan River.

In general, the results of the white sturgeon study in the Wells Reservoir were similar to the results of a study conducted in the neighboring Rocky Reach Reservoir in 2001-2002 (Chelan PUD 2005). Both studies captured similar numbers of sturgeon using similar amounts of effort and similar capture techniques. Radio-telemetry data from both studies suggest that very little activity occurs during the overwintering period. Both studies suggest that limited recruitment into each population is occurring based on the presence of juvenile fish in both reservoirs (Chelan PUD 2005; Jerald 2007).

## 1.3 Sturgeon Propagation and Supplementation

The first recorded attempts at artificial propagation of sturgeon were made by Ovsyandikov in Russia in 1870 and Green in the U.S. in 1875. Significant efforts to artificially propagate sturgeon continued in North America between 1875 and 1912, however, by 1920 practically all these efforts were abandoned (Conte et al. 1988). Sturgeon hatchery research continued in the Soviet Union and by the 1980s the Soviets operated approximately 20 hatcheries producing 70 to 100 million fingerlings annually. The success of the sturgeon hatchery programs in the Soviet Union rekindled interest in sturgeon research in the U.S. The work of Detlaf, Gerbilisky, Ginzburg, Kozin, Doroshov and their associates laid the groundwork for the advancement of sturgeon programs throughout North America (Conte et al. 1988).

In 1979, a grant from the U.S. Fish and Wildlife Service to researchers at the University of California led to a resurgence of sturgeon research. The development of hatchery technologies for white sturgeon has allowed the advancement of a growing commercial sturgeon aquaculture industry on the West Coast. A hatchery manual for white sturgeon (Conte et al. 1988) was developed by University of California (Davis) researchers.

Within the native range of white sturgeon in North America, early attention has been placed on the advancement of a specific type of sturgeon hatchery involved in what is termed "conservation aquaculture". Essentially these facilities are used as tools for the recovery of endangered or depressed sturgeon species/stocks. Given the issues associated with legislation regarding endangered species in North America (the Endangered Species Act in the U.S. and the Species at Risk Act in Canada), it is deemed unacceptable to stock large numbers of generic-stock white sturgeon as a method to recover endangered populations. Instead, a conservation aquaculture program was developed that factors in issues/concerns such as genetic make-up, genetic swamping, interaction with adjacent populations, breeding plans, family numbers, etc., as compared to a typical hatchery where production numbers and fish health are the dominant concerns. At present, the four white sturgeon conservation aquaculture facilities presently operating in the Pacific Northwest are:

Kootenai Sturgeon Hatchery constructed in 1991 on the Kootenai River near Bonners Ferry, Idaho and run by the Kootenai Tribe of Idaho. This facility is the main culture facility for the Kootenai white sturgeon recovery program.

Kootenay Trout and Sturgeon Hatchery (KTSH) at the upper end of Lake Koocanusa near Wardner, B.C and run by the British Columbia Ministry of Environment (BCMOE). This facility was originally a trout hatchery and was expanded in 1998 as a failsafe facility to raise sturgeon for the Kootenai white sturgeon recovery program and in 2001 commenced production for the Upper Columbia White Sturgeon Recovery program.

The Washington Department of Fish and Wildlife, Spokane Tribe of Indians, and Colville Confederated Tribes established an aquaculture program in Washington in 2003 at WDFW's Columbia Basin Hatchery (CBH) in Moses Lake to assist with the Upper Columbia White Sturgeon Recovery program. All fish produced in the Washington program were released into the Washington section of the Transboundary Reach of the Columbia River. Initially the Washington program utilized Upper Columbia white sturgeon juveniles, and then eggs and larvae provided from the KTSH. The Washington program became self-sufficient in 2006 when they began collecting and spawning their own broodstock. Spawning activities were conducted at the WDFW Sherman Creek Hatchery located near Kettle Falls, WA. The progeny from these fish were raised at the CBH before being released into the Washington section of the Transboundary Reach of the Columbia River. Beginning in 2010, the Washington program experimented with the capture of wild larvae as alternative to brood capture. After positive results, the program discontinued adult broodstock capture and shifted their entire production to wild caught larvae in 2011.

In 2009, the Yakima Nation initiated construction of a white sturgeon culture facility at Marion Drain near Toppenish, WA. This facility received its first broodstock (from McNary Reservoir) in late spring 2010 and is presently rearing sturgeon to be out planted in 2012 as part of the Priest Rapids WSMP and Rocky Reach WSMP.

The ultimate goal of each conservation aquaculture program is to ensure the continued existence of the population while attempting to maximize genetic diversity and keep hatchery-produced fish as "wild" as possible. This approach is fundamentally different from a traditional fish production facility.

## 2.0 PLAN DEVELOPMENT

The goal of the WSMP is to promote growth of the white sturgeon population in the Wells Project area to a level that is commensurate with the available habitat and characterized by a diverse age structure consisting of multiple cohorts (juvenile and adult). This White Sturgeon Broodstock Collection and Breeding Plan is a key component of the WSMP and is the initial step toward increasing the white sturgeon population in the Wells Reservoir. Based upon the available information on the white sturgeon population segment (as summarized in Section 2.0), the Aquatic SWG agreed that efforts should focus, initially, on supplementation efforts to increase the population within the Wells Reservoir in order to address Project effects. Once the population numbers have been increased to a level that can be studied, as determined by the Aquatic SWG, Douglas shall implement a monitoring and evaluation program to accurately assess natural recruitment, juvenile habitat use, emigration rates, carrying capacity, and the potential for natural reproduction so as to inform the scope of a future, long-term supplementation strategy.

The White Sturgeon Broodstock Collection and Breeding Plan supports the following objectives as outlined in the WSMP:

Objective 1: Supplement the white sturgeon population in order to address Project effects, including impediments to migration and associated bottlenecks in spawning and recruitment;

Objective 2: Determine the effectiveness of the supplementation activities through a monitoring and evaluation program;

Objective 3: Determine the potential for natural reproduction in the Wells Reservoir in order to appropriately inform the scope of future supplementation activities;

Objective 4: Adaptively manage the supplementation program as warranted by the monitoring results and in consultation with the Aquatic SWG.

In order to meet these objectives, Douglas, in consultation with the ASWG, is required to develop and implement a White Sturgeon Broodstock Collection and Breeding Plan in Year 1 of the ten year Phase 1 of the implementation of the WSMP. This Plan should be compatible with other similar plans in the Columbia River mainstem. The desired end point is augmentation and maintenance of the sturgeon population through supplementation in order to provide a stable future population.

The following assumptions were considered in the preparation of this Plan:

- natural reproduction is present but appears to be insufficient in the foreseeable future to maintain a stable or increasing population of sturgeon in the Project area;
- the carrying capacity of the Project area is substantially greater than existing white sturgeon population levels;
- recruitment to the existing white sturgeon population at levels necessary to sustain or increase the populations will require supplementation of the existing population;

### 2.1 WSMP Phase I Supplementation Goals

The annual supplementation target for the WSMP is up to 5,000 yearling white sturgeon annually for four consecutive years (up to 20,000 fish total). Additional years and numbers of juvenile sturgeon to be stocked during Phase I would be determined by the Aquatic SWG and would not exceed 15,000 juvenile sturgeon (total of up to 35,000 juvenile sturgeon during Phase I).

### 2.2 Population Model Scenarios

Population trajectories were modeled for the white sturgeon populations in Wells Reservoir with a simple age-structure demographic model using: i) hypothetical hatchery and wild sturgeon recruitment rates; ii) current data on abundance, growth, maturation, and juvenile and adult survival; and iii) the assumptions inherent in the most recent version of the model developed for use in the Upper Columbia River. The following scenario represents expected population responses to supplementation measures (i.e., releasing 5000 hatchery-raised juveniles annually for 4 years into Wells Reservoir and 2500 juveniles per year for the remaining 6 years of the 10-year Phase 1 program). Because of the approximate 25 to 30 year age until full maturation (assumed to be age-25 for the baseline model), the existing adult population is projected to decline to very low numbers over the next 30 years even with the immediate release of hatchery-reared juveniles. After this period, adult numbers build as hatchery sturgeon mature and recruit to the adult population. A key parameter that determines the subsequent status of the population is the number of natural recruits produced by the hatchery-origin adults. This annual recruitment value is unknown at this time, so this input was arbitrarily adjusted to the number required to maintain a stable adult population at the specified target level.

The population trajectory modeled for Wells Reservoir is illustrated below for the baseline scenario. The results of other model runs to determine effects on changes to model assumptions of stocking rates, survival, and age-at-maturity are discussed.

### 2.3.1 Baseline Population

A baseline scenario was modeled based on the following assumptions:

- an initial wild population of 34 fish;
- a stocking rate of 5,000 juveniles per year for the first 4 years (commencing in 2014) with 2500 juveniles per year for the following 6 years;
- zero natural recruits per year for the first 25 years and then 200 natural recruits per year after 25 years;
- females maturing at age-25; and
- population metric data (e.g., growth, survival, size-at-maturity, etc.) from adjacent white sturgeon populations in the upper and middle Columbia River.

This scenario produces an initial rapid population increase to approximately 1,800 adults by 2045, with a subsequent decline in population to the target level of approximately 1,000 adults by 2060 when the progeny of the hatchery adults start to mature and begin to contribute to the wild population (Figure 1). Assuming a 1:1 sex ratio of fish surviving to adulthood, approximately half of the adults would be mature females of which about 115 would spawn in any given year (assuming a 5-year spawning interval for females) by 2045 and decline to 80 females by 2060 (Figure 2). Restoration of a relatively stable sturgeon age distribution for this scenario can be expected in approximately 50 years based on a natural recruitment rate after 25 years of 200 age-1 fish annually (Figure 3).

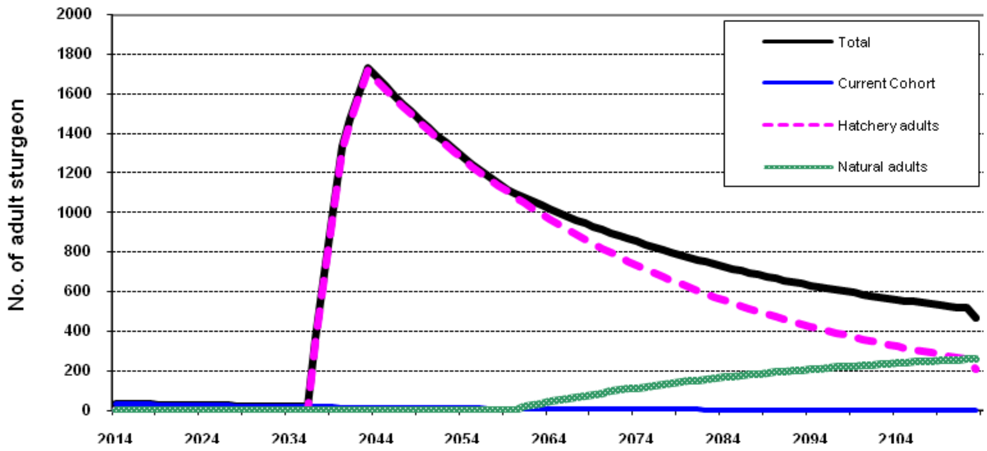



**Figure 1 Projected future wild and hatchery adult white sturgeon population size following implementation of a baseline supplementation scenario in Wells Reservoir.**

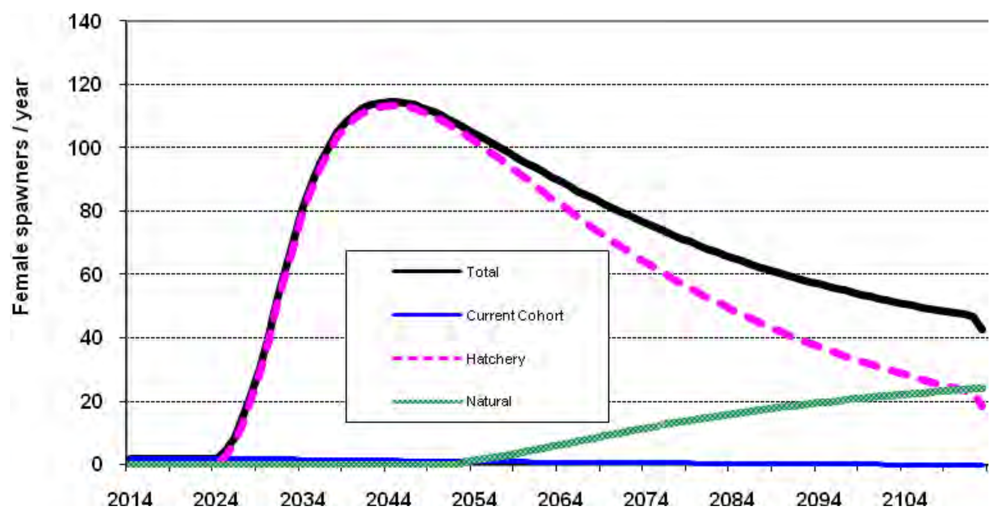



**Figure 2 Projected future reproductive potential of white sturgeon following implementation of a baseline supplementation scenario in Wells Reservoir.**

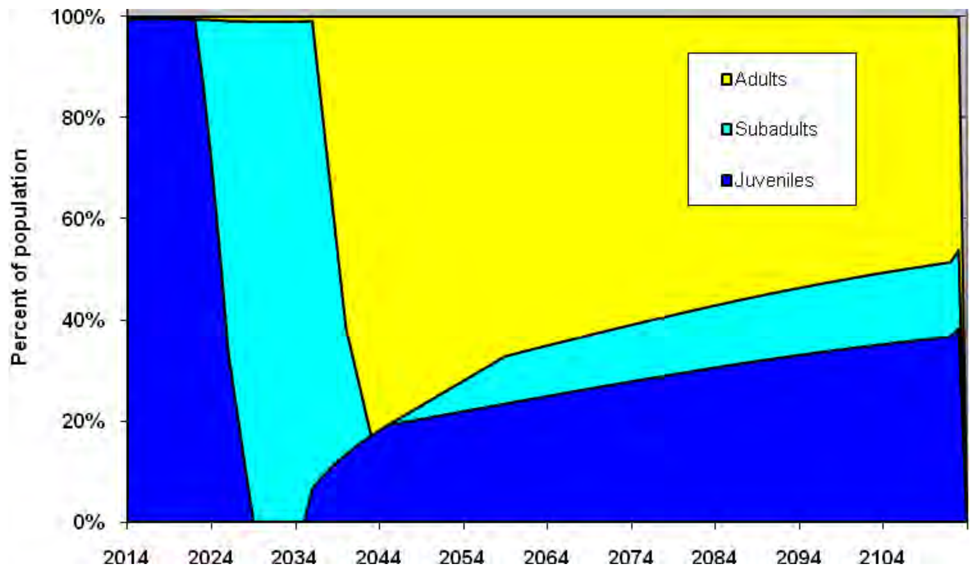



**Figure 3 Projected changes in sturgeon age composition following implementation of a baseline supplementation scenario in Wells Reservoir.**

Maintenance of an adult population size of more than 1,000 adults may not be achievable or desirable in Wells Reservoir. Monitoring of the population status and growth would be required to identify and mitigate negative density-dependent effects on growth and survival. A controlled harvest for sub-adults can be used as a means to adjust future population levels of adult white sturgeon. Using the model above and applying a 5% annual harvest commencing 10 years after the initial stocking and targeting the 100 – 150 cm FL size-class (pre-spawners), would reduce the maximum population size to 1,400 adults. If this harvest were increased to 10% for this size class, total maximum population would be approximately 1,200 adults. Both these estimates assume constant levels of natural recruitment after 25 years.

## 3.0 BROODSTOCK COLLECTION

The Wells WSMP requires that *"the initial source of brood stock shall be determined within the first year of issuance of the new license. Collection of brood stock shall occur consistent with the brood stock collection plan in years 1-4 of the new license. Any additional years during the Phase I program (first ten years of the new license) in which brood stock collection shall occur in order to facilitate additional juvenile stocking into the Wells Reservoir (Section 4.1.2) will be determined by the Aquatic SWG. The intent of brood stock collection is to use their progeny, if feasible, for future white sturgeon stocking activities in the Wells Reservoir. The brood stock collection plan shall be updated annually, or as otherwise recommended by Douglas in consultation with the ASWG, to incorporate new and appropriate information.*

The Wells WSMP calls for the release of up to 5,000 juveniles per year for four years into Wells Reservoir. In consultation with the Aquatic SWG, yearling fish for release shall be acquired from appropriate wild Columbia River sources. Sturgeon for supplementation may be obtained through the collection of gametes from adult broodstock and/or collection of wild larval, subyearling and/or yearling fish. Gametes and/or fish younger than yearlings will be grown out to yearlings in an artificial production environment.

Broodstock contribution of six male and six female spawning sturgeon that would contribute to six maternal families is the recommended target if broodstock collection is utilized to provide up to 5,000 yearling sturgeon annually. If six maternal families are not available through broodstock collection the total of number of juveniles to be released may be less than the 5,000 maximum target. Juveniles obtained from "drift larval capture" techniques (use of D-Rings nets) may be used to provide juveniles for rearing as an alternative or supplemental strategy. Both broodstock collection and drift larval capture are considered pilot programs in the upper mid-Columbia River (Bonneville Dam to Grand Coulee Dam) at this time.

During spring 2010 and 2011, broodstock collection efforts were conducted in several areas of the Columbia River from Rock Island Dam downstream to Bonneville Dam. These initial efforts to meet the supplementation obligations for the Priest Rapids and Rocky Reach WSMPs produced a 2Mx1F spawning cross in 2010 and a 1x1 cross in 2011. Considering the low sturgeon populations in the Wells, Rocky Reach, and Rock Island reservoirs, it is likely that broodstock capture efforts in these reservoirs would be relatively unproductive and insufficient to meet initial supplementation targets. Therefore, the Aquatic SWG recommends that:

i. The preferred collection area for year 1 and 2 (2012 and 2013) white sturgeon supplementation efforts is the greater middle Columbia River from Bonneville Dam upstream to Grand Coulee Dam. Additional collection areas may be considered for future years.
ii. Collection sites, assignments, and appropriate fishing efforts will be coordinated pre-season.
iii. Participants in supplementation capture efforts for the mid-Columbia PUDs will communicate regularly in-season to discuss collection status and coordinate any necessary changes to collection efforts.

Brood stock and/or gametes originating from the lower (below Bonneville Dam) and/or upper (above Grand Coulee Dam) Columbia River white sturgeon stocks may be acceptable for supplementation in future years (2014+).

# 4.0 WHITE STURGEON BREEDING PLAN

## 4.1 Factorial Mating Designs for Captive-Spawned Wild Broodstock

The following examples of mating scenarios have been adopted from the breeding plan of the UCWSRI and Nechako White Sturgeon Recovery Initiative and assume that maturation of most fish can be synchronized with hormone injections and temperature manipulations. The example factorial breeding plan calls for the spawning of six male and six female fish. A full 6X6 factorial breeding plan is unlikely to be realized at one spawning event. A more likely scenario is the two – 3X3 breeding matrices scenario described below.

In cases where at least three male and three female fish are retained to spawn at any one time, the partial factorial matrix shown in Table 1 would be employed. In a full factorial design, all six males would be crossed with all six females and *vice versa*. This would maximize genetic diversity in the breeding design. However, as Busack and Knudson (2007) note, a lesser increase in genetic gain for the breeding population potential is realized by a full factorial matrix increase of 5X5 to 10X10 than can be achieved by an increase from a 2X2 to a 5X5 matrix; the relationship of efficiency is not linear. They also note that in hatchery situations, large full factorial breeding matrices are often impractical. In the scenario where conservation release numbers are capped at the levels of thousands of juveniles, the practicality of dividing a single clutch of eggs into six even groups per female becomes difficult and onerous and small-batch handling effects may negatively influence survival outcomes; it is best to handle eggs effectively and safely to optimize results. To this end, the 6X6 breeding matrix is divided into two partial 3X3 matrices.

In Table 1, three female fish are spawned with each of three males and *vice versa*. If one or more females do not spawn at the same time, fertilization of her/their ova may be completed at a later date providing that the matrix is completed using all the males in the partial matrix. In the end, families will be grouped and cultured by maternal family and therefore there is no need to be temporally synchronized. In this regard, the milt from the male fish may have to be retained and stored under conditions that permit optimal fertilization in the final event, or the male will need to supply additional high-quality milt on a later occasion. If one or more males do not supply milt for a later spawning event to complete the matrix, the default position is to substitute male milt from other donors not currently in the matrix. Imperative here is the preservation of the genetic variability within the maternal family; of secondary importance is the completion of the full factorial matrix as written.

**Table 1 Idealized partial factorial breeding design in a 6 female X 6 male scenario resulting in the production of six discrete families and eighteen half-sib families.**

| Female | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Male 1 | | | | | | |
| Male 2 | | | | | | |
| Male 3 | | | | | | |
| Male 4 | | | | | | |
| Male 5 | | | | | | |
| Male 6 | | | | | | |

### 4.2 Non-factorial Circumstances

The scenario where few fish in breeding condition are captured and retained in captivity, or where brood females undergo gonad regression, fewer than three fish of either gender may be available. In this circumstance, the matrix should be followed as completely as possible to maximize the genetic diversity in the captive-bred fish. For example, if one of three female fish regress or fail to spawn, then the remaining two viable females should be crossed with the three males. This means a 2 female X 3 male matrix could be followed as opposed to a 2X2 matrix. Other subsequent female fish captured and induced to spawn would also be crossed with the three males to round out the breeding matrix.

The flexibility of the factorial mating design is further illustrated in a scenario where only four or five spawning female sturgeon are captured. The matrix can be adapted to have a 4 female X 6 male or 5 female X 6 male breeding plan to produce 4 or 5 families with 24 and 30 half-sib families, respectively. This flexibility gives the hatchery the maximum capability to produce genetically distinct families to maximize the genetic diversity of juvenile sturgeon entering the system.

## 5.0 LITERATURE CITED


Anders, P.J., and M.S. Powell. 2001. Genetic impact of proposed white sturgeon supplementation in Rock Island Reservoir. Memorandum to BPA Project 86-50 Cooperators. February 28, 2001.

Börk, K.; Drauch, A.; Israel, J. A.; Pedroia, J.; Rodzen, J.; May, B. 2008: Development of new microsatellite primers for white and green sturgeon. Cons. Genet. **9**, 973-979.

Busack, C., and C. M. Knudsen. 2007. Using factorial mating designs to increase the effective number of breeders in fish hatcheries. Aquaculture 273:24-32.

Chelan PUD (Public Utility District No. 1 of Chelan County). 2005. Rocky Reach White Sturgeon Management Plan. Public Utility District No. 1 of Chelan County, Wenatchee, WA.

Conte, F.S., S.I. Doroshov, P.B. Lutes, and E.M. Strange. 1988. Hatchery Manual for the White Sturgeon *Acipenser transmontanus* Richardson. With application to other North American Acipenseridae. University of California, Davis.

Douglas PUD (Public Utility District No. 1 of Douglas County) 2008. White Sturgeon Management Plan Wells Hydroelectric Project FERC Project No. 2149.

Drauch, A.; Börk, K.; May, B.; Rodzen, J. 2006: Development of new microsatellite markers for white sturgeon and continued genetic monitoring of the KTOI broodstock. Unpubl. technical report to Kootenai Tribe of Idaho, Award #01633, Bonners Ferry, ID, pp. 22.

Dupont-Nivet, M., M. Vandeputte, P. Haffray, and B. Chevassus. 2006. Effect of different mating designs on inbreeding, genetic variance and response to selection when applying individual selection in fish breeding programs. Aquaculture 252:161-170.

Fiumera, A. C., B. A. Porter, G. Looney, M. A. Asmussen, and J. C. Avise. 2004. Maximizing offspring production while maintaining genetic diversity in supplemental breeding programs of highly fecund managed species. Conservation Biology 18:94-101.

Irvine, R. L.; Schmidt, D. C.; Hildebrand, L. R.; 2007: Population status of white sturgeon in the lower Columbia River within Canada. Trans. Am. Fish. Soc. **136,** 1472-1479.

Jerald, T. 2007: White sturgeon (*Acipenser transmontanus*) population assessment in Wells Reservoir. Master's Thesis. Central Washington Univ., Ellensburg, WA. pp. 59.

Kincaid, H.L. 1993. Breeding plan to preserve the genetic variability of the Kootenai River white sturgeon. Report prepared for the Bonneville Power Administration. Contract No. DE-A179-93B002886. Portland, Oregon.

Kootenai Tribe of Idaho. 2004. Ireland, S.C., P. J. Anders and R.C.P. Beamesderfer eds. An Adaptive Multidisciplinary Conservation Aquaculture Plan for Endangered Kootenai River White Sturgeon. Management Plan prepared by the Kootenai Tribe of Idaho with assistance from S. P. Cramer and Associates. 56 pp.

Rodzen, J. A.; May, B. P. 2002: Inheritance of microsatellite loci in the white sturgeon (*Acipenser transmontanus*). Genome **45,** 1064-1076.

Rodzen, J.; May, B.; Anders, P.; Ireland, S. 2004: Initial microsatellite analysis of wild Kootenai River white sturgeon and subset brood stock groups used in a conservation aquaculture program. Unpubl. technical report to Bonneville Power Administration, award #88-64, Portland, OR, pp. 36.

Smith, C. T.; Nelson, R. J.; Pollard, S.; Rubidge, E.; McKay, S. J.; Rodzen, J.; May, B.; Koop, B. 2002: Population genetic analysis of white sturgeon (*Acipenser transmontanus*) in the Fraser River. J. Appl. Ichthyol. **18,** 307-312.

UCRWSRI. 2002. Upper Columbia River White Sturgeon Recovery Initiative. Draft Recovery Plan. April 15, 2002. 86p.

Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology [online]1(2):1. http://www.consecol.org/vol1/iss2/art1

# RFP #11-19-W JUVENILE COLUMBIA RIVER WHITE STURGEON *(ACIPENSER TRANSMONTANUS*) FOR POPULATION SUPPLEMENTATION IN THE WELLS RESERVOIR, COLUMBIA RIVER, WASHINGTON

# REQUEST FOR PROPOSALS #11-19-W:

# JUVENILE COLUMBIA RIVER WHITE STURGEON (*ACIPENSER TRANSMONTANUS)* FOR POPULATION SUPPLEMENTATION IN THE WELLS RESERVOIR, COLUMBIA RIVER, WASHINGTON

**September, 2011**

Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, Washington 98802

## 1.0 OVERVIEW

Public Utility District No. 1 of Douglas County, Washington (Douglas PUD) is the owner and operator of the Wells Hydroelectric Project (Wells Project), FERC No. 2149, located in Chelan, Douglas and Okanogan counties. On July 12, 1962, the Federal Power Commission (FPC), predecessor to the FERC, granted Douglas PUD a 50-year license to construct and operate the Wells Project. The current FERC operating license will expire May 31, 2012.

Since 2006, Douglas PUD has actively engaged with federal, state and tribal stakeholders to settle all remaining aquatic resources issues related to the relicensing of the Wells Project. The outcome of these negotiations was the Wells Aquatic Settlement Agreement (ASA) (Appendix A). Signatory parties to the ASA are: Douglas PUD, the United States Fish and Wildlife Service, the Washington State Department of Fish and Wildlife, the Washington State Department of Ecology, the Confederated Tribes of the Colville Reservation, the Confederated Tribes and Bands of the Yakama Nation, and the Bureau of Land Management. Collectively, these parties comprise the Aquatic Settlement Work Group (Aquatic SWG).

The ASA provides the legal framework under which Douglas PUD will implement the measures included in the Wells White Sturgeon Management Plan (WSMP) (Appendix B). In order to meet the supplementation objective within the WSMP, Douglas PUD, in consultation with the Aquatic SWG, developed a White Sturgeon Brood Stock Collection and Breeding Plan to determine suitable white sturgeon origin and composition for the first two years of supplementation (Appendix C).

## 2.0 PROPOSAL

The purpose of this solicitation is to request proposals to supply wild origin fertilized gametes, sub-yearling, and/or yearling white sturgeon toward fulfillment of Douglas PUD's obligation to supplement the Wells Reservoir white sturgeon population with up to 5,000 marked and tagged yearling white sturgeon annually in years 2 and 3 of the new license, consistent with the WSMP Brood Stock Collection and Breeding Plan. Satisfactory performance of the successful vendor in meeting the initial supplementation obligation may lead to award of future contracts to provide this service.

The Aquatic SWG implements the ASA under a facilitated, adaptive management framework. Aquatic SWG decisions are made on a consensus basis; while cost is a consideration, the Aquatic SWG will ultimately select the proposal which best meets the ecological objectives contained within the WSMP.

Proposals shall contain a technical section and a cost section. The technical section should thoroughly address all aspects of meeting the supplementation objective consistent with the appended Aquatic Settlement, White Sturgeon Management Plan, and Broodstock Collection and Breeding Plan. Proposals that include delivery of gametes or collected larval or sub-yearling fish should include delivery to, and coordination with, the Wells Fish Hatchery.

Details to be provided include, as appropriate: sturgeon origin, collection methods, holding, spawning, rearing, transportation and delivery; the experience, qualifications and facilities of the proponent; an itemized list of tasks and deliverables; staff and resources that will be committed to tasks and proposed timelines/schedules/descriptions; and a description of regulatory compliance. Duration of the proposal is that required to meet the supplementation objectives for years 1 and 2 of the new Wells Project FERC license. The cost section should be itemized and fully documented.

Douglas PUD shall consult with the Aquatic Settlement Work Group to evaluate the technical merits of each proposal. Douglas PUD, as licensee, will be responsible to ensure that obligations imposed by the new FERC license are met. Final contractor selection will first be sought by consensus of the Aquatic Settlement Parties; however, Douglas PUD will reserve the right to select the contractor in the event unanimous agreement cannot be reached among the Aquatic Settlement Parties, in order to comply in a timely fashion with the terms of the new FERC license.

Firms responding to this notice must be properly licensed. All responding firms must submit a letter of interest, a statement of qualifications, a list of related completed projects, no less than three references with telephone numbers, and a general brochure describing the firm’s activities. After screening the materials received, the District may request interviews with selected firms.

Interested respondents must deliver to Douglas PUD an original and five (5) copies of their documents and qualifications no later than 5:00 p.m. (PST) on November 30, 2011. Minority and women-owned firms are encouraged to submit proposals. **Please mark the outside of the package with Request for Proposals 11-19-W White Sturgeon Supplementation.**

# Exhibit A

**Request for Proposals: Juvenile Columbia River White Sturgeon (*Acipenser transmontanus*) Supplementation**

Appendix A: Wells Aquatic Settlement Agreement
Appendix B: White Sturgeon Management Plan
Appendix C: Wells White Sturgeon Broodstock Collection and Breeding Plan

# AQUATIC SETTLEMENT AGREEMENT

**A Settlement Agreement in Support of the Measures identified within the:**

**White Sturgeon Management Plan**
**Bull Trout Management Plan**
**Pacific Lamprey Management Plan**
**Resident Fish Management Plan**
**Aquatic Nuisance Species Management Plan**
**and**
**Water Quality Management Plan**

**Wells Hydroelectric Project**
**FERC Project No. 2149**

October 2008

**BLANK PAGE**

# AQUATIC SETTLEMENT AGREEMENT
# Wells Hydroelectric Project
# FERC License No. 2149

## 1.0 PARTIES

This Aquatic Settlement Agreement (Agreement) is entered into by and between the Public Utility District No. 1 of Douglas County, Washington (Douglas), a Washington municipal corporation, the United States Fish and Wildlife Service (USFWS), the Washington State Department of Fish and Wildlife (WDFW), the Washington State Department of Ecology (Ecology), the Confederated Tribes of the Colville Reservation (Colville), the Confederated Tribes and Bands of the Yakama Nation (Yakama), the Bureau of Indian Affairs (BIA), and the Bureau of Land Management (BLM). The above entities who have executed this Agreement, herein collectively referred to as the "Parties" and individually as "Party," have actively participated in the development of this Agreement and associated Aquatic Resource Management Plans.

This Agreement shall be binding on, and inure to the benefit of, the above-listed Parties and their successors and assigns, unless otherwise specified in this Agreement.

The National Marine Fisheries Service (NMFS) was invited to participate in the development of this Agreement, but declined to be a signatory Party because its interests are currently satisfied by the measures within the Wells Anadromous Fish Agreement and Habitat Conservation Plan (HCP). Additional entities may become Parties to this Agreement following unanimous consent of all the existing Parties to the Agreement and after executing a signature page and submitting it to Douglas and the Federal Energy Regulatory Commission (FERC).

## 2.0 RECITALS

2.1 The Wells Hydroelectric Project (Wells Project) is located at river mile 515.6 on the Columbia River in the State of Washington. Wells Dam is located approximately 30 river miles downstream from the Chief Joseph Hydroelectric Project, owned and operated by the United States Army Corps of Engineers, and 42 miles upstream from the Rocky Reach Hydroelectric Project, owned and operated by Chelan County Public Utility District. The nearest town is Pateros, Washington, which is located approximately 8 miles upstream from Wells Dam.

2.2 The Wells Project is the chief generating resource for Douglas. It includes ten generating units with a nameplate rating of 774,300 kilowatts (kW) and a peaking capacity of approximately 840,000 kW. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. Adult fish passage facilities reside on both sides of the hydrocombine, which is 1,130 feet long, 168 feet wide, with a crest elevation of 795 feet in height. Juvenile fish passage facilities are located across the powerhouse of the dam. The system was developed by Douglas and uses a barrier system to modify the intake velocities on spillways 2, 4, 6, 8, and 10. The Wells Project fish bypass system is the most efficient juvenile fish bypass system on the mainstem Columbia River. The bypass system on average collects and safely passes 92.0 percent of the spring migrating salmonids (yearling Chinook, steelhead, and sockeye) that arrive at Wells Dam and 96.2 percent of the summer migrating subyearling Chinook that arrive at the dam (Skalski et al., 1996).

2.3 The Wells Reservoir is approximately 30 miles long. The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir. The Wells Project boundary extends approximately 1.5 miles up the Methow River and approximately 15.5 miles up the Okanogan River. The normal maximum surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet (ac-ft) and usable storage of 97,985 ac-ft at elevation of 781 feet above mean sea level (MSL).

2.4 Douglas has various reservoir and surface water rights associated with the operation of the Wells Project including the following certificates (S3-00362, R3-00363, R4-26075, and S4-26074). These certificates provide reservoir impoundment rights for 331,200 ac-ft of water and power generation rights for 220,000 cubic feet per second (cfs) of water.

2.5 In March 1979, in response to petitions from tribes and other entities, FERC initiated a consolidated proceeding on juvenile fish protection for the Mid-Columbia hydroelectric projects, including the Wells Project.

2.6 In 1990, following the installation of 10 new high-efficiency turbine runners and the installation and preliminary testing of a new and highly effective juvenile fish bypass system, Douglas entered into a long-term fisheries settlement agreement with NMFS, USFWS, WDFW, Colville, Yakama, and Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

2.7 On June 21, 2004, FERC approved the HCP. The HCP superseded the 1990 long-term fisheries settlement agreement. The HCP represents the culmination of over 10 years of negotiations between Douglas, NMFS, USFWS, WDFW, Colville, Yakama, CTUIR, and American Rivers. The HCP is the first hydropower HCP for anadromous salmon and steelhead. The HCP is a 50-year agreement included as an amendment to the Original Operating License. The HCP addresses Project related impacts to spring Chinook, summer/fall Chinook, steelhead, sockeye and coho, collectively referred to as Plan Species. With respect to Plan Species, the HCP parties have agreed to be supportive of Douglas's long-term relicensing efforts. The HCP also provides Endangered Species Act (ESA) coverage for all of the permit species (spring Chinook, summer/fall Chinook, sockeye and steelhead). The HCP also is intended to constitute the HCP participants' terms, conditions and recommendations for Plan Species under Sections 10(a), 10(j), and 18 of the Federal Power Act (FPA), the Fish and Wildlife Conservation Act, the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the Pacific Northwest Electric Power Planning and Conservation Act, and Title 77 of the Revised Code of Washington (RCW) of the State of Washington. On October 16, 2007, FERC officially recognized the HCP as a qualifying Comprehensive Plan pursuant to section 10(a)(2)(A) of the FPA.

2.8 On November 1, 2004, Douglas and Colville executed a settlement agreement to resolve all claims regarding any section 10(e) payments to Colville for the term of the original license and any new FERC license arising from the use of lands within the Wells Project Boundary. Pursuant to the settlement agreement, Douglas and Colville also executed a power sales contract and a power sales service agreement. On February 11, 2005 the FERC issued an order approving the settlement agreement and granting approval of the power sales contract under section 22 of the FPA.

2.9 The Original Operating License for the Wells Project will expire on May 31, 2012. Douglas is using the Integrated Licensing Process (ILP) as required by FERC regulations issued July 23, 2003 (18 CFR Part 5). Pursuant to the ILP regulations Douglas submitted to FERC, on December 1, 2006, a Notice of Intent to file an application for a New License and a Pre-Application Document.

2.10 In March of 2006, following two years of collaborative discussions related to relicensing studies, Douglas approached stakeholders regarding its desire to develop an Aquatic Settlement Agreement for those resources not already protected by the Original Operating License, the HCP, or other related agreements. Stakeholders active in the development of this Agreement included the USFWS, NMFS, WDFW, Ecology, Colville, and Yakama.

2.11 Douglas plans to file a Draft License Application (DLA) with FERC on or before December 31, 2009, and plans to file a Final License Application (FLA) for a New License with FERC on or before May 31, 2010. Douglas plans to include this Agreement in the DLA and FLA. It is the Parties' expectation that the Agreement will be signed prior to filing the DLA.

## 3.0 DEFINITIONS

3.1 "Adaptive Management" means an iterative and rigorous process used by the Aquatic Settlement Work Group (Aquatic SWG) to achieve biological goals and objectives. In the context of the relicensing of the Wells Project, this process is intended to improve the management of Aquatic Resources affected by Project operations, in order to achieve the desired goals and objectives of the Aquatic Resource Management Plans as effectively and efficiently as possible, in accordance with the provisions of this Agreement. The process used by the Aquatic SWG has many steps including the following:

a. Develop initial hypotheses regarding any potential Project impacts and potential protection or mitigation measures;

b. Complete studies to determine whether the hypothesized impacts are valid, and if valid, quantify the impact resulting from the Project;

c. If the hypothesized impact is validated and quantified, then the Aquatic SWG shall identify appropriate goals and objectives and implementing measures;

d. Implement reasonable and appropriate measures to avoid, minimize or mitigate the identified Project impact;

e. Develop monitoring and evaluation methodologies for determining whether the goals and objectives have been achieved;

f. Should the measures be successful at mitigating or minimizing Project impact(s), then periodic monitoring shall take place to confirm that such goals and objectives continue to be achieved;

g. Should the implemented measures fail to achieve the goals and objectives over a reasonable time frame, then the Aquatic SWG shall evaluate additional or revised measures, including those previously considered in the six Aquatic Resource Management Plans, and implement any additional or revised appropriate and reasonable measures, or explain why such goals and objectives cannot be achieved;

h. If such goals and objectives have not been achieved over a reasonable time frame, then the Aquatic SWG may reevaluate and revise such goals and objectives.

3.2 "Aquatic Settlement Agreement" means this document as well as Attachment A (Proposed License Articles) and Attachments B through G (Aquatic Resource Management Plans).

3.3 "Aquatic Resource Management Plans" refers to the six aquatic management plans developed in close collaboration with the Aquatic SWG. These six plans are independently known as the White Sturgeon Management Plan (WSMP), Bull Trout Management Plan (BTMP), Pacific Lamprey Management Plan (PLMP), Resident Fish Management Plan (RFMP), Aquatic Nuisance Species Management Plan (ANSMP) and Water Quality Management Plan (WQMP).

3.4 "Aquatic Resources" refers to the resources addressed by the six Aquatic Resource Management Plans contained within Attachments B through G.

3.5 "Aquatic SWG" refers to the Aquatic Settlement Work Group. The Aquatic SWG is comprised of one voting representative from each of the Parties to this Agreement. The Aquatic SWG is the group charged with the responsibility of implementing this Agreement.

3.6 "Chair" refers to a neutral third party, selected unanimously by the Parties and funded by Douglas to coordinate the Aquatic SWG meetings.

3.7 "HCP" refers to the Wells Anadromous Fish Agreement and Habitat Conservation Plan.

3.8 "Licensee" means the Public Utility District No. 1 of Douglas County or Douglas.

3.9 "New Operating License" means the first long-term operating license for Project No. 2149 to be issued by the FERC to Douglas that takes effect after the expiration of the Original Operating License and any subsequent annual licenses that take effect after expiration of the New Operating License.

3.10 "Original Operating License" means the original 50-year operating license, as amended, for Project No. 2149 issued by the FERC with an expiration date of May 31, 2012 and any subsequent annual licenses that take effect after expiration of the Original Operating License, but before the effective date of the New Operating License.

3.11 A "Party" means an entity who has executed a signature page for this Agreement, and who is identified in Section 1 (Parties) or meets the criteria in Section 1 (Parties).

3.12 "Plan Species" refers to the five anadromous fish species covered by the HCP. The five species of fish covered by the HCP are spring Chinook, summer/fall Chinook, steelhead, sockeye and coho.

3.13 "Project" means the Wells Hydroelectric Project, licensed to Douglas by the FERC as Project No. 2149.

3.14 "Proposed License Articles" means license articles proposed by the Parties to the FERC in this Agreement, and contained in Attachment A hereto.

3.15 "Unanimous" and "unanimously" mean that all of the Parties who vote or abstain at an appropriately noticed meeting pursuant to this Agreement agree or abstain on an action. An abstention does not affect or prevent a vote from being unanimous. See Section 11.5 (Voting).

## 4.0 THE PURPOSE OF THE AGREEMENT

The Parties agree that the purpose of this Agreement is to resolve all remaining Aquatic Resource issues related to compliance with all federal and state law applicable to the issuance of a New Operating License for the Project. Subject to the reservations of authority in Section 13 (Reservations of Authority) of this Agreement, this Agreement establishes Douglas's obligations for the protection, mitigation, and enhancement of Aquatic Resources affected by Project operations under the New Operating License and its obligations to comply with all related federal and state laws applicable to the issuance of the New Operating License for the Project. It also specifies procedures to be used by the Parties to ensure that the New Operating License is implemented consistent with this Agreement and other laws. The Parties agree that this Agreement is fair, reasonable, and in the public interest within the meaning of FERC Rule 602, 18 C.F.R. § 385.602(g)(3).

The six Aquatic Resource Management Plans contained in Attachments B through G, together with the HCP will function as the Water Quality Attainment Plan (WQAP) in support of the Clean Water Act Section 401 Water Quality Certification for the Wells Project. As of the effective date of the Agreement, pursuant to Section 5 (Term of License and This Agreement), the Parties agree that the measures set forth in the Aquatic Resource Management Plans are adequate to identify and address Project impacts to Aquatic Resources and are expected to achieve the goals and objectives set forth in each of the six Aquatic Resource Management Plans. However, during the course of the New Operating License, there may be instances where the measures found in individual management plans may need to be adapted. In these instances, "Adaptive Management" will be used to achieve the biological goals and objectives.

## 5.0 TERM OF LICENSE AND THIS AGREEMENT

Douglas will seek a term of 50 years for the New Operating License. The Parties agree to support a 50-year term for the New Operating License. Subject to Section 7 (Effective Dates and Implementation of Attachments), this Agreement shall become effective when signed by Douglas and at least one other Party and shall remain in effect throughout the term of the New Operating License unless this Agreement is terminated sooner pursuant to Section 8 (Termination of Agreement).

## 6.0 TRANSFER OF LICENSE AND AGREEMENT

In the event the New Operating License is transferred in whole from Douglas to another entity and Douglas is not a co-licensee of the Project, the Parties agree that Douglas shall have no further obligations under the New Operating License or this Agreement following such transfer.

## 7.0 EFFECTIVE DATES AND IMPLEMENTATION OF ATTACHMENTS

The proposed measures contained within Attachment A (Proposed License Articles) and Attachments B through G (Aquatic Resource Management Plans) shall become effective upon issuance of a FERC order granting a New Operating License to Douglas, except to the extent the implementation of any such measures is prohibited, prevented, or rendered impracticable by the FERC order.

## 8.0 TERMINATION OF AGREEMENT

## 8.1 Automatic Termination Events

This Agreement shall terminate automatically: (1) at the end of the term of the Agreement as set forth in Section 5 (Term of License and This Agreement); (2) in the event the FERC does not issue a New Operating License to Douglas for the Project; (3) in the event Douglas withdraws from this Agreement based on Section 8.2 (Withdrawal Events); or (4) in the event the New Operating License is revoked.

## 8.2 Withdrawal Events

### 8.2.1 Non-Compliance

A Party may elect at any time to withdraw from the Agreement pursuant to Section 8.2.4 (Conditions Precedent to Withdrawal) based on non-compliance of another Party with the provisions of the Agreement, subject to the following procedures: (1) a Party asserts that another Party is not complying with the terms of the Agreement; (2) the Party documents and presents evidence supporting assertion of non-compliance in writing; and (3) the issue of non-compliance is taken to Dispute Resolution, Section 12 (Dispute Resolution).

### 8.2.2 Governmental Action

Should a government agency take an action that is materially inconsistent with the terms of this Agreement, including a material inconsistency with or modification of Attachment A (Proposed License Articles) or Attachments B through G (Aquatic Resource Management Plans), then the Parties (not including the government agency, if a Party) shall meet and consider the available actions to address the material inconsistency. Such actions may include a joint or separate request(s) for rehearing with the FERC, a joint or separate appeal(s) to the Washington State Pollution Control Hearing Board (PCHB), judicial review to remove or modify the material inconsistency, or any other action that would address the inconsistency. One or more Parties may proceed to pursue such actions even if all Parties do not wish to participate.

If the material inconsistency is sustained upon the completion of such actions, a Party may: (1) elect to withdraw from this Agreement pursuant to Section 8.2.4 (Conditions Precedent to Withdrawal); (2) agree to implement this Agreement subject to such governmental action; or (3) enter into additional discussions to determine whether an alternative agreement can be reached.

### 8.2.3 Impossibility

A Party may elect to withdraw from the Agreement pursuant to Section 8.2.4 (Conditions Precedent to Withdrawal) in the event the Parties agree in writing that the obligations imposed by this Agreement are impossible to achieve.

### 8.2.4 Conditions Precedent to Withdrawal

Two conditions must be satisfied before a Party can withdraw from the Agreement pursuant to Section 8.2.1 (Non-Compliance), Section 8.2.2 (Governmental Action), or Section 8.2.3 (Impossibility). First, the Party proposing to withdraw from the Agreement shall provide written notice to all other Parties of the substantive basis for its intent to withdraw. The notice shall include a complete statement of reasons and be served in accordance with the requirements of Section 17.2 (Special Notifications). Second, the substantive basis for the proposed withdrawal must be taken to Dispute Resolution (Section 12).

Following Dispute Resolution, a Party choosing to withdraw shall provide all other Parties with notice of withdrawal. The notice shall be in writing and served in accordance with the requirements of Section 17.2 (Special Notifications). A notice of withdrawal shall become effective sixty (60) days from the date the notice was provided to all other Parties. The right to withdraw shall be waived if not exercised within sixty (60) days of completion of Dispute Resolution.

### 8.2.5 Effect of Withdrawal

Except as set forth in Section 8.2.6 (Effect of Termination), in the event a Party withdraws from this Agreement, this Agreement places no constraints on the withdrawing Party, shall not thereafter be binding on the withdrawing Party, and the withdrawing Party may exercise all rights and remedies that the Party would otherwise have outside this Agreement.

### 8.2.6 Effect of Termination

Upon expiration of this Agreement, or in the event this Agreement is terminated, voided or determined for any reason to be unenforceable before the end of its term, then: (1) Douglas shall continue to implement the last agreed-upon measures until the FERC orders otherwise and (2) the Parties are not restrained in any manner from advocating to the FERC appropriate measures to replace this Agreement.

# 9.0 OBLIGATIONS OF THE PARTIES

## 9.1 Licensee Obligations

Douglas shall file this Agreement with the FERC as an offer of settlement pursuant to Rule 602 consisting of a fully executed copy of this Agreement and an explanatory statement. The offer of settlement related to this Agreement shall be included within both the Draft and Final License Applications, and Attachments B through G shall be identified therein as Douglas's proposed environmental measures for Aquatic Resources pursuant to 18 C.F.R. § 5.18(a)(5)(C). Douglas shall request that the FERC incorporate, without modification, the Attachments to this Agreement as conditions of the New Operating License. Douglas shall use reasonable efforts to obtain a FERC order issuing the New Operating License in a timely manner. Douglas shall also: (1) submit a statement in support of this Agreement to NMFS and USFWS, as part of any comments in the ESA Section 7 consultation process; (2) ensure that any supplemental information, comments, or responses to comments filed by Douglas with the FERC in the context of the relicensing process are consistent with this Agreement; (3) in the event of an appeal of the Project's 401 certification, submit a statement in support of this Agreement to the PCHB and any court reviewing a decision of the PCHB; and (4) actively support incorporation of the Proposed License Articles into the New Operating License in all other relevant regulatory proceedings.

## 9.2 Obligations of All Parties (Including Licensee)

Except as provided below and in Section 13 (Reservations of Authority), each Party shall support this Agreement by ensuring that all documents filed with the FERC or any other agency or forum, are consistent with this Agreement. Documents covered by this Section include: (1) any recommendations, conditions and/or prescriptions, or any terms and conditions related to Aquatic Resources; (2) as to Parties other than the USFWS, any ESA Section 7 consultation documents or comments on such documents; (3) as to USFWS, any ESA Section 7 consultation documents, or comments on such documents, or any biological opinions, subject to Section 13 (Reservations of Authority); and (4) any supplemental information, comments or responses to comments.

In the event that a Party receives or develops new information, data, or analyses that it intends to file with the FERC or any other agency or administrative body, such Party shall consult with the Aquatic SWG pursuant to Section 11 (Aquatic Settlement Work Group) of this Agreement, to the extent practicable, and shall notify all Parties as soon as practicable.

Except as provided in Section 13 (Reservation of Authority), if a Party proposes to submit to FERC a condition and/or prescription based upon new information, data, or analyses, the Party must comply with the procedures of Section 12 (Dispute Resolution) if the Aquatic SWG does not unanimously approve such condition or prescription.

## 10.0 MODIFICATION OF AGREEMENT

This Agreement may be amended or modified only in writing and with written unanimous consent of all Parties.

## 11.0 AQUATIC SETTLEMENT WORK GROUP

### 11.1 Committee Representation

There shall be an Aquatic SWG composed of one technical representative and a separate policy representative for each Party. The policy representative shall be an individual of a higher management level within each organization relative to the technical representative. Each Party shall provide all other Parties with written notice of its designated representatives and designated alternate(s) to the Aquatic SWG. Each Party with representation on the SWG shall have one vote.

Upon request by any Party, Douglas shall provide a forum for a meeting or meetings of the policy representatives. The Parties anticipate that the policy representatives will meet at least once annually during the term of the New Operating License to review progress and implementation of this Agreement.

### 11.2 Meetings

The Aquatic SWG shall meet as specified in the respective Aquatic Resource Management Plans or when requested by any member following notice. However, such notice may be waived by a member if done so expressly in writing to the Chair. NMFS may attend all meetings of the Aquatic SWG for coordination purposes with HCP activities and shall be provided copies of notices and agendas for Aquatic SWG meetings. Individuals representing entities that are not a Party to this Agreement may attend meetings following unanimous approval from all of the Parties. Nothing in this Agreement shall preclude any Party from having multiple non-designated representatives from their organization participate in any properly noticed Aquatic SWG meeting.

### 11.3 Chair of the Aquatic SWG

The Parties shall unanimously select and Douglas shall fund a neutral, non-voting Chair for the Aquatic SWG. The Chair will prepare an annual list of statements of agreement based upon the results of studies, prepare progress reports, prepare meeting minutes, facilitate and mediate the meetings, and assist the members of the Aquatic SWG in making decisions. The Aquatic SWG shall evaluate the performance of the Chair at least every three (3) years or upon request of two or more members of the Aquatic SWG.

### 11.4 Meeting Notice

The Chair shall provide all committee members with a minimum of ten (10) business days advanced written notice of all meetings unless a member waives notice in writing or such waiver is reflected in the approved meeting minutes. The notice shall contain an agenda of all matters to be addressed and voted on during the meeting. Means of notice will be determined by the Parties. Unless urgent action is required, to determine the date for a meeting, the Chair will poll the Parties in an effort to identify a meeting date on which all interested Parties are able to attend. If a date is not available for all Parties to meet within a reasonable time, the Chair will select the date that best accommodates the most Parties.

## 11.5 Voting

The Aquatic SWG shall act by unanimous vote of those present in person or by telephone. However, the Aquatic SWG may develop its own rules and procedures for voting, which may include expanding the methods of voting (e.g., proxy, writing, or other methods). The Chair shall ensure that all members are sent notices with agenda items that may be brought to a vote during the proposed Aquatic SWG meeting.

If a Party's designated representative(s) cannot be present for an agenda item scheduled for a vote, that Party may request the Chair in advance of his/her expected absence to delay a vote or determination of unanimous approval for up to five (5) business days on the subject agenda item. Alternatively, if the Parties cannot convene for a vote within five (5) business days once a vote has been delayed, the Chair shall consult with the absent Party to solicit and record that Party's vote or abstention. The Chair and Parties shall make a reasonable effort to ensure that a vote on any specified agenda item is delayed only once.

If the Aquatic SWG cannot reach unanimous consent, then upon request by any Party, that agenda item shall be referred to the dispute resolution process set forth in Section 12 (Dispute Resolution). The Parties shall negotiate in good faith and attempt to resolve issues at a technical level prior to elevating issues to Dispute Resolution.

Any entity who is not a Party to this Agreement does not have voting rights on the Aquatic SWG or any other committee established under this Agreement.

## 11.6 Authority and Purpose of Aquatic SWG

The Aquatic SWG will be used as the primary forum for consultation and coordination among the Parties in connection with conducting studies and implementing the measures set forth in this Agreement and as set forth in Section 12 (Dispute Resolution). Any entity not executing this Agreement shall not be a Party to this Agreement and shall not be entitled to vote on any committee established by this Agreement.

In connection with implementation of the Aquatic Resource Management Plans, the Parties agree to use Adaptive Management as defined herein. Adaptive Management involves many steps that may include forming a hypothesis regarding any potential Project related impacts, initial hypothesis development and testing, identifying potential Project related impacts, protection or mitigation measures, and the collection of data or information necessary to test the hypothesis and developing studies to determine whether the hypothesis is valid. If the hypothesized impact is validated, certain process and study steps are necessary to quantify the impact(s) resulting from the Project.

When hypothesized impacts are validated and quantified through a systematic process, the Aquatic SWG may refine management goals and objectives set forth in the affected Aquatic Resource Management Plans, or add new goals and objectives as appropriate. The next step will be to implement appropriate and reasonable measures to avoid, minimize, or mitigate the identified Project impacts. Following the implementation of appropriate and reasonable measures to avoid, minimize, or mitigate the identified Project impacts, the Aquatic SWG will develop and Douglas will implement monitoring and evaluation methods for determining whether the goals and objectives of the plan are being achieved. If those refinements are successful, then periodic monitoring shall be implemented to confirm that such goals and objectives continue to be achieved. If the implemented measures fail to achieve the refined or new goals and objectives over a reasonable time frame, then the Aquatic SWG shall: (1) evaluate additional or modified measures, including those previously considered in the six Aquatic Resource Management Plans, and implement any additional or revised appropriate and reasonable measures; or (2) explain why such goals and objectives cannot be achieved.

If after a reasonable period of time such goals and objectives have not been achieved, the Aquatic SWG will, as needed, reevaluate and further refine such goals and objectives. The Aquatic SWG may establish its own procedural guidelines for Adaptive Management decisions and related decision process steps, as necessary, to monitor and evaluate established Aquatic Resource Management Plan goals and objectives and to develop new goals and objectives, studies and mitigation measures.

The Aquatic SWG will consult on, coordinate, and oversee all aspects of implementation of the Aquatic Resource Management Plans. If the Aquatic SWG cannot reach agreement, then these decisions shall be referred to the dispute resolution process in Section 12 (Dispute Resolution).

## 11.7 Studies, Reports, and Meeting Minutes

The Chair will make available all study plans and reports prepared under this Agreement to all members of the Aquatic SWG as soon as reasonably possible. Draft study plans and reports will be distributed to all of the Aquatic SWG representatives for review and comment. Comments will be provided in writing to the Chair within thirty (30) days of receipt of the plan or report unless the Aquatic SWG decides otherwise. Comments will either be addressed in order within the document or made an appendix to the approved study plan or final report.

The Chair will provide draft meeting minutes, including any proposed or final statement(s) of agreements, within ten (10) days after each meeting. Statements of agreement shall be based on a unanimous vote. Minutes shall reflect all significant group discussions and decisions. All Party representatives who were present and participated in the meeting will be allowed ten (10) days to provide corrections and comments in writing to the Chair. Final meeting minutes will be provided to the members of the Aquatic SWG as soon as reasonably possible after comments have been received. If disagreements exist, as to the proposed meeting minutes, then the Chair will include all perspectives in the final minutes.

The Chair will work with Douglas to compile all relevant materials into one annual calendar-year report. The annual report shall include all final study plans, reports, meeting minutes and statements of agreements, and a list of future proposed actions as agreed to by the Aquatic SWG. The Chair will provide the annual report to Aquatic SWG members for review and approval prior to being filed with FERC. Comments on the annual report shall be provided in writing to the Chair within thirty (30) days of receipt unless the Aquatic SWG decides otherwise. Douglas PUD shall work with the Aquatic SWG to establish a central electronic database that is accessible to all of the Parties. This electronic database will contain all of the documents related to implementation of this Agreement.

## 12.0 DISPUTE RESOLUTION

### 12.1 Dispute Resolution Process

If a dispute arises out of or relates to this Agreement, the disputing Parties agree to first use their best efforts to cooperatively resolve such dispute. The disputing Parties shall use their best efforts to resolve disputes arising in the normal course of business at the technical level between each disputing Party's staff with appropriate authority to resolve such disputes.

When a dispute arises between two or more Parties and cannot be resolved in the normal course of business at the technical level, one or more of the disputing Parties shall provide written notice specifying the disputed issues to the Chair, with copies to all Parties. The notice shall describe the specific nature and background of the dispute. All notices shall be served in accordance with the requirements of Section 17.2 (Special Notifications).

Within three (3) days of receiving the notice, or as the Parties otherwise agree, the Chair shall schedule a meeting of the technical representatives of the Aquatic SWG to consider and attempt to resolve the dispute. The technical representatives of the Aquatic SWG shall meet within thirty (30) days or as the Parties otherwise agree, after receiving the notice of dispute.

If after ten (10) business days, or as otherwise agreed, the Chair determines that the Parties' technical representatives are unable to resolve the dispute then the Chair shall immediately submit the matter in writing to the policy representatives of each of the respective Parties. The policy representatives shall meet within thirty (30) days or as the Parties otherwise agree, after receiving notice from the Chair.

If after ten (10) business days, or as otherwise agreed, the Chair determines that the Parties' policy representatives are unable to resolve the dispute then the Chair shall immediately submit the matter in writing to the executive representatives of each of the respective Parties. The executive representatives shall meet within thirty (30) days or as otherwise agreed, after receiving notice from the Chair. If the executive representatives are unable to resolve the dispute within fifteen (15) business days or as otherwise agreed, then the disputing Parties may agree to submit the dispute to voluntary mediation or binding arbitration but are not obligated to do either. If the disputing Parties are unable to resolve the dispute through the above processes any Party may pursue other appropriate remedies, including withdrawal from this Agreement pursuant to Section 8.2.4 (Conditions Precedent to Withdrawal).

## 12.2 Arbitration and Mediation

In the event the disputing Parties agree pursuant to Section 12.1 (Dispute Resolution Process) to submit a dispute to binding arbitration or voluntary mediation, the following procedures shall apply. The dispute shall then be referred to a mutually acceptable arbitrator or mediator, or if one cannot be agreed upon, to the nearest office of Washington Arbitration & Mediation Service ("WAMS") for resolution within ninety (90) days of the agreement of the Parties to submit the dispute to arbitration or mediation. If the disputing Parties cannot agree on a mutually acceptable arbitrator or mediator within ten (10) business days of such agreement to arbitrate/mediate, the dispute will be referred to WAMS for preparation of a Strike List for arbitrator/mediator selection. Mediation may occur at any time if agreed upon by the Parties. All arbitration proceedings shall be conducted in accordance with the Rules of Arbitration of WAMS or any other mutually agreed upon arbitrator and shall include reasonable discovery provisions as may be stipulated or ordered. The arbitrator's decision shall be final and binding and judgment may be entered thereon, with all remedies otherwise available in court also available in arbitration.

The disputing Parties shall equally share in the cost of arbitration and mediation associated with this Agreement. Parties that do not have an interest in the outcome of the arbitration or mediation proceeding may elect to abstain from further participation in either arbitration or mediation. The Parties agree that the existence of a dispute notwithstanding, they will continue without delay to carry out all their respective responsibilities under this Agreement that are not affected by the dispute.

Any legal action to enforce a decision of the arbitrator shall be brought either in the United States District Court for the Eastern District of Washington or the FERC, if jurisdiction exists, otherwise such action may be brought in any court of competent jurisdiction. The Colville and Yakama hereby provide a waiver of sovereign immunity that is expressly limited to a legal action filed under this section to enforce a decision of the arbitrator.

## 13.0 RESERVATIONS OF AUTHORITY

The reservation of authority under Section 13.1 (Federal Power Act) of this Agreement is not intended to limit the right of any Party to seek redress with FERC with respect to an issue related to the implementation or enforcement of this Agreement.

### 13.1 Federal Power Act

Each Party reserves any authority it may have pursuant to the FPA in the event that: (1) this Agreement is not filed with the FERC; (2) the Party withdraws from this Agreement pursuant to the procedures set forth in Section 8.2 (Withdrawal Events); or (3) this Agreement is terminated pursuant to Section 8.1 (Automatic Termination Events).

The USFWS reserves the Secretary of the Interior's authorities pursuant to the FPA. The USFWS may exercise any reserved authority under Section 18 of the FPA regarding those species covered by this Agreement including but not limited to bull trout, white sturgeon, Pacific lamprey, and resident fish. In the event that the USFWS includes a reservation of authority in the preliminary, modified or final conditions that it submits to FERC, the inclusion of such reservation shall not be considered to be materially inconsistent with this Agreement.

The USFWS shall provide notice to the Aquatic SWG before exercising its Federal Power Act authority. Following notice, the Aquatic SWG may make recommendations to the USFWS regarding how the exercise of such authority can be accomplished in a manner that is consistent with this Agreement. In the event that the Aquatic SWG does not reach a unanimous decision regarding such recommendations, then Section 12 (Dispute Resolution) shall apply.

### 13.2 Clean Water Act

Ecology reserves its authority to issue a 401 certification under the Clean Water Act (CWA) for the Wells Project under such terms and conditions as it determines are necessary to comply with state and federal laws. The Parties intend that this Agreement, together with the HCP, will satisfy Ecology's requirements for the 401 certification with respect to Aquatic Resources and Plan Species affected by the Wells Project; however, this Agreement does not predetermine the outcome of the 401 certification proceeding or prevent Ecology from responding to new information or analysis or from addressing additional resources that may be affected. Section 12 (Dispute Resolution) shall not apply to the issuance of the 401 certification or a re-issuance of the 401 certification prior to the effective date of the New Operating License.

Ecology reserves all authority it may have to amend the 401 certification or to invoke a reopener clause in the 401 certification to amend the 401 certification for the New Operating License, including, but not limited to, modifying schedules and deadlines, under such terms and conditions as it determines are necessary to comply with state and federal law. Section 12 (Dispute Resolution) shall apply to the exercise of Ecology's reserved authority to amend, modify or reopen the 401 certification during the term of the New Operating License.

Ecology reserves any authority it may have to enforce the 401 certification, state water quality standards, or other appropriate requirements of state law.

## 13.3 Endangered Species Act

This Agreement does not affect the terms of the HCP. USFWS anticipates that the measures in this Agreement together with the measures contained within the HCP will be adequate to satisfy ESA responsibilities for aquatic species under the jurisdiction of USFWS. In addition, USFWS shall use reasonable efforts to exercise its authority under the ESA in a manner that allows this Agreement to be fulfilled. By signing this Agreement, however, the USFWS does not formally bind itself to make any specific recommendations or take any particular action with respect to ESA compliance. The USFWS expressly reserves the right, consistent with federal law, to take such future actions as it may deem necessary to meet its obligations under the ESA.

If the FERC requests draft biological opinion(s), the USFWS shall provide such documents to the FERC. If, in its consultation with the FERC pursuant to Section 7 of the ESA, the USFWS requests any measures that are materially inconsistent with the terms of this Agreement, any Party may invoke Section 12 (Dispute Resolution). The USFWS shall participate in Dispute Resolution to the extent practicable and consistent with its ESA responsibilities.

## 13.4 Douglas Reservation of Authority

Douglas reserves any rights it may have to contest the existence and/or exercise of any reserved authority claimed under this Agreement. In the event that a Party exercises its reserved authority and declines to participate in Dispute Resolution, then Douglas shall have the right to withdraw from the Agreement pursuant to Section 8.2.4 (Conditions Precedent to Withdrawal).

## 13.5 Exercise of Reserved Authority

To the extent practicable, a Party shall provide notice to the Aquatic SWG at least sixty (60) days before exercising any authority reserved under this Agreement that may be materially inconsistent with this Agreement. Following notice, the Aquatic SWG will meet to discuss and make recommendations regarding the exercise of such authority. If the Aquatic SWG does not reach a unanimous decision regarding such recommendations, then any Party may initiate Dispute Resolution (Section 12). However, if in its sole discretion a Party determines expeditious action is required to perform its statutory duties or responsibilities, such Party shall not be required to wait in exercising reserved authority until Dispute Resolution is initiated or concluded. This provision does not apply to the issuance of a 401 certification prior to the effective date of the New Operating License.

## 14.0 CHOICE OF LAWS

This Agreement shall be governed by, and construed, interpreted and enforced in accordance with, the substantive law of the State of Washington (without reference to any principles of conflicts of laws) and applicable federal law.

## 15.0 LIMITATIONS OF REOPENINGS

Except as provided in Section 13 (Reservations of Authority), the Parties shall not invoke or rely upon any reopener clause set forth in the New Operating License for the Wells Project for the purposes of obtaining additional license articles, conditions or measures or to promote changes in Project structures or operations related to the protection, mitigation and enhancement of Aquatic Resources.

## 16.0 FORCE MAJEURE

### 16.1 No Liability for Force Majeure

No Party shall be liable to any other Party for breach of this Agreement as a result of a failure to perform or for delay in performance of any provision of this Agreement if, based on evidence provided by the non-performing Party to the other Parties, such performance is delayed or prevented by Force Majeure. In the event of an enforcement action, the non-performing Party bears the burden of proving by a preponderance of the evidence the existence of Force Majeure, including the absence of negligence. The term "Force Majeure" means any cause reasonably beyond the performing Party's control, which could not be avoided with the exercise of due care, and which occurs without the fault or negligence of the Party whose performance is affected by the Force Majeure. Force Majeure events may be unforeseen, foreseen, foreseeable, or unforeseeable, including without limitation natural events; labor or civil disruption; terrorism; breakdown or failure of Project works not caused by failure to properly design, construct, operate, or maintain; new regulations or laws that are applicable to the Project; orders of any court or agency having jurisdiction over the Party's actions; delay in a FERC order becoming final; or delay in issuance of any required permit.

### 16.2 Notice

The Party whose performance is affected by Force Majeure shall notify the other Parties in writing within seven (7) days, or as soon thereafter as practicable, after becoming aware of any event that such Party contends constitutes Force Majeure. Such notice shall identify the event causing the delay or anticipated delay, estimate the anticipated length of delay, state the measures taken or to be taken to minimize the delay, and estimate the timetable for implementation of the measures. The affected Party shall make all reasonable efforts to promptly resume performance of this Agreement and, when able, resume performance of its obligations and give the other Parties written notice to that effect.

## 17.0 NOTICES

### 17.1 Routine Notifications

Unless this Agreement specifically requires otherwise, any routine notice, demand or request provided for in this Agreement, or served, given or made in connection with it, shall be in writing and shall be deemed properly served, given or made if delivered in person or sent by delivery, including email, or sent by mail, postage prepaid to the designated technical and policy representatives of each Party.

### 17.2 Special Notifications

Unless this Agreement specifically requires otherwise, special notice shall be defined as any notice related to either a withdrawal or dispute resolution notification. All special notices prepared, served, given or made in connection with either withdrawal or dispute resolution, shall be in writing and shall be deemed properly served, given or made if delivered in person or sent by acknowledged delivery, including return receipt email, or sent by registered mail return receipt requested, postage prepaid to the technical, policy and executive representatives officially designated by each Party.

## 18.0 MISCELLANEOUS

### 18.1 Further Assurances

The Parties shall use best efforts to assist each other in performing their obligations under this Agreement including providing documents and information as may reasonably be requested.

### 18.2 No Consequential, Incidental or Punitive Damages

There shall be no liability under this Agreement for any consequential, punitive, exemplary, incidental or indirect losses or damages.

### 18.3 Severability

If any provision of this Agreement is held to be illegal, invalid, or unenforceable under any present or future law, and if the rights or obligations of any Party under this Agreement will not be materially and adversely affected thereby: (1) such provision will be fully severable; (2) this Agreement shall be construed and enforced as if such illegal, invalid, or unenforceable provision had never comprised a part thereof; (3) the remaining provisions of this Agreement shall remain in full force and effect and will not be affected by the illegal, invalid or unenforceable provision or by its severance here from; and (4) in lieu of such illegal, invalid or unenforceable provision, the Parties shall, in good faith, negotiate a mutually acceptable, legal, valid and enforceable provision as similar in terms to such illegal, invalid or unenforceable provision as may be possible, and shall promptly take all actions necessary to amend the Agreement to include the mutually acceptable, legal, valid and enforceable provision.

## 18.4 Waivers

Except as otherwise provided herein, no provision of this Agreement may be waived except in writing. No failure by any Party to exercise, and no delay in exercising, short of the statutory period, any right, power, or remedy under this Agreement shall operate as a waiver thereof. Any waiver at any time by a Party of its right with respect to a default under this Agreement, or with respect to any other matter arising in connection therewith, shall not be deemed a waiver with respect to any subsequent default or matter.

## 18.5 No Third-Party Beneficiaries

None of the promises, rights, or obligations contained in this Agreement shall inure to the benefit of any person or entity not a Party to this Agreement; and no action may be commenced or prosecuted against any Party by any third party claiming to be a third-party beneficiary of this Agreement or the transactions contemplated hereby.

## 18.6 No Reliance

Each Party acknowledges that in entering into this Agreement, it has not relied on any statement, representation, or promise of the other Party or any other person or entity, except as expressly stated in this Agreement.

## 18.7 Assumption of Risk

In entering into this Agreement, each of the Parties assumes the risk of any mistake of fact or law, and if either or both of the Parties should subsequently discover that any understanding of the facts or the law was incorrect, none of the Parties shall be entitled to, nor shall attempt to, set aside this Agreement or any portion thereof. This provision does not affect the right of any Party to withdraw from this Agreement in accordance with Section 8.2 (Withdrawal Events).

## 18.8 Waiver of Defenses

The Parties release each other from any and all claims relating to the formation and negotiation of this Agreement, including reformation, rescission, mistake of fact, or mistake of law. The Parties further agree that they waive and will not raise in any court, administrative body or other tribunal any claim in avoidance of or defense to the enforcement of this Agreement other than the express conditions set forth in this Agreement.

## 18.9 Independent Counsel

The Parties acknowledge that they have been represented by independent counsel in connection with this Agreement, they fully understand the terms of this Agreement, and they voluntarily agree to those terms for the purposes of making a full compromise and settlement of the subject matter of this Agreement.

## 18.10 Headings

The headings used for the sections herein are for convenience and reference purposes only and shall in no way affect the meaning or interpretation of the provisions of this Agreement.

## 18.11 Interpretations

In this Agreement, unless a clear contrary intention appears: (1) the singular number includes the plural number and vice versa; (2) reference to any person includes such person's successors and assigns but, if applicable, only if such successors and assigns are permitted by this Agreement, and reference to a person in a particular capacity excludes such person in any other capacity; (3) reference to any gender includes each other gender; (4) reference to any agreement (including this Agreement), document or instrument means such agreement, document or instrument as amended or modified and in effect from time to time in accordance with the terms thereof and, if applicable, the terms hereof; (5) reference to any Section, Schedule, Attachment, or Exhibit means such Section, Schedule, Attachment, or Exhibit to this Agreement, and references in any Section, Schedule, Attachment, Exhibit, or definition to any clause means such clause of such Section, Schedule, Attachment, Exhibit, or definition; (6) "hereunder", "hereof", "hereto", "herein," and words of similar import are references to this Agreement as a whole and not to any particular section or other provision hereof unless specifically stated; (7) relative to the determination of any period of time, "from" means "from and including", "to" means "to but excluding" and "through" means "through and including"; (8) "including" (and with correlative meaning "include") means including without limiting the generality of any description preceding such term; and (9) reference to any law (including statutes and ordinances) means such law as amended, modified, codified or reenacted, in whole or in part, and in effect from time to time, including rules and regulations promulgated thereunder.

## 18.12 Venue

To the extent permitted by law, the venue for any action to enforce or interpret this Agreement involving any Federal or Tribal Parties shall be the United States District Court for the Eastern District of Washington or the FERC, and the venue for all other Parties shall be a Washington State court of competent jurisdiction or the FERC.

## 18.13 Legal Authority

Each Party represents and warrants to the other Parties that it has full authority and power to enter into this Agreement, that the Party's representatives who sign below are duly authorized by it to enter into this Agreement, and that nothing herein violates any law, regulation, judicial or regulatory order, or agreement applicable to such warranting Party.

**BLANK PAGE**

Agreement Execution

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed by their proper officers respectively being thereunto duly authorized, and their respective corporate seals to be hereto affixed, the 19 day of January, 200~~8~~9

PUBLIC UTILITY DISTRICT NO. 1 of DOUGLAS COUNTY, WASHINGTON

By: T. James Davis
T. James Davis, President

By: Lynn M. Heminger
Lynn M. Heminger, Vice President

By: Ronald E. Skagen
Ronald E. Skagen, Secretary

Address of Notice:

Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, Washington 98802-4497

**BLANK PAGE**

UNITED STATES FISH AND WILDLIFE SERVICE

Dated: 7/31/2009

By: Ken S. Berg

Title: Project Leader

Address of Notice:

United States Fish and Wildlife Service
11103 East Montgomery Drive
Spokane, Washington 99206

United States Fish and Wildlife Service
215 Melody Lane, Suite 119
Wenatchee, WA 98801-5933

**BLANK PAGE**

STATE OF WASHINGTON, DEPARTMENT OF FISH & WILDLIFE

Dated: 11/20/08

By: ______________________

Title: RD Region 2

Address of Notice:

Washington State Department of Fish and Wildlife
600 Capital Way North
Olympia, Washington 98501-1091

Washington State Department of Fish and Wildlife
1540 Alder Street N.W.
Ephrata, Washington 98823-7669

**BLANK PAGE**

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY

Dated: 11/18/08

By: ______________________

Title: SECTION MANAGER,
WATER QUALITY PROGRAM

Address of Notice:

Washington State Department of Ecology
15 West Yakima Avenue, Suite 200
Yakima, Washington 98902-3452

**BLANK PAGE**

CONFEDERATED TRIBES OF THE COLVILLE RESERVATION

Dated: 11-10-08

By: Michael Finley

Title: Vice Chairman

Address of Notice:

Confederated Tribes of the Colville Reservation
Natural Resource Committee
P.O. Box 150
Nespelem, Washington 99155

**BLANK PAGE**

CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION

Dated: February 24, 2009

By: Ralph Sampson Jr.

Title: Yakama Nation Tribal Council, Chairman

Address of Notice:

Confederated Tribes and Bands of the Yakama Nation
PO Box 151
Toppenish, Washington 98948

**BLANK PAGE**

UNITED STATES, BUREAU OF LAND MANAGEMENT

Dated: Nov 13, 2009

By: [signature]

Title: Field Manager

Address of Notice:

Bureau of Land Management
915 North Walla Walla
Wenatchee, Washington 98801-1521

**BLANK PAGE**

UNITED STATES, BUREAU OF INDIAN AFFAIRS

Dated: ________________________

By: ________________________________

Title: ________________________________

Address of Notice:

Bureau of Indian Affairs
911 NE 11th Avenue
Portland, OR 97232

**BLANK PAGE**

# ATTACHMENT A: PROPOSED LICENSE ARTICLES

**BLANK PAGE**

ATTACHMENT A: PROPOSED LICENSE ARTICLES

Article 1. The licensee shall implement the measures set forth in section 4 of the White Sturgeon Management Plan, dated August 2008, which is incorporated herein by reference, in consultation with the Aquatic Settlement Working Group. The licensee shall obtain prior Commission approval for any substantial modification or addition to Project works or operations necessary to implement such measures. The licensee shall also submit any proposed amendment to the White Sturgeon Management Plan to add to, or modify any of, the measures or objectives set forth therein to the Commission for approval. The licensee shall file an annual report with the Commission by May 31st of each year to document all studies, measures and other activities completed in the previous year.

Article 2. The licensee shall implement the measures set forth in section 4 of the Bull Trout Management Plan, dated August 2008, which is incorporated herein by reference, in consultation with the Aquatic Settlement Working Group. The licensee shall obtain prior Commission approval for any substantial modification or addition to Project works or operations necessary to implement such measures. The licensee shall also submit any proposed amendment to the Bull Trout Management Plan to add to, or modify any of, the measures or objectives set forth therein to the Commission for approval. The licensee shall file an annual report with the Commission by May 31st of each year to document all studies, measures and other activities completed in the previous year.

Article 3. The licensee shall implement the measures set forth in section 4 of the Pacific Lamprey Management Plan, dated August 2008, which is incorporated herein by reference, in consultation with the Aquatic Settlement Working Group. The licensee shall obtain prior Commission approval for any substantial modification or addition to Project works or operations necessary to implement such measures. The licensee shall also submit any proposed amendment to the Pacific Lamprey Management Plan to add to, or modify any of, the measures or objectives set forth therein to the Commission for approval. The licensee shall file an annual report with the Commission by May 31st of each year to document all studies, measures and other activities completed in the previous year.

Article 4. The licensee shall implement the measures set forth in section 4 of the Resident Fish Management Plan, dated August 2008, which is incorporated herein by reference, in consultation with the Aquatic Settlement Working Group. The licensee shall obtain prior Commission approval for any substantial modification or addition to Project works or operations necessary to implement such measures. The licensee shall also submit any proposed amendment to the Resident Fish Management Plan to add to, or modify any of, the measures or objectives set forth therein to the Commission for approval. The licensee shall file an annual report with the Commission by May 31st of each year to document all studies, measures and other activities completed in the previous year.

Article 5. The licensee shall implement the measures set forth in section 4 of the Aquatic Nuisance Species Management Plan, dated August 2008, which is incorporated herein by reference, in consultation with the Aquatic Settlement Working Group. The licensee shall obtain prior Commission approval for any substantial modification or addition to Project works or operations necessary to implement such measures. The licensee shall also submit any proposed amendment to the Aquatic Nuisance Species Management Plan to add to, or modify any of, the measures or objectives set forth therein to the Commission for approval. The licensee shall file an annual report with the Commission by May 31st of each year to document all studies, measures and other activities completed in the previous year.

Article 6. The licensee shall implement the measures set forth in section 4 of the Water Quality Management Plan, dated October 2008, which is incorporated herein by reference, in consultation with the Aquatic Settlement Working Group. The licensee shall obtain prior Commission approval for any substantial modification or addition to Project works or operations necessary to implement such measures. The licensee shall also submit any proposed amendment to the Water Quality Management Plan to add to, or modify any of, the measures or objectives set forth therein to the Commission for approval. The licensee shall file an annual report with the Commission by May 31st of each year to document all studies, measures and other activities completed in the previous year.

# WHITE STURGEON MANAGEMENT PLAN

# WELLS HYDROELECTRIC PROJECT

# FERC PROJECT NO. 2149

August 2008

Prepared by:
Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

# EXECUTIVE SUMMARY

The White Sturgeon Management Plan (WSMP) is one of six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement (Agreement). Collectively, these six Aquatic Resource Management Plans are critical to direct implementation of Protection, Mitigation, and Enhancement measures (PMEs) during the term of the new license and, together with the Wells Anadromous Fish Agreement and Habitat Conservation Plan (HCP) will function as the Water Quality Attainment Plan (WQAP) in support of the Clean Water Act Section 401 Water Quality Certification for the Wells Hydroelectric Project (Project).

To ensure active stakeholder participation and support, the Public Utility District No. 1 of Douglas County (Douglas) developed all of the resource management plans in close coordination with agency and tribal natural resource managers (Aquatic Settlement Work Group or Aquatic SWG). During the development of this plan, the Aquatic SWG focused on developing management priorities for resources potentially impacted by Project operations. Members of the Aquatic SWG include the U.S. Fish and Wildlife Service (USFWS), Washington Department of Ecology (Ecology), Washington State Department of Fish and Wildlife (WDFW), the Confederated Tribes of the Colville Reservation (Colville), the Confederated Tribes and Bands of the Yakama Indian Nation (Yakama), and Douglas.

The National Marine Fisheries Service (NMFS) was invited to participate in the development of Aquatic Resource Management Plans, but declined because its interests are currently satisfied by the measures within the HCP.

The goal of the WSMP is to increase the white sturgeon (*Acipenser transmontanus*) population in the Wells Reservoir to a level that can be supported by the available habitat and characterized by a diverse age structure consisting of multiple cohorts (juvenile and adult). In addition, the WSMP is intended to support spawning, rearing and migration as identified by the aquatic life designated use under WAC 173-201A in the Washington state water quality standards. Based upon the information available as of December 2006, the Aquatic SWG determined that an assessment of Project effects on white sturgeon was not practical given sturgeon life history characteristics and the limited number of fish estimated to exist in the Project. Therefore, the Aquatic SWG concluded that resource measures related to white sturgeon should focus on population protection and enhancement by means of supplementation as an initial step in order to increase the number of fish within the Wells Reservoir. In addition to the initial supplementation activities, implementation of a monitoring and evaluation program shall be conducted to accurately assess natural recruitment, juvenile habitat use, emigration rates, carrying capacity, and the potential for natural reproduction so as to inform the scope of a future, longer-term supplementation strategy. All objectives were developed in order to meet the WSMP goal. The PMEs presented within the WSMP are designed to meet the following objectives:

Objective 1: Supplement the white sturgeon population in order to address Project effects, including impediments to migration and associated bottlenecks in spawning and recruitment;

Objective 2: Determine the effectiveness of the supplementation activities through a monitoring and evaluation program;

Objective 3: Determine the potential for natural reproduction in the Wells Reservoir in order to appropriately inform the scope of future supplementation activities;

Objective 4: Adaptively manage the supplementation program as warranted by the monitoring results;

Objective 5: Evaluate whether there is biological merit to providing safe and efficient adult upstream passage;

Objective 6: Identify white sturgeon educational opportunities that coincide with WSMP activities.

This WSMP is intended to be compatible with other white sturgeon management plans in the Columbia River mainstem. Furthermore, this management plan is intended to be not inconsistent with other management strategies and recovery goals of federal, state and tribal natural resource management agencies. The WSMP is not intended to be a harvest management plan and does not create or supersede jurisdiction over fisheries management decisions made by the responsible fishery agencies and tribes. However, the WSMP activities are expected to ultimately support appropriate and reasonable harvest opportunities consistent with the goals of the responsible fishery agencies and tribes and designated use for harvest under WAC 173-201A identified in the Washington state water quality standards. Should the responsible fishery agencies and tribes determine that there is an ongoing harvestable surplus of sturgeon in the Wells Reservoir, then this indicates significant progress toward achievement of the goals and objectives of this plan.

# 1.0 INTRODUCTION

The White Sturgeon Management Plan (WSMP) is one of six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement (Agreement). Collectively, these six Aquatic Resource Management Plans are critical to direct implementation of Protection, Mitigation, and Enhancement measures (PMEs) during the term of the new license and, together with the Wells Anadromous Fish Agreement and Habitat Conservation Plan (HCP) will function as the Water Quality Attainment Plan (WQAP) in support of the Clean Water Act Section 401 Water Quality Certification for the Wells Hydroelectric Project (Project).

To ensure active stakeholder participation and support, the Public Utility District No. 1 of Douglas County (Douglas) developed all of the resource management plans in close coordination with agency and tribal natural resource managers (Aquatic Settlement Work Group or Aquatic SWG). During the development of this plan, the Aquatic SWG focused on developing management priorities for resources potentially impacted by Project operations. Entities invited to participate in the Aquatic SWG include the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), Washington Department of Ecology (Ecology), Washington State Department of Fish and Wildlife (WDFW), the Confederated Tribes of the Colville Reservation (Colville), the Confederated Tribes and Bands of the Yakama Indian Nation (Yakama), and Douglas.

The WSMP will direct implementation of measures to protect against and mitigate for potential Project impacts on white sturgeon (*Acipenser transmontanus*). To ensure active stakeholder involvement and support, Douglas developed this plan, along with the other aquatic management plans, in close coordination with the members of the Aquatic SWG.

The Aquatic SWG agrees on the need to develop a plan for the long-term management of white sturgeon in the Project. This management plan summarizes the relevant resource issues and background (Section 2), identifies the goal and objectives of the plan (Section 3), and describes the relevant PMEs (Section 4) for white sturgeon during the term of the new license.

# 2.0 BACKGROUND

## 2.1 White Sturgeon Biology

White sturgeon are the largest of all North American freshwater fish. They are found in marine waters and freshwaters of rivers along the Pacific coast from Monterey, California to Cook Inlet in northwestern Alaska (Wydoski and Whitney 2003). Significant populations of the Pacific Coast appear to be restricted to three locations: the Sacramento, Fraser, and Columbia rivers (Lane 1991). White sturgeon are distributed throughout the U.S. portion of the Columbia River and in many of its larger tributaries. Historically, white sturgeon migrated throughout the mainstem Columbia River from the estuary to the headwaters, although passage was probably limited at times by large rapids and falls (Brannon and Setter 1992).

White sturgeon are long-lived fish, with fin ray analysis documenting fish over 100 years in age (Beamesderfer et al. 1995). This anadromous species has been reported to reach a length of 20 feet and a weight of 1,800 pounds (Wydoski and Whitney 2003). In the Columbia River, white sturgeon spawn in the spring between April and July. Only a small percentage of adult white sturgeon in the Columbia River spawn in a given year. Intervals between spawning have been estimated to be between 3 and 11 years. White sturgeon deposit eggs through broadcast spawning at water temperatures between 10 and 18°C. Mature white sturgeon commonly produce between 100,000 and 300,000 eggs, but larger fish may produce up to 3 million eggs (Wydoski and Whitney 2003). Spawning and egg incubation in the Columbia River occur in the swiftest water available (2.6-9.2 feet per second) at depths between 13.1 and 65.6 feet over cobble, boulder, and bedrock substrates (Wydoski and Whitney 2003). In mainstem Columbia River reservoirs, spawning occurred within 5 miles downstream of the mainstem dams. Eggs hatch in approximately 7 days at 15°C.

Columbia River white sturgeon are reported to have declined in numbers because of numerous factors, including obstruction of migration by mainstem hydroelectric dams, altered stream flows, altered hydrologic regimes, altered temperature regimes, reduced spawning habitat, and over harvest (van der Leeuw et al. 2006; Wydoski and Whitney 2003). Variations in population characteristics also have been attributed to differences in exploitation rates and recruitment success, access to marine food resources, and suitability of hydrologic conditions and available habitats (Devore et al. 1995). During the 1800s, prior to construction of mainstem hydroelectric dams on the Columbia River, white sturgeon were in great demand for their caviar and smoked flesh. In 1892, during the peak of commercial harvest activities, approximately 2.5 million kilograms of white sturgeon were harvested (Wydoski and Whitney 2003). Regulations of the white sturgeon fishery began with a 4-foot minimum size limit established in 1899. Several regulations were established from 1899 to 2000 to manage the fishery in the lower Columbia River, although, effective recovery efforts did not begin until spawners were protected in the 1950s (Wydoski and Whitney 2003).

Beginning in the 1930s, with the construction of Rock Island, Grand Coulee, and Bonneville dams, migration was disrupted because white sturgeon generally do not pass upstream through fishways that were built for salmon, although they do pass downstream through dams (Lepla et al. 2001). Construction of hydroelectric projects in the mid-Columbia River Basin, such as Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells has also affected the upstream movement of white sturgeon. Current populations in the Columbia River basin can be divided into three groups: fish below the Bonneville Dam, with access to the ocean; fish isolated functionally, but not genetically, between dams; and fish in several large tributaries. However, the population dynamics and factors regulating production of white sturgeon within isolated populations in the mid-Columbia River reservoirs such as the Rocky Reach and Wells reservoirs are not well understood.

## 2.2 White Sturgeon Management and Recovery Efforts

Management programs to protect and restore white sturgeon in the Kootenai River and the upper Columbia River are on-going and have provided a relevant framework for the development of a white sturgeon management plan in the Wells Reservoir. The Kootenai and upper Columbia sturgeon recovery efforts have also provided a good technical framework for implementing a sturgeon management plan. The strategies and activities outlined in these aforementioned management programs have provided important information, which has been used to develop an effective WSMP.

### 2.2.1 Kootenai River White Sturgeon Recovery

In the early 1990s following concerns that white sturgeon populations were decreasing due to near total recruitment failure, a detailed monitoring program was instituted by the Idaho Department of Fish and Game (IDFG) to provide more information on white sturgeon species status in the Kootenai River system. In 1994, the USFWS listed the Kootenai stock of white sturgeon as an endangered species, which introduced a higher level of management and control by various authorities in the drainage and region. A Recovery Team was established to provide technical direction regarding hatchery supplementation efforts. A final Kootenai White Sturgeon Recovery Plan was signed by the USFWS in 1999.

Kootenai white sturgeon recovery efforts consist of a multi-faceted approach aimed at improving survival at various life history stages. Coordinated flow releases during spring are a major habitat restoration focus designed to increase natural recruitment, although currently it is difficult to assess the relationship between flows and recruitment success (USFWS 1999). Directed stocking programs, which address genetic concerns, stocking rates, and fish size at release, have also been implemented to boost juvenile sturgeon in the Kootenai system. The Kootenai Tribe of Idaho in collaboration with the Kootenay Trout Hatchery (KTH) in Canada are primarily responsible for producing high-quality juvenile white sturgeon for the directed stocking program. Information collected from annual monitoring activities, which assess survival, growth rates, and natural spawning success, allow for an adaptive management approach with regards to the stocking program.

### 2.2.2 Upper Columbia River White Sturgeon Recovery

In 2002, a bi-national Recovery Team, termed the Upper Columbia White Sturgeon Recovery Initiative (UCWSRI) finalized the Upper Columbia White Sturgeon Recovery Plan in response to concerns that the transboundary white sturgeon population residing between Hugh L. Keenleyside Dam and Grand Coulee Dam consists of an aging and declining population with extremely limited recruitment. The Recovery Team, consisting of technical representatives from Federal, Provincial, and State resource management agencies and from Canadian and U.S. tribes, directs the recovery program.

Due to near total recruitment failure over the past two decades, a decision was made early in the recovery planning process to move immediately to development of a hatchery program to produce juvenile sturgeon for stocking (UCWSRI 2002). The breeding plan (Kincaid 1993) developed for the Kootenai sturgeon program was used as a model for the upper Columbia sturgeon. Rearing of all fish for the stocking program occurs at the KTH. Similar to the Kootenai recovery strategy, a juvenile index monitoring program to assess growth, survival, health, distribution, and relative abundance of released juveniles shall provide information essential to monitoring the upper Columbia sturgeon population and the success of the hatchery stocking program.

### 2.2.3 Rocky Reach White Sturgeon Management Plan

The relicensing process for the Rocky Reach Hydroelectric Project brought fisheries agencies, tribes, and interested parties together in a Natural Resources Working Group (NRWG) that provided an opportunity for comprehensive review of current and future management priorities for fish resources potentially impacted by ongoing Project operations (Chelan PUD 2005). In 2004 and 2005, NRWG members collaborated on the development of goals and objectives to manage the white sturgeon population within the Rocky Reach Project boundary under the new license. Based upon the information collected from white sturgeon field studies implemented by Chelan PUD in 2001 and 2002, a white sturgeon management plan was developed to promote population growth of sturgeon to a level commensurate with the available habitat. The Rocky Reach management plan measures include the implementation of a white sturgeon supplementation program, a monitoring program to determine population characteristics, and tracking surveys to determine movements and to assess potential spawning locations.

### 2.2.4 Priest Rapids Project White Sturgeon Management Plan

As part of the Priest Rapids Project relicensing, white sturgeon populations were investigated in the Priest Rapids and Wanapum reservoirs from 1999 to 2003. Results of the study have assisted in identifying a framework for the future development and implementation of a Priest Rapids Project White Sturgeon Management Plan. Biological objectives associated with this management plan consist of increasing white sturgeon populations to a level commensurate with available habitat through a supplementation program and the implementation of a monitoring program to determine population characteristics such as natural recruitment, spawning, rearing, growth, survival, and rates of emigration.

## 2.3 Project White Sturgeon Study

Since little information existed on the status of white sturgeon populations in the mid-Columbia, Chelan, Grant, and Douglas PUDs each initiated studies of white sturgeon to support their current or upcoming relicensing processes. The information gathered from these studies was intended to provide basic white sturgeon life history information, distribution, and current population sizes in the mid-Columbia River Basin. Additionally, study results provided the foundation for the development of appropriate management goals and objectives.

From 2001-2003, Douglas implemented a study to examine the white sturgeon population within the Project. Prior to the implementation of this study, little information on white sturgeon was available for the Wells Reservoir. WDFW catch record card returns for 1993 and 1994 indicate that legal size white sturgeon were present in the Wells Reservoir (Brad James, WDFW, pers. comm.). Additionally, information from previous studies in reservoirs upstream and downstream supported the existence of a population. The primary objectives of the study were to provide basic information on the population abundance, age structure, size, and growth of Project white sturgeon; analyze movements of white sturgeon within the Reservoir; and compare the data collected during this study with data collected during assessments at other projects (Jerald 2007).

During the summers of 2001 and 2002, setlines were deployed in the Wells Reservoir. Sturgeon captured on setlines were measured, marked with passive integrated transponder (PIT) tags and with scute markings. Additionally, a select number of captured fish were fitted with radio-transmitters to track movements and had pectoral fin rays removed for age analysis using standard methodologies (Beamesderfer et al. 1989).

Setline sampling took place over a two-year timeframe with a total of 129 setlines deployed and retrieved from throughout the reservoir. In total, 13 white sturgeon were captured during the 2-year study with the majority of the fish being captured in the Columbia River within five miles of the mouth of the Okanogan River. Twelve of the captured fish were PIT tagged. Subsequently, five recapture events were recorded for a total of 18 capture events during the mark-recapture period (one fish was recaptured twice). Population abundance was estimated to be 31.35±17.51. The 95% confidence interval for sturgeon abundance was calculated to be CI (13<N<218). The results of the mark-recapture portion of the study indicated that the sturgeon population in the Wells Reservoir is small with a point estimate of 31 fish over 50 cm in length (Skalski and Townsend 2005).

The length of the 13 fish captured during the study ranged from 60-202 cm. Two of the fish were classified as juveniles (<90 cm fork length) while 11 were classified as sub-adults or adults. It is important to note that the capture methodology was not designed to provide accurate sampling of fish under 50 cm. Captured sturgeon ranged in age from 6 to 30 years old (based on 11 fish) demonstrating that all of these fish recruited to the Wells Reservoir after Wells Dam was completed in 1967 with strong year class recruitment between the years 1972 and 1978 and again between 1988 and 1996. The presence of fish within these age classes suggests that successful recruitment within or to the Wells Reservoir is occurring either through (1) spawning within the Wells Reservoir and/or (2) immigration into the Wells Reservoir from populations upstream. Two white sturgeon were captured in 2001 and subsequently recaptured in 2002 to provide limited growth rate information. One juvenile fish was measured at 65 cm (fork length) on July 11, 2001. The fish was again captured on September 26, 2002 and measured 87 cm. This represented a growth rate of 22 cm in 14 months, or 18.9 cm/year. One adult fish was captured on August 9, 2001 measuring 197 cm (fork length). The fish was subsequently captured on September 6, 2002 and measured 199 cm representing a 2 cm growth rate over approximately 13 months, or 1.85 cm/year (Jerald 2007). In October 2006, this fish was found dead along the shoreline of the Columbia River adjacent to the mouth of the Okanogan River. At that time, biologists measured the fish at 228.5 cm representing a 29.5 cm increase in length over a four year period or an average of 7.4 cm of growth per year.

A total of six white sturgeon were fitted with radio-tags and monitored throughout the study period using mobile and fixed telemetry. Telemetry data along with setline capture data verify that white sturgeon congregate in the Columbia River near the Okanogan River confluence during the summer, fall, and winter months with none of the six fish being detected downstream from Brewster (RM 530) or upstream of Park Island (RM 538). Very little movement of tagged sturgeon was observed during winter months. In the spring of 2002, one of the five mature fish radio-tagged made an upstream migration into the Okanogan River and two different radio-tagged mature sized sturgeon made movements into the Okanogan River during 2003.

In general, the results of the white sturgeon study in the Wells Reservoir were similar to the results of a study conducted in the neighboring Rocky Reach Reservoir in 2001-2002 (Chelan PUD 2005). Results indicate that the Wells Reservoir adult sturgeon population is estimated from 13-217 fish. These results are similar to the Rocky Reach assessment which estimated numbers of sturgeon from 50-115 fish. Both studies captured similar numbers of sturgeon using similar amounts of effort and similar capture techniques (Rocky Reach=18 sturgeon, Wells=13 sturgeon). Radio-telemetry data from both studies suggest that very little activity occurs during the overwintering period. Wells Reservoir sturgeon ranged in age from 6 to 30 years old while Rocky Reach sturgeon ranged in age from 7 to 50 years old. Both studies suggest that some recruitment into each population is occurring given the presence of juvenile fish in their respective reservoirs (Chelan PUD 2005; Jerald 2007).

## 3.0 GOAL AND OBJECTIVES

The goal of the WSMP is to increase the white sturgeon population in the Wells Reservoir to a level that can be supported by the available habitat and characterized by a diverse age structure consisting of multiple cohorts (juvenile and adult). In addition, the WSMP is intended to support spawning, rearing and migration as identified by the aquatic life designated use under WAC 173-201A in the Washington state water quality standards. Based upon the available information, the Aquatic SWG agreed that a rigorous and reliable assessment of ongoing Project effects on white sturgeon was not practical given sturgeon life history characteristics and the limited number of fish estimated to exist in the Wells Reservoir. Therefore, the Aquatic SWG concluded that efforts should focus, initially, on supplementation efforts to increase the population within the Wells Reservoir in order to address Project effects. Once the population numbers have been increased to a level that can be studied, as determined by the Aquatic SWG, Douglas shall implement a monitoring and evaluation program to accurately assess natural recruitment, juvenile habitat use, emigration rates, carrying capacity, and the potential for natural reproduction so as to inform the scope of a future, long-term supplementation strategy. The PMEs of the WSMP are designed to meet the following objectives:

Objective 1: Supplement the white sturgeon population in order to address Project effects, including impediments to migration and associated bottlenecks in spawning and recruitment;

Objective 2: Determine the effectiveness of the supplementation activities through a monitoring and evaluation program;

Objective 3: Determine the potential for natural reproduction in the Wells Reservoir in order to appropriately inform the scope of future supplementation activities;

Objective 4: Adaptively manage the supplementation program as warranted by the monitoring results and in consultation with the Aquatic SWG;

Objective 5: Evaluate whether there is biological merit to providing safe and efficient adult upstream passage;

Objective 6: Identify white sturgeon educational opportunities that coincide with WSMP activities.

This WSMP is intended to be compatible with other white sturgeon management plans in the Columbia River mainstem. Furthermore, this management plan is intended to be not inconsistent with other management strategies and recovery goals of federal, state and tribal natural resource management agencies. The WSMP is not intended to be a harvest management plan and does not create or supersede jurisdiction over fisheries management decisions made by the responsible fishery agencies and tribes. However, the WSMP activities are expected to ultimately support appropriate and reasonable harvest opportunities consistent with the goals of the responsible fishery agencies and tribes and designated use for harvest under WAC 173-201A identified in the Washington state water quality standards. Should the responsible fishery agencies and tribes determine that there is an ongoing harvestable surplus of sturgeon in the Wells Reservoir, then this indicates significant progress toward achievement of the goals and objectives of this plan.

Douglas in consultation with the Aquatic SWG, developed the goal, objectives, and PMEs described in this section. The extent to which implementation of the proposed PMEs successfully achieve the WSMP goal and objectives identified shall be determined through the monitoring and evaluation program. Once the results of the monitoring and evaluation program have been considered, Douglas shall determine, in consultation with the Aquatic SWG, whether changes to the sturgeon stocking program are needed to meet the goals and objectives of the management plan.

The schedule for implementation of specific measures within the WSMP is based on the best information available at the time the Plan was developed. As new information becomes available, implementation of each activity may be adjusted through consultation with the Aquatic SWG.

# 4.0 PROTECTION, MITIGATION AND ENHANCEMENT MEASURES

In order to fulfill the goal and objectives described in Section 3.0, Douglas, in consultation with the ASWG, shall develop and implement a white sturgeon management program that includes PMEs. The Program shall be designed for implementation in two phases. Phase I of the PMEs shall be implemented during the first ten years of the new license and consist of supplementation, monitoring and evaluation activities. Results of Phase I PMEs will be used to inform the scope of continued PMEs during Phase II, which shall be implemented for the remainder of the new license.

Douglas, in consultation with the ASWG, shall initiate implementation of the following PMEs during the 50-year license term:

Phase I (Years 1-10)

- Development of a Brood Stock Collection and Breeding Plan (Year 1 and updated as determined by the Aquatic SWG, See Section 4.1.1);
- Brood Stock Collection (Years 1-4 and other years TBD by the Aquatic SWG, see Section 4.1.1);
- Juvenile Stocking (Years 2-5 and other years TBD by the Aquatic SWG, see Section 4.1.2);
- Index Monitoring Program (Years 3-5 and 2 more years prior to Year 10 TBD by the Aquatic SWG, see Section 4.2.1);
- Marked Fish Tracking (Years 3-5 and 2 more years prior to Year 10 TBD by the Aquatic SWG, see Section 4.2.2);
- Natural Reproduction Assessments (5 annual assessments over the license term, see Section 4.2.3)[*];

[*] Natural reproduction assessments can be implemented over the term of the license (Phase I and Phase II) as determined by the Aquatic SWG.

Phase II (Years 11-50)

- Long-term juvenile stocking (stocking rate and frequency TBD by Aquatic SWG in Years 11-50, see Section 4.4.1);
- Supplementation Program Review (Years 11-50 TBD by the Aquatic SWG, see Section 4.4.2);
- Long-term Index Monitoring Program (Year 12 and once every 3-5 years thereafter TBD by the Aquatic SWG, see Section 4.4.3);
- Adult Passage Evaluation (Year 11 and once every 10 years thereafter, see Section 4.4)

As determined by the Aquatic SWG, appropriate educational opportunities coinciding with implementation of WSMP activities (Section 4.5) will be made available during the entire 50 year license term.

The following sections describe, in detail, the components, timing of implementation, and decision-making process of the PMEs to be conducted during Phase I and II of the white sturgeon management program.

## 4.1 Phase I Supplementation Program (Objective 1)

### 4.1.1 Brood Stock Collection and Breeding Plan

Due to the low numbers of sturgeon indicated by the 2001-2003 white sturgeon study and the need to increase genetic variation, there is a low probability that brood stock from only the Wells Reservoir can be utilized as the basis for supplementation activities. Consequently, other sources of fish must be considered in addition to capturing fish from Wells Reservoir to increase the white sturgeon population. Within one year of issuance of the new license Douglas shall prepare and implement a Brood Stock Collection and Breeding Plan, in consultation with the Aquatic SWG, which considers such factors as genetics and questions of imprinting, and are consistent with the goal and objectives of the WSMP and includes the level of detail provided in other existing white sturgeon breeding plans.

Following is a prioritized list of juvenile fish source options that shall be incorporated into a Brood Stock Collection and Breeding Plan:

- Brood stock collected from the Wells Reservoir;
- Brood stock collected from nearby reservoirs (Priest Rapids, Wanapum, Rocky Reach, Rock Island);
- Brood stock collected from McNary Reservoir;
- Juvenile production from the Lake Roosevelt white sturgeon recovery effort;
- Brood stock collected from below Bonneville Dam in the lower Columbia River;
- Juveniles purchased from a commercial facility.

A white sturgeon supplementation program may include, but may not be limited to, the following implementation options (Not listed in a priority order):

- Build new or retrofit existing Douglas funded hatchery facilities to accommodate white sturgeon brood stock, egg incubation, and juvenile rearing;
- Development of a mid-Columbia hatchery facility funded by the three PUDs (Douglas, Chelan, and Grant) to accommodate various phases of white sturgeon supplementation; brood stock, egg incubation, and juvenile rearing;
- Direct release into the Wells Reservoir of juveniles produced via appropriate Breeding Plan criteria and reared at a commercial facility;
- Direct release into the Wells Reservoir juveniles or adults trapped and hauled from the lower Columbia River.

The initial source of brood stock shall be determined within the first year of issuance of the new license. Collection of brood stock shall occur consistent with the brood stock collection plan in years 1-4 of the new license. Any additional years during the Phase I program (first ten years of the new license) in which brood stock collection shall occur in order to facilitate additional juvenile stocking into the Wells Reservoir (Section 4.1.2) will be determined by the Aquatic SWG. The intent of brood stock collection is to use their progeny, if feasible, for future white sturgeon stocking activities in the Wells Reservoir. The brood stock collection plan shall be updated annually, or as otherwise recommended by Douglas in consultation with the ASWG, to incorporate new and appropriate information.

### 4.1.2 Juvenile White Sturgeon Stocking

Within two years following issuance of the new license, Douglas shall release up to 5,000 yearling white sturgeon into the Wells Reservoir annually for four consecutive years (20,000 fish total). Additional years and numbers of juvenile sturgeon to be stocked during Phase I will be determined by the Aquatic SWG and will not exceed 15,000 juvenile sturgeon (total of 35,000 juvenile sturgeon during Phase I). In consultation with the Aquatic SWG, yearling fish for release shall be acquired through one or more of the sources listed in priority order in Section 4.1.1 above, or through other measures identified by the Aquatic SWG. If juvenile sturgeon stocking deadlines cannot be achieved, the Aquatic SWG will determine alternative implementation measures that will be undertaken by Douglas (see Table 4.7-1, footnote 2).

Douglas shall ensure that all hatchery-reared juvenile white sturgeon released into the Wells Reservoir are marked with Passive Integrated Transponder (PIT) tags and year-specific scute marks for monitoring purposes described in Section 4.2 of this plan. In order to allow for tracking of juvenile white sturgeon emigration described under Section 4.2.2, Douglas shall ensure that up to one percent (or a maximum of 50) of the juvenile white sturgeon released into the Wells Reservoir are large enough to allow implantation of an active tag prior to release. In addition, following the third year of supplementation (unless the Aquatic SWG determines more analysis is required), the Aquatic SWG may elect to release juveniles at an earlier or later life stage for the fourth year in order to compare success of fish released at varying life stages. For example, the Aquatic SWG may elect to have a proportion of the hatchery-reared juveniles released at differing size intervals (with the minimum size being that which permits PIT tagging), in order to monitor potential differences in survival and growth during future indexing periods.

## 4.2 Phase I Monitoring and Evaluation Program (Objective 2)

Douglas shall conduct a monitoring and evaluation program within the Wells Reservoir for the purpose of assessing the effectiveness of the supplementation activities described in Section 4.1 and outlined in Table 4.7-1. Monitoring shall include both an Index Monitoring Program (Section 4.2.1) and a Marked Fish Tracking Program (Section 4.2.2). Both of these studies will be used to collect life history and population dynamics information including rates of fish movements into and out of the Wells Reservoir and habitat use. Douglas shall also obtain updated information, when available, on other white sturgeon recovery programs (e.g., Upper Columbia River, Kootenai River, mid-Columbia PUDs), in order to improve the monitoring and evaluation program and refine its implementation. The results of this information will also inform supplementation, monitoring and evaluation activities during implementation of Phase II of the WSMP.

### 4.2.1 Index Monitoring Program

Within three years following issuance of the New License, Douglas shall initiate a three-year index monitoring program (Years 3-5) for juvenile and adult sturgeon in the Wells Reservoir to determine age-class structure, survival rates, abundance, density, condition factor, growth rates, and to identify distribution and habitat selection of juvenile sturgeon. The indexing methods shall include using gillnets, set lines or other appropriate recapture methods for juveniles and adults.

As a component of the Phase I indexing program, Douglas shall capture and implant active tags in a portion of the juvenile and sexually mature adult sturgeon population found in the Wells Reservoir. This tagging effort shall be used to augment broodstock collection (Section 4.1.1), population level information and juvenile habitat use (Section 4.2.2) and natural reproduction potential (Section 4.2.3).

After the initial three-year indexing period (Years 3-5), Douglas shall conduct an additional two years of index monitoring in Phase I as determined by the Aquatic SWG. After year 9, an additional year of index monitoring would take place in year 12 and then every three to five years over the term of the new license (Phase II) to assess age-class structure, survival rates, abundance, condition factor, growth rates; identify distribution and habitat selection of juvenile sturgeon; and to inform the supplementation program strategy (see Table 4.7-1).

Frequency (every 3, 4 or 5 years) of implementation of a long-term index monitoring activities (after year 12) will be determined by the Aquatic SWG. Phase II index monitoring activities will not consist of implantation of active tags in captured individuals.

### 4.2.2 Marked Fish Tracking Program

Beginning in year three of the new license and continuing for three years (Years 3-5), Douglas shall conduct tracking surveys of the juvenile white sturgeon that were released with active tags as part of supplementation activities. This will require one percent of each of the annual classes of juvenile sturgeon (up to a maximum of 50 fish each year) released in years 2, 3, 4, and 5 to be reared large enough to implant an active tag for tracking purposes (See Table 4.7-1). The purpose of tracking active-tagged fish is to determine juvenile white sturgeon emigration rates out of the Wells Reservoir and habitat use within the Wells Reservoir.

Douglas shall repeat the tracking survey for two additional years during Phase I (see Table 4.7-1). The additional two years of surveys shall track: 1) active tags implanted in a percentage of juvenile fish from previous years of supplementation activities (dependent upon tag life) and 2) any juvenile and adult fish implanted with active tags during the last indexing period preceding the survey. Subsequent Phase I surveys are likely to coincide with the additional Phase I index monitoring and juvenile stocking activities.

### 4.2.3 Determining Natural Reproduction Potential (Objective 3)

In years where environmental conditions are appropriate, Douglas shall track sexually mature adult sturgeon that were captured and implanted with active tags under Section 4.2.1 for the purpose of identifying potential spawning locations and determining natural reproduction potential. Appropriate environmental conditions may be determined by examining the following factors: water quality and quantity (i.e., flow, temperature, and turbidity), the presence of reproductively viable adults during index monitoring activities, and the status of maturity for supplemented fish. In years in which sexually mature adult sturgeon are tagged under Section 4.2.1, Douglas may also utilize egg collection mats in combination with tracking in areas of the Wells Reservoir for the purpose of identifying potential spawning locations and activity. Five surveys of natural reproduction using adult tracking and/or egg mat placement shall occur over the term of the new license. Several of these surveys are intended to be implemented during the latter part of the license in order to examine the natural reproductive potential of supplemented fish recruiting to sexually maturity. These activities will support the aquatic life designated use for spawning under WAC 173-201A in the Washington state water quality standards.

## 4.3 Phase II Supplementation and Monitoring Program (Objective 2 and 4)

The information collected through activities described in Section 4.1-4.3 will provide insight into the population dynamics, habitat availability, and limiting factors that affect the natural population structure of white sturgeon within the Wells Reservoir. This information will inform supplementation, monitoring and evaluation activities during implementation of Phase II supplementation and monitoring activities in the WSMP for the duration of the new license term after year 10.

### 4.3.1 Long-Term Juvenile White Sturgeon Stocking

The number and frequency of yearlings released in Phase II of the white sturgeon supplementation program will range from 0 to 5,000 fish. Stocking rates shall be based on the results of the Phase I Monitoring and Evaluation Program (Section 4.2) and determination of carrying capacity (Section 4.3) and shall be consistent with the goal and objectives of the WSMP. The Phase II stocking rates can also be adjusted as determined by the Aquatic SWG (also see Table 4.7-1, footnotes 2 and 3).

### 4.3.2 Supplementation Program Review

Douglas shall compile information on other white sturgeon supplementation programs in the Columbia River Basin in order to assess whether the white sturgeon supplementation program being implemented at the Project is: (i) consistent and comparable with the technology and methods being implemented by other supplementation programs in the region; (ii) reasonable in cost and effective to implement at the Project; and (iii) consistent with the supplementation program goals and objectives. The supplementation program review will be conducted annually in coordination with the development of the annual report (Section 4.6).

### 4.3.3 Long-term Index Monitoring Program

Beginning in Year Twelve of the new license and every 3 to 5 years thereafter for the duration of the new license, Douglas shall continue to conduct a Phase II Index Monitoring Study for juvenile and adult sturgeon in the Wells Reservoir. This program will be used to monitor age-class structure, survival rates, abundance, condition factor, growth rates, identify distribution and habitat selection of juvenile sturgeon, and may continue to support broodstock collection activities. The indexing methods will include using gillnets or other appropriate recapture methods for juveniles and set lines for adults and will not consist of actively tracking fish. Frequency (every 3, 4, or 5 years) of implementation of long-term index monitoring activities (after year 12) will be determined by the Aquatic SWG.

## 4.4 Evaluation and Implementation of Adult Passage Measures (Objective 5)

In Year Eleven of the new license and every 10 years thereafter for the duration of the new license unless otherwise determined by the Aquatic SWG, the Aquatic SWG shall evaluate the biological merit to providing upstream passage for adult white sturgeon. The assessment of biological merit shall be determined by: (i) evaluating information gathered from monitoring and evaluation activities and determining whether there is significant biological benefit and need for upstream passage; (ii) the availability of reasonable and appropriate means to provide upstream passage; and (iii) consensus from all other operators of the mid-Columbia projects to implement adult upstream passage measures[1]. If all three criteria above are met, Douglas, in consultation with the Aquatic SWG shall develop adult passage measures that are consistent with measures being implemented by other mid-Columbia project operators.

## 4.5 Educational Opportunities Coinciding with WSMP Activities (Objective 6)

Douglas, in consultation with the Aquatic SWG, shall identify appropriate WSMP activities as opportunities for education to local public entities such as schools, cities, fishing and recreation groups, and other interested local groups. WSMP activities that may be appropriate for public participation are hatchery tours, release of hatchery juveniles, and tagging of juveniles prior to release.

## 4.6 Reporting

Douglas will provide a draft annual report to the Aquatic SWG summarizing the previous year's activities undertaken in accordance with the WSMP. The report will document all white sturgeon activities conducted within the Project. Furthermore, any decisions, statements of agreement, evaluations, or changes made pursuant to this WSMP will be included in the annual report. If significant activity was not conducted in a given year, Douglas will prepare a memorandum providing an explanation of the circumstances in lieu of the annual report.

[1] The intent is to provide connectivity to the Hanford Reach white sturgeon population.

## 4.7 Implementation Schedule

Table 4.7-1 outlines an estimated long-term schedule of the activities described in Sections 4.1-4.4.

**Table 4.7-1 Project White Sturgeon Implementation Schedule**

| New License Year | Brood Stock Plan and Collection[1] | Release Fish into Wells Reservoir[2] | Index Monitoring[3] | Tracking Marked Fish[4] | Natural Production Assessment[5] | Adult Passage Evaluation |
|---|---|---|---|---|---|---|
| PHASE I | | | | | | |
| 1 | X | | | | TBD | |
| 2 | X | X | | | | |
| 3 | X | X | X | X | TBD | |
| 4 | X | X | X | X | | |
| 5 | TBD | X | X | X | | |
| 6 | TBD | TBD | | | TBD | |
| 7 | TBD | TBD | TBD | TBD | | |
| 8 | TBD | TBD | | | | |
| 9 | TBD | TBD | TBD | TBD | | |
| 10 | TBD | TBD | | | TBD | |
| PHASE II[6] | | | | | | |
| 11 | Level and frequency TBD | Level and frequency TBD | | | | X[7] |
| 12 | | | X | | | |
| 13-50 | | | TBD | | TBD | Every ten years after Year 11 |

[1]Douglas brood stock plan shall be completed within one year following this issuance of the new license. Brood stock collection activities will occur at a minimum in years 1-4 during the new license term. Additional years, during Phase I, will be determined by the Aquatic SWG. In Year 11 (Phase II), level and frequency of activity will be determined by the Aquatic SWG and will be based upon the level of long-term supplementation identified from monitoring results.

[2]No more than a total of 35,000 fish will be stocked in Phase I (Years 1-10). The Phase II supplementation program will be determined by the Aquatic SWG and consistent with the goal of the WSMP.

[3] Results of the index monitoring activities will be used to determine the scope of future supplementation activities. Index monitoring activities from year 12 through the remainder of the new license term will occur at a frequency of 3-5 years as determined by the Aquatic SWG.

[4] Active-tagged juvenile and adult sturgeon will be tracked to assess emigration, habitat use, and potential spawning locations. This activity will occur in years 3, 4, and 5. Two additional years will be determined by the Aquatic SWG but will likely be consistent with years in which index monitoring activities are implemented.

[5] Tracking of reproductively viable adult sturgeon in combination with deployment of egg collection mats to identify natural production in the Wells Reservoir during 5 separate years over the term of the new license based on flow conditions or other data as determined by the Aquatic SWG.

[6] Phase II activities will consist only of brood stock plan and collection, stocking activities, index monitoring, and potentially natural reproduction assessments for the remainder of the new license.

[7] Adult Passage Evaluations will occur in Year 11 and every 10 years thereafter for the term of the new license.

# 5.0 REFERENCES


Beamesderfer, R.C., J.C. Elliot, and C.A. Foster. 1989. Report A. Pages 5-52. In: A.A. Nigro [editor]. Status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. Annual Progress Report. Prepared for the U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Beamesderfer, R.C., T.A. Rien, and A.A. Nigro. 1995. Differences in the dynamics and potential production of impounded and unimpounded white sturgeon populations in the lower Columbia River. Transactions of the American Fisheries Society 124: 857-872.

Brannon, E. and A. Setter. 1992. Movements of white sturgeon in Roosevelt Lake. Final Report (1988-1991) to Bonneville Power Administration, Portland Or. Project No. 89-45:35 p.

Devore, J.D., B.W. James, C.A. Tracy, and D.A. Hale. 1995. Dynamics and potential production of white sturgeon in the unimpounded lower Columbia River: Transactions of the American Fisheries Society, v. 124, Issue 6, p. 845-856.

Jerald, T. 2007. White Sturgeon (Acipenser transmontanus) Population Assessment in Wells Reservoir. MSc Thesis. Central Washington University, Ellensburg, WA.

Kincaid, H.L. 1993. Breeding plan to preserve the genetic variability of the Kootenai River white sturgeon. Report prepared for the Bonneville Power Administration Contract No. DE-A179-93B002886.

Lane, E.D. 1991. Status of white sturgeon, Acipenser transmontanus, in Canada. Canadian Field-Nat. 105:161-68.

Lepla, K., J.A. Chandler, and P. Bates. 2001. Status of Snake River white sturgeon associated with the Hells Canyon complex. Idaho Power Technical Report Appendix E.3.1-6 Chapter 1. 24 pp.

van der Leeuw, B.K., M.J. Parsley, C.D. Wright, and E.E. Kofoot. 2006. Validation of critical assumption of the riparian habitat hypothesis for white sturgeon: U.S. Geological Survey Scientific Investigation Report 2006-5225, 20 p.

Public Utility District No. 1 of Chelan County (Chelan PUD). 2005. Rocky Reach White Sturgeon Management Plan. Public Utility District No. 1 of Chelan County, Wenatchee, WA.

Skalski, J.R. and R.L. Townsend. 2005. Analysis of the Douglas County Public Utility District #1 Sturgeon Mark-Recapture Study. Columbia Basin Research. School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA.

Upper Columbia White Sturgeon Recovery Initiative (UCWSRI). 2002. Upper Columbia White Sturgeon Recovery Plan. November 28, 2002. 90 pp.

U.S. Fish and Wildlife Service (USFWS). 1999. Recovery Plan for the White Sturgeon (Acipenser transmontanus): Kootenai River Population. U.S. Fish and Wildlife Service, Portland, Oregon. 96 pp. plus appendices.

Wydoski, R.S. and R.R. Whitney. 2003. Inland Fishes of Washington. Second Edition. American Fisheries Society. University of Washington Press.

# WHITE STURGEON BROODSTOCK COLLECTION AND BREEDING PLAN

# WELLS HYDROELECTRIC PROJECT
# FERC PROJECT NO. 2149

Public Utility District No.1 of Douglas County
East Wenatchee, WA 98802

**September 2011**

# Table of Contents

# 1.0 INTRODUCTION

## 1.1 Wells Project Relicensing

As a component of the FERC relicensing of the Wells Hydroelectric Project (Wells Project), the Public Utility District No. 1 of Douglas County (Douglas) developed a White Sturgeon Management Plan (WSMP; Douglas PUD 2008) as one of six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement (Agreement). The WSMP was developed in close coordination with agency and tribal natural resource managers (Aquatic Settlement Work Group or Aquatic SWG). During the development of this plan, the Aquatic SWG focused on developing management priorities for resources potentially impacted by Project operations.

The WSMP for the Wells Project was based on similar plans that have been developed in other areas of the middle and upper Columbia River Basin, specifically the Kootenai White Sturgeon Recovery Plan, the Upper Columbia White Sturgeon Recovery Initiative (UCWSRI 2002), the Priest Rapids White Sturgeon Management Plan (Grant PUD 2009), and the Rocky Reach White Sturgeon Management Plan (Chelan PUD 2005). The Kootenai and Upper Columbia recovery programs were implemented in 1996 and 2001, respectively. The Priest Rapids WSMP was initiated in 2009 and the Rocky Reach WSMP was initiated in 2010.

## 1.2 Wells Project White Sturgeon Population Status

Research to determine the abundance, distribution, population dynamics, biophysical attributes of preferred habitat, seasonal movement patterns, and spawning characteristics of white sturgeon were conducted in Wells Reservoir from 2001 to 2003 (Jerald 2007). This information has been summarized below and where applicable, has been used to tailor the White Sturgeon Broodstock Collection and Breeding Plan to the Wells Project area.

A relatively small population of white sturgeon (estimated at 34 fish; 95% CI of 13 - 217 fish), primarily consisting of adults, is present in the Wells Reservoir. Based on set line capture and radio telemetry movement information, white sturgeon were found primarily near the confluence of the Okanogan and Columbia rivers and in the lower Okanogan River. White sturgeon were not documented during telemetry surveys or setline surveys that took place outside this area during the spawning period. The location of spawning areas and the occurrence of spawning in the reservoir have not been documented.

Sex ratios for white sturgeon captured in the Wells Reservoir were not determined. Captured sturgeon ranged in age from 6 to 30 years old demonstrating that all of these fish recruited to the Wells Reservoir after Wells Dam was completed in 1967 with strong year class recruitment between the years 1972 and 1978 and again between 1988 and 1996. The presence of fish within these age classes suggests that successful recruitment within or to the Wells Reservoir is occurring either through (1) spawning within the Wells Reservoir and/or (2) immigration into the Wells Reservoir from populations upstream.

Catches were dominated by white sturgeon from 60 to 135 cm fork length (FL), which represented fish between the 1988 to 1997 year-class and from 180 to 210 cm FL (1972 to 1978 year-class). These two groups accounted for all captures. The histogram showed a relatively low distribution of younger juvenile white sturgeon, with 15% of the total catch composed of juvenile fish less than 90 cm. However, the use of set lines with large circle hooks (11/0, 13/0 and 15/0) likely reduced the capture of smaller, younger fish.

Two white sturgeon were captured and subsequently recovered to provide growth rate information. One juvenile grew from 65 cm FL at capture on July 11, 2001 to 87 cm FL on September 26, 2002, a growth rate of 22 cm in 14 months. One adult fish caught on August 9, 2001 measured 197 cm FL and when recaptured on September 6, 2002 measured 199 cm FL, a 2 cm growth over approximately 13 months. This fish was subsequently found deceased in October of 2006 and was 228.5 cm FL, which represented an increase of 29.5 cm FL over an approximate four year period (average of 7.4 cm per year).

In total, six white sturgeon were radio-tagged and monitored throughout the study period using mobile and fixed telemetry. Telemetry data along with set line capture data verified that white sturgeon congregated in the Columbia River near the Okanogan River confluence during the summer, fall, and winter months with none of the six fish being detected downstream from Brewster (RM 530) or upstream of Park Island (RM 538). Very little movement of tagged sturgeon was observed during winter months. In the spring of 2002, one adult made an upstream migration into the Okanogan River; in 2003, two different adults undertook movements into the Okanogan River.

In general, the results of the white sturgeon study in the Wells Reservoir were similar to the results of a study conducted in the neighboring Rocky Reach Reservoir in 2001-2002 (Chelan PUD 2005). Both studies captured similar numbers of sturgeon using similar amounts of effort and similar capture techniques. Radio-telemetry data from both studies suggest that very little activity occurs during the overwintering period. Both studies suggest that limited recruitment into each population is occurring based on the presence of juvenile fish in both reservoirs (Chelan PUD 2005; Jerald 2007).

### 1.3 Sturgeon Propagation and Supplementation

The first recorded attempts at artificial propagation of sturgeon were made by Ovsyandikov in Russia in 1870 and Green in the U.S. in 1875. Significant efforts to artificially propagate sturgeon continued in North America between 1875 and 1912, however, by 1920 practically all these efforts were abandoned (Conte et al. 1988). Sturgeon hatchery research continued in the Soviet Union and by the 1980s the Soviets operated approximately 20 hatcheries producing 70 to 100 million fingerlings annually. The success of the sturgeon hatchery programs in the Soviet Union rekindled interest in sturgeon research in the U.S. The work of Detlaf, Gerbilisky, Ginzburg, Kozin, Doroshov and their associates laid the groundwork for the advancement of sturgeon programs throughout North America (Conte et al. 1988).

In 1979, a grant from the U.S. Fish and Wildlife Service to researchers at the University of California led to a resurgence of sturgeon research. The development of hatchery technologies for white sturgeon has allowed the advancement of a growing commercial sturgeon aquaculture industry on the West Coast. A hatchery manual for white sturgeon (Conte et al. 1988) was developed by University of California (Davis) researchers.

Within the native range of white sturgeon in North America, early attention has been placed on the advancement of a specific type of sturgeon hatchery involved in what is termed "conservation aquaculture". Essentially these facilities are used as tools for the recovery of endangered or depressed sturgeon species/stocks. Given the issues associated with legislation regarding endangered species in North America (the Endangered Species Act in the U.S. and the Species at Risk Act in Canada), it is deemed unacceptable to stock large numbers of generic-stock white sturgeon as a method to recover endangered populations. Instead, a conservation aquaculture program was developed that factors in issues/concerns such as genetic make-up, genetic swamping, interaction with adjacent populations, breeding plans, family numbers, etc., as compared to a typical hatchery where production numbers and fish health are the dominant concerns. At present, the four white sturgeon conservation aquaculture facilities presently operating in the Pacific Northwest are:

Kootenai Sturgeon Hatchery constructed in 1991 on the Kootenai River near Bonners Ferry, Idaho and run by the Kootenai Tribe of Idaho. This facility is the main culture facility for the Kootenai white sturgeon recovery program.

Kootenay Trout and Sturgeon Hatchery (KTSH) at the upper end of Lake Koocanusa near Wardner, B.C and run by the British Columbia Ministry of Environment (BCMOE). This facility was originally a trout hatchery and was expanded in 1998 as a failsafe facility to raise sturgeon for the Kootenai white sturgeon recovery program and in 2001 commenced production for the Upper Columbia White Sturgeon Recovery program.

The Washington Department of Fish and Wildlife, Spokane Tribe of Indians, and Colville Confederated Tribes established an aquaculture program in Washington in 2003 at WDFW's Columbia Basin Hatchery (CBH) in Moses Lake to assist with the Upper Columbia White Sturgeon Recovery program. All fish produced in the Washington program were released into the Washington section of the Transboundary Reach of the Columbia River. Initially the Washington program utilized Upper Columbia white sturgeon juveniles, and then eggs and larvae provided from the KTSH. The Washington program became self-sufficient in 2006 when they began collecting and spawning their own broodstock. Spawning activities were conducted at the WDFW Sherman Creek Hatchery located near Kettle Falls, WA. The progeny from these fish were raised at the CBH before being released into the Washington section of the Transboundary Reach of the Columbia River. Beginning in 2010, the Washington program experimented with the capture of wild larvae as alternative to brood capture. After positive results, the program discontinued adult broodstock capture and shifted their entire production to wild caught larvae in 2011.

In 2009, the Yakima Nation initiated construction of a white sturgeon culture facility at Marion Drain near Toppenish, WA. This facility received its first broodstock (from McNary Reservoir) in late spring 2010 and is presently rearing sturgeon to be out planted in 2012 as part of the Priest Rapids WSMP and Rocky Reach WSMP.

The ultimate goal of each conservation aquaculture program is to ensure the continued existence of the population while attempting to maximize genetic diversity and keep hatchery-produced fish as "wild" as possible. This approach is fundamentally different from a traditional fish production facility.

## 2.0 PLAN DEVELOPMENT

The goal of the WSMP is to promote growth of the white sturgeon population in the Wells Project area to a level that is commensurate with the available habitat and characterized by a diverse age structure consisting of multiple cohorts (juvenile and adult). This White Sturgeon Broodstock Collection and Breeding Plan is a key component of the WSMP and is the initial step toward increasing the white sturgeon population in the Wells Reservoir. Based upon the available information on the white sturgeon population segment (as summarized in Section 2.0), the Aquatic SWG agreed that efforts should focus, initially, on supplementation efforts to increase the population within the Wells Reservoir in order to address Project effects. Once the population numbers have been increased to a level that can be studied, as determined by the Aquatic SWG, Douglas shall implement a monitoring and evaluation program to accurately assess natural recruitment, juvenile habitat use, emigration rates, carrying capacity, and the potential for natural reproduction so as to inform the scope of a future, long-term supplementation strategy.

The White Sturgeon Broodstock Collection and Breeding Plan supports the following objectives as outlined in the WSMP:

Objective 1: Supplement the white sturgeon population in order to address Project effects, including impediments to migration and associated bottlenecks in spawning and recruitment;

Objective 2: Determine the effectiveness of the supplementation activities through a monitoring and evaluation program;

Objective 3: Determine the potential for natural reproduction in the Wells Reservoir in order to appropriately inform the scope of future supplementation activities;

Objective 4: Adaptively manage the supplementation program as warranted by the monitoring results and in consultation with the Aquatic SWG.

In order to meet these objectives, Douglas, in consultation with the ASWG, is required to develop and implement a White Sturgeon Broodstock Collection and Breeding Plan in Year 1 of the ten year Phase 1 of the implementation of the WSMP. This Plan should be compatible with other similar plans in the Columbia River mainstem. The desired end point is augmentation and maintenance of the sturgeon population through supplementation in order to provide a stable future population.

The following assumptions were considered in the preparation of this Plan:

- natural reproduction is present but appears to be insufficient in the foreseeable future to maintain a stable or increasing population of sturgeon in the Project area;
- the carrying capacity of the Project area is substantially greater than existing white sturgeon population levels;
- recruitment to the existing white sturgeon population at levels necessary to sustain or increase the populations will require supplementation of the existing population;

### 2.1 WSMP Phase I Supplementation Goals

The annual supplementation target for the WSMP is up to 5,000 yearling white sturgeon annually for four consecutive years (up to 20,000 fish total). Additional years and numbers of juvenile sturgeon to be stocked during Phase I would be determined by the Aquatic SWG and would not exceed 15,000 juvenile sturgeon (total of up to 35,000 juvenile sturgeon during Phase I).

### 2.2 Population Model Scenarios

Population trajectories were modeled for the white sturgeon populations in Wells Reservoir with a simple age-structure demographic model using: i) hypothetical hatchery and wild sturgeon recruitment rates; ii) current data on abundance, growth, maturation, and juvenile and adult survival; and iii) the assumptions inherent in the most recent version of the model developed for use in the Upper Columbia River. The following scenario represents expected population responses to supplementation measures (i.e., releasing 5000 hatchery-raised juveniles annually for 4 years into Wells Reservoir and 2500 juveniles per year for the remaining 6 years of the 10-year Phase 1 program). Because of the approximate 25 to 30 year age until full maturation (assumed to be age-25 for the baseline model), the existing adult population is projected to decline to very low numbers over the next 30 years even with the immediate release of hatchery-reared juveniles. After this period, adult numbers build as hatchery sturgeon mature and recruit to the adult population. A key parameter that determines the subsequent status of the population is the number of natural recruits produced by the hatchery-origin adults. This annual recruitment value is unknown at this time, so this input was arbitrarily adjusted to the number required to maintain a stable adult population at the specified target level.

The population trajectory modeled for Wells Reservoir is illustrated below for the baseline scenario. The results of other model runs to determine effects on changes to model assumptions of stocking rates, survival, and age-at-maturity are discussed.

### 2.3.1 Baseline Population

A baseline scenario was modeled based on the following assumptions:

- an initial wild population of 34 fish;
- a stocking rate of 5,000 juveniles per year for the first 4 years (commencing in 2014) with 2500 juveniles per year for the following 6 years;
- zero natural recruits per year for the first 25 years and then 200 natural recruits per year after 25 years;
- females maturing at age-25; and
- population metric data (e.g., growth, survival, size-at-maturity, etc.) from adjacent white sturgeon populations in the upper and middle Columbia River.

This scenario produces an initial rapid population increase to approximately 1,800 adults by 2045, with a subsequent decline in population to the target level of approximately 1,000 adults by 2060 when the progeny of the hatchery adults start to mature and begin to contribute to the wild population (Figure 1). Assuming a 1:1 sex ratio of fish surviving to adulthood, approximately half of the adults would be mature females of which about 115 would spawn in any given year (assuming a 5-year spawning interval for females) by 2045 and decline to 80 females by 2060 (Figure 2). Restoration of a relatively stable sturgeon age distribution for this scenario can be expected in approximately 50 years based on a natural recruitment rate after 25 years of 200 age-1 fish annually (Figure 3).

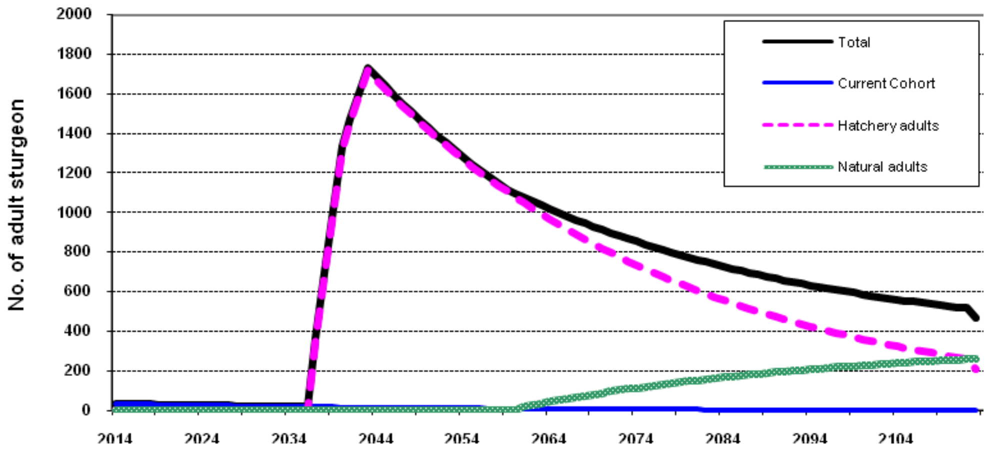



**Figure 1 Projected future wild and hatchery adult white sturgeon population size following implementation of a baseline supplementation scenario in Wells Reservoir.**

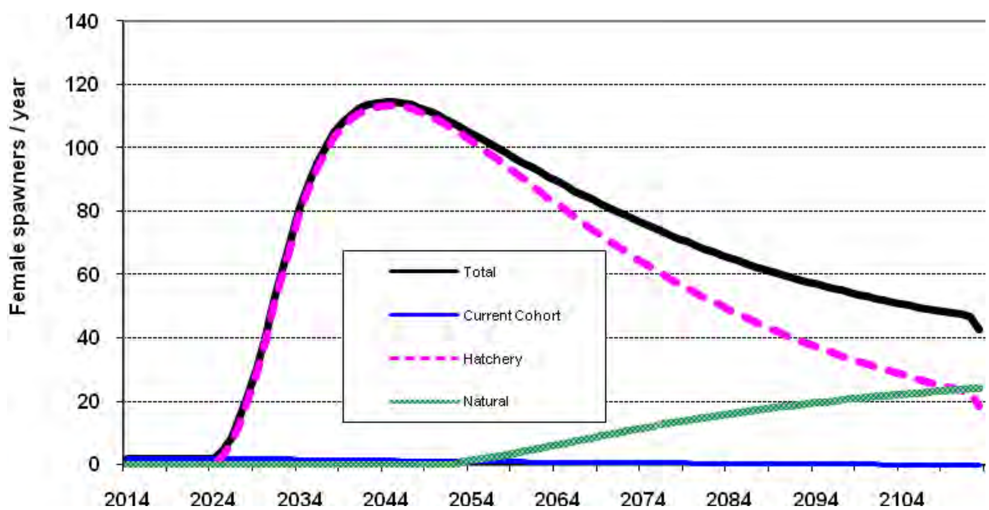



**Figure 2 Projected future reproductive potential of white sturgeon following implementation of a baseline supplementation scenario in Wells Reservoir.**

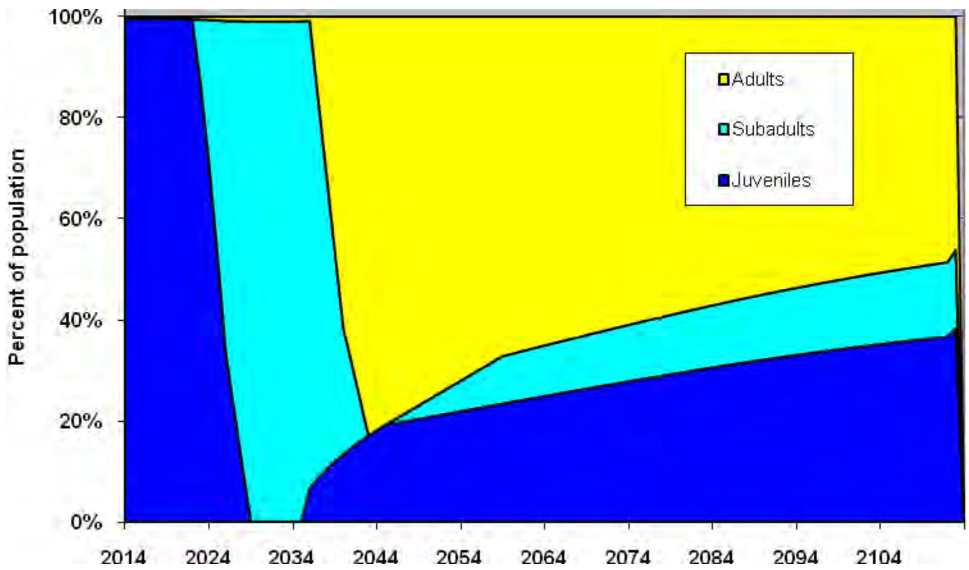



**Figure 3 Projected changes in sturgeon age composition following implementation of a baseline supplementation scenario in Wells Reservoir.**

Maintenance of an adult population size of more than 1,000 adults may not be achievable or desirable in Wells Reservoir. Monitoring of the population status and growth would be required to identify and mitigate negative density-dependent effects on growth and survival. A controlled harvest for sub-adults can be used as a means to adjust future population levels of adult white sturgeon. Using the model above and applying a 5% annual harvest commencing 10 years after the initial stocking and targeting the 100 – 150 cm FL size-class (pre-spawners), would reduce the maximum population size to 1,400 adults. If this harvest were increased to 10% for this size class, total maximum population would be approximately 1,200 adults. Both these estimates assume constant levels of natural recruitment after 25 years.

## 3.0 BROODSTOCK COLLECTION

The Wells WSMP requires that *“the initial source of brood stock shall be determined within the first year of issuance of the new license. Collection of brood stock shall occur consistent with the brood stock collection plan in years 1-4 of the new license. Any additional years during the Phase I program (first ten years of the new license) in which brood stock collection shall occur in order to facilitate additional juvenile stocking into the Wells Reservoir (Section 4.1.2) will be determined by the Aquatic SWG. The intent of brood stock collection is to use their progeny, if feasible, for future white sturgeon stocking activities in the Wells Reservoir. The brood stock collection plan shall be updated annually, or as otherwise recommended by Douglas in consultation with the ASWG, to incorporate new and appropriate information.*

The Wells WSMP calls for the release of up to 5,000 juveniles per year for four years into Wells Reservoir. In consultation with the Aquatic SWG, yearling fish for release shall be acquired from appropriate wild Columbia River sources. Sturgeon for supplementation may be obtained through the collection of gametes from adult broodstock and/or collection of wild larval, subyearling and/or yearling fish. Gametes and/or fish younger than yearlings will be grown out to yearlings in an artificial production environment.

Broodstock contribution of six male and six female spawning sturgeon that would contribute to six maternal families is the recommended target if broodstock collection is utilized to provide up to 5,000 yearling sturgeon annually. If six maternal families are not available through broodstock collection the total of number of juveniles to be released may be less than the 5,000 maximum target. Juveniles obtained from "drift larval capture" techniques (use of D-Rings nets) may be used to provide juveniles for rearing as an alternative or supplemental strategy. Both broodstock collection and drift larval capture are considered pilot programs in the upper mid-Columbia River (Bonneville Dam to Grand Coulee Dam) at this time.

During spring 2010 and 2011, broodstock collection efforts were conducted in several areas of the Columbia River from Rock Island Dam downstream to Bonneville Dam. These initial efforts to meet the supplementation obligations for the Priest Rapids and Rocky Reach WSMPs produced a 2Mx1F spawning cross in 2010 and a 1x1 cross in 2011. Considering the low sturgeon populations in the Wells, Rocky Reach, and Rock Island reservoirs, it is likely that broodstock capture efforts in these reservoirs would be relatively unproductive and insufficient to meet initial supplementation targets. Therefore, the Aquatic SWG recommends that:

i. The preferred collection area for year 1 and 2 ~~(2012 and 2013)~~ white sturgeon supplementation efforts is the greater middle Columbia River from Bonneville Dam upstream to Grand Coulee Dam. Additional collection areas may be considered ~~for future years~~ by the Aquatic Settlement Work Group.
ii. Collection sites, assignments, and appropriate fishing efforts will be coordinated pre-season.
iii. Participants in supplementation capture efforts for the mid-Columbia PUDs will communicate regularly in-season to discuss collection status and coordinate any necessary changes to collection efforts.

Brood stock and/or gametes originating from the lower (below Bonneville Dam) and/or upper (above Grand Coulee Dam) Columbia River white sturgeon stocks may be acceptable for supplementation in future years ~~(2014+) as recommended by Wells Reservoir sturgeon managers~~.

## 4.0 WHITE STURGEON BREEDING PLAN

### 4.1 Factorial Mating Designs for Captive-Spawned Wild Broodstock

The following examples of mating scenarios have been adopted from the breeding plan of the UCWSRI and Nechako White Sturgeon Recovery Initiative and assume that maturation of most fish can be synchronized with hormone injections and temperature manipulations. The example factorial breeding plan calls for the spawning of six male and six female fish. A full 6X6 factorial breeding plan is unlikely to be realized at one spawning event. A more likely scenario is the two – 3X3 breeding matrices scenario described below.

In cases where at least three male and three female fish are retained to spawn at any one time, the partial factorial matrix shown in Table 1 would be employed. In a full factorial design, all six males would be crossed with all six females and *vice versa*. This would maximize genetic diversity in the breeding design. However, as Busack and Knudson (2007) note, a lesser increase in genetic gain for the breeding population potential is realized by a full factorial matrix increase of 5X5 to 10X10 than can be achieved by an increase from a 2X2 to a 5X5 matrix; the relationship of efficiency is not linear. They also note that in hatchery situations, large full factorial breeding matrices are often impractical. In the scenario where conservation release numbers are capped at the levels of thousands of juveniles, the practicality of dividing a single clutch of eggs into six even groups per female becomes difficult and onerous and small-batch handling effects may negatively influence survival outcomes; it is best to handle eggs effectively and safely to optimize results. To this end, the 6X6 breeding matrix is divided into two partial 3X3 matrices.

In Table 1, three female fish are spawned with each of three males and *vice versa*. If one or more females do not spawn at the same time, fertilization of her/their ova may be completed at a later date providing that the matrix is completed using all the males in the partial matrix. In the end, families will be grouped and cultured by maternal family and therefore there is no need to be temporally synchronized. In this regard, the milt from the male fish may have to be retained and stored under conditions that permit optimal fertilization in the final event, or the male will need to supply additional high-quality milt on a later occasion. If one or more males do not supply milt for a later spawning event to complete the matrix, the default position is to substitute male milt from other donors not currently in the matrix. Imperative here is the preservation of the genetic variability within the maternal family; of secondary importance is the completion of the full factorial matrix as written.

**Table 1 Idealized partial factorial breeding design in a 6 female X 6 male scenario resulting in the production of six discrete families and eighteen half-sib families.**

| Female | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Male 1 | | | | | | |
| Male 2 | | | | | | |
| Male 3 | | | | | | |
| Male 4 | | | | | | |
| Male 5 | | | | | | |
| Male 6 | | | | | | |

### 4.2 Non-factorial Circumstances

The scenario where few fish in breeding condition are captured and retained in captivity, or where brood females undergo gonad regression, fewer than three fish of either gender may be available. In this circumstance, the matrix should be followed as completely as possible to maximize the genetic diversity in the captive-bred fish. For example, if one of three female fish regress or fail to spawn, then the remaining two viable females should be crossed with the three males. This means a 2 female X 3 male matrix could be followed as opposed to a 2X2 matrix. Other subsequent female fish captured and induced to spawn would also be crossed with the three males to round out the breeding matrix.

The flexibility of the factorial mating design is further illustrated in a scenario where only four or five spawning female sturgeon are captured. The matrix can be adapted to have a 4 female X 6 male or 5 female X 6 male breeding plan to produce 4 or 5 families with 24 and 30 half-sib families, respectively. This flexibility gives the hatchery the maximum capability to produce genetically distinct families to maximize the genetic diversity of juvenile sturgeon entering the system.

## 5.0 LITERATURE CITED

Anders, P.J., and M.S. Powell. 2001. Genetic impact of proposed white sturgeon supplementation in Rock Island Reservoir. Memorandum to BPA Project 86-50 Cooperators. February 28, 2001.

Börk, K.; Drauch, A.; Israel, J. A.; Pedroia, J.; Rodzen, J.; May, B. 2008: Development of new microsatellite primers for white and green sturgeon. Cons. Genet. **9**, 973-979.

Busack, C., and C. M. Knudsen. 2007. Using factorial mating designs to increase the effective number of breeders in fish hatcheries. Aquaculture 273:24-32.

Chelan PUD (Public Utility District No. 1 of Chelan County). 2005. Rocky Reach White Sturgeon Management Plan. Public Utility District No. 1 of Chelan County, Wenatchee, WA.

Conte, F.S., S.I. Doroshov, P.B. Lutes, and E.M. Strange. 1988. Hatchery Manual for the White Sturgeon *Acipenser transmontanus* Richardson. With application to other North American Acipenseridae. University of California, Davis.

Douglas PUD (Public Utility District No. 1 of Douglas County) 2008. White Sturgeon Management Plan Wells Hydroelectric Project FERC Project No. 2149.

Drauch, A.; Börk, K.; May, B.; Rodzen, J. 2006: Development of new microsatellite markers for white sturgeon and continued genetic monitoring of the KTOI broodstock. Unpubl. technical report to Kootenai Tribe of Idaho, Award #01633, Bonners Ferry, ID, pp. 22.

Dupont-Nivet, M., M. Vandeputte, P. Haffray, and B. Chevassus. 2006. Effect of different mating designs on inbreeding, genetic variance and response to selection when applying individual selection in fish breeding programs. Aquaculture 252:161-170.

Fiumera, A. C., B. A. Porter, G. Looney, M. A. Asmussen, and J. C. Avise. 2004. Maximizing offspring production while maintaining genetic diversity in supplemental breeding programs of highly fecund managed species. Conservation Biology 18:94-101.

Irvine, R. L.; Schmidt, D. C.; Hildebrand, L. R.; 2007: Population status of white sturgeon in the lower Columbia River within Canada. Trans. Am. Fish. Soc. **136,** 1472-1479.

Jerald, T. 2007: White sturgeon (*Acipenser transmontanus*) population assessment in Wells Reservoir. Master's Thesis. Central Washington Univ., Ellensburg, WA. pp. 59.

Kincaid, H.L. 1993. Breeding plan to preserve the genetic variability of the Kootenai River white sturgeon. Report prepared for the Bonneville Power Administration. Contract No. DE-A179-93B002886. Portland, Oregon.

Kootenai Tribe of Idaho. 2004. Ireland, S.C., P. J. Anders and R.C.P. Beamesderfer eds. An Adaptive Multidisciplinary Conservation Aquaculture Plan for Endangered Kootenai River White Sturgeon. Management Plan prepared by the Kootenai Tribe of Idaho with assistance from S. P. Cramer and Associates. 56 pp.

Rodzen, J. A.; May, B. P. 2002: Inheritance of microsatellite loci in the white sturgeon (*Acipenser transmontanus*). Genome **45,** 1064-1076.

Rodzen, J.; May, B.; Anders, P.; Ireland, S. 2004: Initial microsatellite analysis of wild Kootenai River white sturgeon and subset brood stock groups used in a conservation aquaculture program. Unpubl. technical report to Bonneville Power Administration, award #88-64, Portland, OR, pp. 36.

Smith, C. T.; Nelson, R. J.; Pollard, S.; Rubidge, E.; McKay, S. J.; Rodzen, J.; May, B.; Koop, B. 2002: Population genetic analysis of white sturgeon (*Acipenser transmontanus*) in the Fraser River. J. Appl. Ichthyol. **18,** 307-312.

UCRWSRI. 2002. Upper Columbia River White Sturgeon Recovery Initiative. Draft Recovery Plan. April 15, 2002. 86p.

Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology [online]1(2):1. http://www.consecol.org/vol1/iss2/art1

## Beau Patterson

**From:** Beau Patterson
**Sent:** Friday, November 18, 2011 11:14 AM
**To:** 'Bao Le'; Bill Towey (bill.towey@colvilletribes.com); Bob Jateff (jatefrjj@dfw.wa.gov); 'Bob Rose'; Bret Nine; Bruce Suzumoto (bruce.suzumoto@noaa.gov); 'Bryan Nordlund'; Chad Jackson; Donella Miller; 'Jason McLellan'; Jeff Korth (korthjwk@dfw.wa.gov); 'Jessi Gonzales'; 'jim_l_craig@fws.gov'; Joe Peone (joe.peone@colvilletribes.com); 'Karen Kelleher'; 'Keith.Kirkendall@noaa.gov'; kirk.truscott@colvilletribes.com; 'Mark_Miller@fws.gov'; 'Hallock, Molly (DFW)'; 'Irle, Pat (ECY)'; 'Patrick Luke'; Patrick Verhey (Patrick.Verhey@dfw.wa.gov); Paul Ward (ward@yakama.com); 'RD_Nelle@fws.gov'; 'Steve Lewis'; Steve Parker (parker@yakama.com); Steve Rainey; 'Carmen Andonaegui'; Mike Schiewe; Bob Dach (robert.dach@bia.gov); Keith Hatch (keith.hatch@bia.gov); Murauskas, Joshua (Josh.Murauskas@chelanpud.org); 'Mike Clement'; Hildebrand, Larry; 'Jon Merz'; 'Irle, Pat (ECY)'; 'Brad James'
**Cc:** Mary Mayo; Shane Bickford; Andrew Gingerich
**Subject:** Correction to: REQUEST FOR PROPOSALS #11-19-W: JUVENILE COLUMBIA RIVER WHITE STURGEON (ACIPENSER TRANSMONTANUS) FOR POPULATION SUPPLEMENTATION IN THE WELLS RESERVOIR, COLUMBIA RIVER, WASHINGTON
**Attachments:** 11-19-W RFP amended 11-18-2011-bp.pdf

It has been brought to my attention that the document in Appendix C of this RFP (White Sturgeon Broodstock Collection and Breeding Plan) does not include approved revisions made during the September 14, 2011 Aquatic Settlement Work Group meeting and approved by the Settlement Parties.

The corrections do not substantively affect the requested proposal. They are found on page 10 of the WSBCBP, page 77 of the 81 page 11-19-W RFP.pdf document (amended this date and attached). The revisions in their entirety are:

i. The preferred collection area for year 1 and 2 ~~(2012 and 2013)~~ white sturgeon supplementation efforts is the greater middle Columbia River from Bonneville Dam upstream to Grand Coulee Dam. Additional collection areas may be considered ~~for future years by the Aquatic Settlement Work Group~~.
ii. Collection sites, assignments, and appropriate fishing efforts will be coordinated pre-season.
iii. Participants in supplementation capture efforts for the mid-Columbia PUDs will communicate regularly in-season to discuss collection status and coordinate any necessary changes to collection efforts.

Brood stock and/or gametes originating from the lower (below Bonneville Dam) and/or upper (above Grand Coulee Dam) Columbia River white sturgeon stocks may be acceptable for supplementation in future years ~~(2014+) as recommended by Wells Reservoir sturgeon managers~~.

Please contact me if you have any questions.

Thanks,

Beau Patterson
Senior Natural Resources Scientist
Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, WA 98801
(509) 884-7191

# 2009 ASSESSMENT OF ADULT PACIFIC LAMPREY RESPONSE TO VELOCITY REDUCTIONS AT WELLS DAM FISHWAY ENTRANCES (2009 DIDSON STUDY REPORT)

# ASSESSMENT OF ADULT PACIFIC LAMPREY RESPONSE TO VELOCITY REDUCTIONS AT WELLS DAM FISHWAY ENTRANCES (2009 DIDSON Study Report)

## WELLS HYDROELECTRIC PROJECT

## FERC NO. 2149

April 2010

Prepared by:

P.N. Johnson
LGL Limited
Stevenson, Washington

And

B. Le
Long View Associates
Portland, Oregon

And

J.G. Murauskas
Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

**Table of Contents**

## List of Tables

# ABSTRACT

Researchers conducting studies at hydroelectric projects on the Columbia River have suggested that high velocity conditions at fishway entrances designed to attract salmonids may be an obstacle for adult lampreys during their upstream migration. Previous studies indicate that operational modifications that create lowered velocities at fishway entrances may result in increased fishway entrance efficiency for lamprey. To test this theory at Wells Dam, Dual-frequency Identification Sonar (DIDSON) was used to passively assess adult Pacific lamprey passage behavior in response to operational modifications at the Wells Dam fishway entrances in 2009.

DIDSON units were deployed during the peak migration period (20 August to 24 September) at Wells Dam to sample upstream passage events along the entire width of the fishway entrances and 1.3 m of vertical coverage above the sills (about 26% of the wetted vertical opening). Lamprey passage was examined relative to variable head differential treatments: existing high condition (0.46 m), moderate condition (0.31 m), and low condition (0.15 m). Treatments lasted four hours each evening (21:00 through 00:59) and were scheduled in a randomized block design to allow at least ten separate days for each treatment. Data collected during the treatment periods were reviewed and all lamprey observations were described.

Eleven behavioral sequences of adult lampreys were observed, including eight in the west fishway and three in the east fishway. Six of these observations originated upstream of the sill and therefore did not provide information on fishway approach and entrance behavior. The remaining five lampreys were observed approaching the fishway entrances, three of which were able to complete entry. Two of the three observed entrances occurred under reduced treatment levels, although the two failed attempts occurred during both low and high treatment periods. DIDSON footage documented a lamprey swimming freely through the entrance under a reduced operational condition. Observations where fish utilized burst and attach movements (one of which lingered for an extended period of time) occurred during both a high and low treatment period. The diminutive lamprey run in 2009 resulted in few fish observed at Wells Dam, precluding statistically significant evaluation of these results. Nonetheless, operational modifications implemented in 2009 suggest strong potential for increasing entrance efficiency. Pooling observations that occurred during reduced velocity treatments shows a 67% (2 of 3) entrance efficiency compared to 50% (1 of 2) under normal conditions. Despite the low sample size, these results are encouraging and continued investigation is recommended.

These results suggest that: (1) some lampreys demonstrate exploratory behavior, in addition to rejections associated with fishway entrance velocities; (2) spatial and temporal DIDSON coverage (vertical coverage and diel timing, respectively) under the 2009 configuration did not capture all entrance events; (3) reduced head differentials show promise in providing an environment conducive to upstream passage of lampreys; and (4) these operations do not negatively influence passage of adult salmon.

Despite the low sample size of lampreys available in 2009, DIDSON was an effective non-invasive technique for assessing behaviors in the fishway entrances. It remains to be determined to what degree improved entrance efficiency may be attributed to entrance velocity reductions,

lack of radio-tagging effects, and possibly a synergistic interaction between both variables. Advantages of DIDSON over other lamprey sampling methods are discussed as are recommendations for improving lamprey passage assessment at Wells Dam in future years. This study was initiated under early implementation of measures identified in the Wells Pacific Lamprey Management Plan (PLMP) to identify and address any adverse Project-related impacts on passage of adult Pacific lamprey. The PLMP is one of six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement (Agreement) developed in support of the Wells Hydroelectric Project (Project) Integrated Licensing Process. Similar to all management plans under the Agreement, the PLMP was developed in close coordination with agency and tribal natural resource managers to direct implementation of measures to protect against and mitigate for potential Project impacts to aquatic resources during the term of the new license.

# 1.0 INTRODUCTION

The Pacific lamprey (*Entosphenus tridentatus*) is an anadromous member of the jawless fish family (Petromyzontidae) that inhabits marine and freshwater systems from southern California to the Aleutian Islands in Alaska. Historically, Pacific lampreys were widely distributed throughout Washington State and served as an important ecological and cultural resource to the region (Close et al. 2002). Construction of hydroelectric and irrigation projects without fish passage facilities and the development of elaborate fishways specifically designed for salmon and steelhead in the Columbia River Basin (Basin), has limited the ability of migrating adult lampreys to reach upstream spawning locations, presumably contributing to Basin-wide population declines observed since 2004 (Close et al. 2002; Robichaud et al. 2009 ).

Research to better understand adult lamprey passage behavior was initiated at Wells Dam in 2004 (Nass et al. 2005). Subsequent investigations of lamprey behavior and passage efficiency took place in 2007 and 2008 (LGL and Douglas PUD 2008; Robichaud et al. 2009). The 2007-2008 studies identified the following:

- Entrance efficiencies ranged from 14% in 2007 to 33% in 2008, for a two year average of 27%.
- Lower fishway passage efficiency was 33% over both years although 2008 trapping operations that resulted in complete exclusion of passage in the middle portion of the fishway may have significantly biased these results.
- Upper fishway passage efficiency was 100% and passage times were relatively fast (median passage times = 6.7 h) indicating that little or no passage impediments exist in this portion of the Wells fishways.
- A majority of lamprey may be uncounted at Wells Dam as 73% (11/15) of radio-tagged lamprey ascending the upper fishway bypassed the adult counting stations.
- No fallbacks were observed over all study years including in 2004.
- Due to low sample sizes, only two unobstructed complete passage events were recorded (31.5 h and 32.7 h). These passage times are excellent compared to studies at other Columbia Basin dams where median passage times ranged ranged up to 7.6 days (Keefer et al., 2008).
- Overall, results indicate that potential passage impediments are restricted to the entrance and lower fishway.

Despite high passage rates and passage efficiency through the upper portions of Wells Project fishways, radio-tagged adult lampreys exhibit difficulty negotiating fishway entrances at Wells Dam. This impediment has been attributed to the hydraulic conditions at fishway entrances caused by the head differential between the fishway collection gallery and tailrace. The standard head differential at Wells Dam fishways is 0.48 m (1.5 ft) ± 0.06 m (0.2 ft). Average velocities (~3.0 m/s) currently experienced in the fishway entrances at Wells Dam are well above the known swimming capability of adult lampreys (Robichaud et al. 2009). Swimming performance of adult lampreys has been reported at 0.9 m/s (sustained swimming) to 2.1 m/s (burst speeds) (Mesa et al. 2003; Daigle et al. 2005). High velocity conditions are typical of fishway entrances in dams throughout the Basin, and have been identified as a key area for improving passage efficiency of adult lampreys through hydroelectric projects.

Radio-telemetry (RT) has been the most widely used technology to assess adult lamprey behavior in the Basin over the last two decades. Although results from RT studies have been useful in identifying passage impediments, recent studies utilizing increased sample sizes and advances in tag technology indicate that the base assumption of RT – that tagged fish are representative of untagged fish – has been consistently violated. Moser et al. (2007) found that there was a significant long-term effect of tagging on lamprey performance and that effects are perhaps more prevalent than the literature suggests. Keefer et al. (2009) also identified issues with RT when 63% of PIT tagged lampreys were found to ascend The Dalles Dam fishway from the top of Bonneville Dam fishways compared to 25% of RT-tagged fish.

Both Moser et al. (2007) and Keefer et al. (2009) found that negative effects of RT tag implantation were particularly evident in smaller lampreys, with passage success often positively correlated with fish size. Thus, tag effects are predictably greater at upstream locations where lampreys have expended more bioenergetic reserves than those sampled downstream and are therefore typically smaller in size. For example, fish used in RT studies at Wells Dam have been as small as 54 cm total length (TL) and 0.27 kg, 29.9% and 55.9% smaller, respectively, than mean values reported at Bonneville Dam (river km 235) in 2001 and 2002 studies. Even more importantly, the girth of lampreys radio-tagged in 2007 and 2008 at Wells Dam averaged 10.2 cm (9.0-12.0 cm), compared to a majority of fish tagged at Bonneville Dam in the 12.5 to 14.9 cm girth range (Moser et al. 2005; Robichaud et al. 2009).

Given the significant negative effects of RT on adult lampreys, combined with the small size and low numbers of fish typically observed at Wells Dam, alternative techniques to monitor lamprey behavior were required. Dual-frequency Identification Sonar (DIDSON) was identified as a promising alternative technology, due to the ability to estimate lamprey entrance efficiencies in a completely non-invasive manner. This is in direct contrast with other sampling methods that require trapping, handling, and invasive surgery of all individuals involved in the study. The use of DIDSON further improves the scientific rigor of researching lamprey behavior by capturing individuals in their natural state and potentially allowing collection of a greater sample size.

The goal of this study was to identify fishway operations that could be used long-term to improve the hydraulic conditions for entry of adult lampreys into the fishways at Wells Dam, without impacting passage of anadromous salmonids. This study and the results are, to our knowledge, the first of its kind in which passive, non-invasive procedures are used to assess passage metrics of lampreys at a hydroelectric project.

This study was initiated under early implementation of measures identified in the Wells Pacific Lamprey Management Plan (PLMP) to identify and address any adverse Project-related impacts on passage of adult Pacific lamprey. The PLMP is one of six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement (Agreement) developed in support of the Wells Hydroelectric Project (Project) Integrated Licensing Process. Similar to all management plans under the Agreement, the PLMP was developed in close coordination with agency and tribal natural resource managers to direct implementation of measures to protect against and mitigate for potential Project impacts to aquatic resources during the term of the new license.

# 2.0 MATERIALS AND METHODS

## 2.1 DIDSON

DIDSON is a multi-beam sonar system capable of capturing near-video quality streaming images of fish moving through its $29^{o}$ x $12^{o}$ field-of-view (Belcher et al. 2001). DIDSON was designed to bridge the gap between existing sonar which can detect acoustic targets at long ranges but cannot record the shape or size of targets, and video technologies which can record fish in clear water at close range but are limited at low light levels or when turbidity is high. DIDSON has high resolution and a fast frame rate that allows it to substitute for optical systems, and is superior to optical systems in turbid water and dark conditions. It has been demonstrated to be effective for monitoring movement and behavior of fish in passageways at hydroelectric facilities (e.g., Ploskey et al. 2005; Johnson et al. 2006).

Two DIDSON units were deployed inside the east and west fish ladder entrances at Wells Dam on 20 August. Aluminum mounting assemblies were used to fasten the units to the walls adjacent to the entrances. The units were placed 6.1 m from the entrances at the elevation of the entrance sill of each fishway and aimed to allow complete horizontal coverage of the sill. This orientation permitted 1.3 m of vertical coverage above sill elevation, which equates to about 26% vertical coverage of the water column at each entrance.

## 2.2 Fishway Operations

Head differential treatments at Wells Dam in 2009 were paired across fish ladders and randomized in eleven three-day blocks. There were three alternative treatments, including the existing high condition (0.46 m), moderate condition (0.31 m), and low condition (0.15 m). These head differentials create average calculated water velocities of approximately 3.0, 2.4, and 1.8 m/s, respectively (note that a velocity gradient is present, with the lowest values occurring at the boundaries). Negotiations with the HCP-Coordinating Committee and analysis of passage data from past RT studies and fishway counts of both steelhead and adult lampreys indicated that treatments occurring during 4-hour blocks (21:00 through 00:59) each evening would provide the highest probability of increasing lamprey sampling events while minimizing any potential impacts to anadromous salmonid passage. Blocked treatments began on 21August and ended on 23 September. One-day unblocked treatments occurred 20-21 August and 23-24 September (Table 1).

## 2.3 Data Collection

Each DIDSON system consisted of the sonar head, 46 m DIDSON cable, DIDSON topside switch box, Toshiba laptop computer, Ethernet cable and 1 GB external hard drives. The laptops were loaded with DIDSON software version 5.23, which was used to set data collection parameters and operate the sonar. GoToMyPC software was loaded on each laptop to allow for remote monitoring of the systems to insure functionality and avoid the need for constant monitoring by technicians. All topside electronics were housed in hard plastic lockable cabinets located on the tailrace deck.

All DIDSON data were collected using the high frequency mode (1.8 MHz). This setting uses the maximum of 96 beams resulting in high-resolution data collection. Data were collected at 10 frames per second using a 5 m-long window length with the window starting at 3.33 m from the sonar heads. Data were collected in successive 10-minute files and ported directly to external hard drives. External hard drives were exchanged at least every three days and data were archived to additional external hard drives.

The DIDSON unit in the west fish ladder operated continuously for 35 days between 20 August (12:20 for west side and 16:40 for east side) and 24 September (12:50). An operating malfunction occurred in the east fish ladder DIDSON unit caused by a dead battery on the CPU board 12 days into the study (2 September). Immediately following the determination that a new unit was needed, the manufacturer shipped the soonest available DIDSON. The unit was received and dive team deployed on 12 September to exchange DIDSON units. Normal data collection was resumed at 13:40 the same day.

## 2.4 Data Processing

Data were processed to determine the presence and behavior of lamprey observed in the DIDSON field-of-view (FOV). Treatment schedules and window counts were ignored to avoid any bias while reviewing data. Data files collected during the treatment periods (21:00 through 00:59) were processed by reviewing the files with the DIDSON playback software. The software has controls allowing for pausing and viewing data in forward and reverse at different speeds. Each data file was initially reviewed at 30 frames per second (3 times the rate in which data were collected). When a lamprey was thought to be observed, the review speed was slowed down to 10 frames per second and reviewed again to determine whether the target in question was a lamprey. Criteria used for separating lamprey from salmonids and other fish included observance of serpentine swimming behavior and the absence of linearity to the body shape.

For each lamprey observed, the following variables were noted: entrance location, date, time of initial and final observance in the FOV, whether the fish encountered and approached the sill heading upstream, and fate. Fate refers to whether the lamprey was observed to enter the fishway gallery, approached the sill but did not enter the gallery, or exited the gallery. Based on swimming behaviors observed, each detected lamprey seen to exit the gallery was classified as to whether their movement appeared to be volitional or non-volitional. Volitional and non-volitional movements were classified based on fish orientation (head or tail first) and any indication of struggle to maintain or change position. Other information regarding lamprey activities such as lateral movements and range from DIDSON were also noted.

For dates in which lamprey were observed in the DIDSON FOV but not seen entering the fish ladders, additional data were processed to determine whether these fish may have entered the ladders prior to 21:00 hour. In these instances, data collected from 19:00 through 20:59 were reviewed in the manner described above.

## 3.0 RESULTS

A total of 11 lamprey observations were recorded during the study period, including eight in the west ladder and three in the east ladder (Table 1). Lamprey activity was most frequent at the west ladder on 20 August when three fish were observed during the 21:00 hour. East ladder activity was highest on 18 September when two fish were observed.

**Table 1. Lamprey behaviors observed using DIDSON at Wells Dam in 2009. Duration in FOV refers to amount of time (in minutes and seconds) each lamprey was present in the DIDSON field-of-view. The Encountered Sill column indicates whether the lamprey was observed to approach the sill heading upstream. Fate depicts whether the lamprey was observed to enter the fish ladder gallery (entry), approached the sill but did not enter the gallery (no entry or reentry), or exited the gallery (exit). Treatment denotes the head differential condition associated with each observation. Shading highlights each fish that encountered the sill heading upstream.**

| Entrance Location | Entrance & Fish Designation | Date | Initial Time | Duration in FOV | Interaction with Sill? | Fate | Treatment |
|---|---|---|---|---|---|---|---|
| West | W1 | 20-Aug | 21:42:17 | 00:05 | No | Entry | Low |
| West | W2 | 20-Aug | 21:49:22 | 00:18 | Yes | Exit/No Reentry | Low |
| West | W3 | 20-Aug | 21:57:24 | 02:25 | Yes | Entry | Low |
| West | W4 | 21-Aug | 23:08:26 | 00:02 | No | Exit | Mod |
| West | W5 | 22-Aug | 0:52:09 | 00:04 | Yes | Entry | Mod |
| West | W6 | 23-Aug | 22:02:04 | 00:14 | No | Exit | Low |
| West | W7 | 26-Aug | 23:15:25 | 00:05 | No | Exit | Low |
| West | W8 | 4-Sep | 22:58:23 | 00:04 | No | Exit | High |
| East | E1 | 15-Sep | 0:11:16 | 00:02 | No | Exit | Low |
| East | E2 | 18-Sep | 21:35:31 | 00:09 | Yes | No Entry | High |
| East | E3 | 18-Sep | 22:19:47 | 10:44 | Yes | Entry | High |

Only the lampreys observed to encounter the sill heading upstream were used to evaluate the effectiveness of the fishway entrance velocity reductions. Six fish were excluded from the analysis because they did not experience the entrance sill during the treatment conditions. Five lampreys were observed approaching the entrance sill during the study. Three of these fish were observed successfully entering the fishway, with entries occurring during each of the three treatments conditions. Two of the three fish that successfully negotiated the fishway entrances attached to the sill prior to entry. One of the three fish was able to free swim into the entrance indicating that velocities associated with the moderate treatment may potentially complement the swimming performance of lamprey at Wells Dam. The attachment behavior occurred under both low and high treatment levels, though the manner and time in which fish remained attached differed (0:02:25 and 0:10:44, respectively). The two lampreys that approached but did not complete entry were observed during the low and high head differential treatments.

## 3.1 Detailed Observations of Lamprey Behaviors

The following detailed descriptions of lamprey behaviors include only those fish that were observed to interact with the sill since only these were fish used in the analysis for evaluating entrance efficiency relative to treatment condition.

- W2 – Initially observed in the gallery about 2 m from the sill moving downstream swimming laterally to the flow; passed over the sill and exited the gallery leaving the sample volume. This fish (assuming it is the same fish) reappeared near the upstream edge on the east side of the sill a couple seconds later before drifting down near the downstream edge of the sill where it appeared to struggle to keep its position which suggests non-volitional movement. This fish then exited the sample volume at maximum range heading downstream.
- W3 – Initially observed attaching itself to the downstream edge on the west side of the sill where it stayed for over two minutes. This fish detached itself and passed upstream over the sill and into the gallery. It exited the sample volume about 0.25 m upstream of the sill.
- W5 – Initially observed outside the gallery about 1 m from the sill swimming in an upstream direction. This fish moved slightly westward before passing over the sill and entering the gallery. It exited the sample volume about 2.5 m from the sill.
- E2 – Initially observed over the sill near the east edge swimming erratically, suggesting non-volitional movement. It maintained position over the sill for a short while before moving downstream and exiting the sample volume at maximum range.
- E3 – Initially observed attached to the top near the center of the sill where it stayed for over 10 minutes. It detached from the sill and moved slightly to the west where it reattached itself briefly, detaching again and moving slightly to the east before swimming upstream over the sill and into the gallery. This fish exited the sample volume about 1 m upstream of the sill.

# 4.0 DISCUSSION

## 4.1 Benefits of DIDSON and Limitations of Radio Telemetry

DIDSON is an effective tool for assessing lamprey passage through a confined area (e.g., a fishway entrance) in terms of efficiency, coverage, and reliability. DIDSON data were retrieved over 17 visits to both the east and west fishways, resulting in 11 observations of adult lampreys – roughly two lampreys for every three site visits. Despite the processing time needed to review the DIDSON footage (~ 1.5 hours per sampling date), the passive sampling method proved to be relatively efficient. This conclusion is even more evident when considering that the adult lamprey counts throughout the Columbia River Basin were at record lows in 2009 and data were only collected from DIDSON units over four hours per evening. In comparison, the first year of RT research at Wells Dam with onsite lamprey trapping required daily visits over a 10-week period. Only six adult lampreys were captured, with a total bycatch of 493 other fishes. Analyses later indicated that trapping efficiency for adult lampreys may have been as low as ~10% (LGL and Douglas PUD 2008) and that the presence of the traps and associated floor exclusion grating induced significant delay and drop back within the ladder thereby influencing the outcome of the 2008 study.

The biological benefits of DIDSON sampling are particularly evident at Wells Dam. Recent research has indicated that laboratory studies often cited to justify the use of RT technology for lamprey research (e.g., Close et al. 2003; Mesa et al. 2003) did not identify the significance of surgical implantation on lamprey swimming performance in field applications. Keefer et al. (2008) found that overall passage efficiency at Bonneville Dam was 22% for radio-tagged lamprey (n = 298), compared to 52% for HD PIT-tagged fish (n = 610). Keefer et al. (2009) also identified issues with RT when 63% of PIT-tagged lampreys were found to ascend The Dalles Dam fishway from last detections at the top of Bonneville Dam fishways, compared to 25% of RT-tagged fish. Moser et al. (2007) found that radio-tagged lampreys at lower Columbia dams had approach times and passage success rates that were significantly related to percent tag mass (relative to lamprey mass) and percent tag girth (relative to lamprey diameter). Based on results of their relatively large field study (> 800 fish), Moser et al. (2007) concluded that "the effect of prolonged swimming with relatively large transmitters may have resulted in eventual abandonment of migration or even death…" At Wells Dam, at least 24% of radio-tagged lampreys in 2008 displayed either a lack of movement (potentially tag shed or mortality) or an absence of detections (indicating uncharacteristic movement out of the study area or tag failure). The high proportion of uncharacteristic detection histories suggests that handling and surgical tagging had a considerable effect on lamprey swimming performance. After censoring these fish from the study, radio-tagged lamprey released in the tailrace had an entrance efficiency of 27% at Wells Dam (N=22) over two years of study (2007 and 2008).

Distance upstream, as related to fish bioenergetics, and seasonality are two additional factors that also confound results of active telemetry and limit comparisons to results reported in previous studies at downriver dams. For example, the research conducted at Lower Columbia River dams that led to the establishment of the '~ 50% passage standard' of adult lamprey selectively tagged only the largest adult lamprey collected from the traps at Bonneville Dam. Moser et al. (2005) reported "due to the abundance of lamprey in 2002, we selected the largest fish to minimize tag effects." The fish used for these studies had a mean weight from 590 g (males) to 627 g (females), and roughly 50% of all tagged fish had girths ≥ 12.5 cm. In comparison, lamprey tagged at Wells Dam in 2007 and 2008 averaged 369 g (range 270-560 g) and 10.2 cm in girth (range 9-12 cm). Though researchers are currently exploring the relationship between bioenergetics and passage success in lamprey (Ho et al. 2008), a positive correlation between fish size and swimming performance has already been identified (Moser et al. 2007).

The use of DIDSON technology to sample lamprey behavior has avoided potentially biased or negative results associated with sampling fish exposed to trapping, handling, chemical immobilization, surgery, and tag implantation. Although DIDSON sampling is often limited in the inability to distinguish among similar species, Pacific lampreys are readily identifiable since they are the only fish present at Wells Dam with their diagnostic shape and swimming behavior. The ability to sample individual fish behaviors in their natural environment through unobtrusive sampling provides researchers with a better understanding of naturally-occurring adult lamprey behavior. Further, the relatively small numbers of lampreys that typically reach the tailrace of

Wells Dam underscores the importance of non-invasive procedures to ensure that sexually mature individuals remain viable for the upcoming spawning season.

## 4.2 DIDSON Limitations

DIDSON cannot be used to determine the fate of individual fish since unique identifiers cannot be detected with this technology. The inability to identify individual fish also has ramifications for comparing lamprey passage efficiency results based on DIDSON to studies involving RT. Typically, passage metrics are calculated in RT studies based on individual fish passing the dam (i.e., the number of failed attempts by an individual fish prior to successful passage is not factored into the metric calculation; Robichaud et al. 2009). Since individual fish cannot be identified with DIDSON, entrance efficiency would be calculated based on the ratio of successful entrances to total attempted entrances (successful + failed). This is an important distinction to make clear in order to avoid false comparisons among different methods of calculating passage metrics.

## 4.3 Behavioral Observations

Observations of lamprey entrance behaviors included free-swimming into the fishway (n=2) and attachment to the sill prior to successful entry into the fishway (n=2). Of the free swimming lampreys detected, one (W5) was seen to pass over the sill while entering the fishway (during a moderate treatment period) and the other (W1) first appeared in the FOV upstream of the sill (during a low treatment period). The two lampreys observed to attach to the sill prior to entering the fishway exhibited varying behaviors. W3 attached itself to the downstream edge of the sill during a low treatment period and remained there for about 2.5 minutes, whereas E3 attached itself to the top of the sill during a high treatment period and remained there for almost 11 minutes. W3 was seen to enter the fishway immediately after detachment while E3 was shown to detach and reattach to the top of the sill before detaching a second time and entering the fishway. It is uncertain whether these differing behaviors are related to treatment condition, but it is reasonable to assume that E3 stayed attached longer than W3 as a result of the higher velocity conditions it encountered as compared to W3. Both fish entered successfully, but during high velocity conditions more effort was clearly necessary as evidenced by the attachment duration and occurrence of multiple attachments. With reduced velocities, W3 entered after a single, short-duration attachment and W5 did not need to burst and attach to enter the fishway.

The two fish that encountered the sill but did not enter the fishways both exhibited difficulty maintaining position, and non-volitional movement downstream. During reduced velocity conditions, W2 appeared to struggle negotiating the flow near the upstream edge of the sill before heading downstream. During high velocity conditions, E2 showed erratic swimming movements over the sill before heading downstream into the tailrace. Presumably, these fish were above the elevation of the sill and as a consequence could not attach to it.

The prevailing thinking has been that adult lampreys exhibit demersal swimming behavior during their migration, encounter fishway structures near the bottom and move up along the face of the dam near fishway openings that they sense based on flow fields (Moser et al. 2002a). The results from this study suggest that lamprey may potentially enter fishways at higher elevations particularly when the velocities have been reduced and there is less of a need for burst and attach behavior. Furthermore, even lamprey entering during velocity conditions resulting from low velocity treatments may use attachment behavior, perhaps for purposes of re-orientation to weaker flow fields prior to entry.

## 4.4 Comparison to Other Studies

Previous studies at Wells Dam using RT with limited sample sizes reported low estimates of lamprey entrance efficiency. For 2004, Nass et al. (2005) reported an estimated entrance efficiency of 30% based on fish tagged and released downstream at Rocky Reach Dam. Studies conducted in 2007 and 2008 at Wells Dam reported an average entrance efficiency over both years of 27% (6 entered of 22 that approached) (LGL and Douglas PUD 2008; Robichaud et al. 2009). Although speculative due to low sample sizes and behavioral/physiological concerns inherent in RT methods, these results provide minimum estimates of lamprey entrance efficiency during high velocity conditions at Wells Dam. In 2009, one of two lampreys detected to encounter the sill during normal (high-velocity) treatments was observed to enter the fishway; an estimated 50% entrance efficiency during normal conditions. With reduced velocity treatments (low and moderate conditions combined) two of three lamprey observed to encounter the sill entered the fishway (67% entrance efficiency). Despite the small sample size, these results show strong potential for increasing entrance efficiency through operational modifications at Wells Dam. It is difficult to contrast the 2009 results to the previous studies since the data used to calculate the metric differ between RT and DIDSON methods (as discussed above). Nonetheless the 67% estimate for entrance efficiency during reduced velocity treatments shows improvement over what has been previously reported at Wells using RT methods (Nass 2005; LGL and Douglas PUD 2008; Robichaud et al. 2009). The encouraging results warrant further investigation examining the potential for improving lamprey entrance efficiency through velocity reduction testing.

High flow velocities at fishway entrances in the Columbia River designed to attract adult salmonids are thought to impede upstream passage of Pacific lampreys (Moser et al. 2002a; 2005; Daigle et al. 2005). Water velocities > 1.2 m/sec in an experimental fishway were shown to deter lampreys (Keefer et al. 2008). The notion that high water velocities obstruct lamprey passage at hydropower projects has led to field studies designed to evaluate the effect of lowered velocities at fishway entrances for improving lamprey passage. Moser (2002b) assessed effects of nighttime flow reductions at fishways in the spillway at Bonneville Dam and found no significant differences in the number of successful lamprey entries during high (2.4 m/sec) and low (1.2 m/sec) velocity conditions. Using RT in 2007, Johnson et al. (2009) demonstrated that lamprey entrance efficiency (the number that successfully entered of those that approached an entrance) increased during low velocity compared to high velocity treatments (26% and 2% for low and high velocity conditions, respectively) at Bonneville Dam’s Powerhouse 2 (PH2) north entrance. At the south entrance of PH2, entrance efficiencies were 32% during low and 24% during high velocity treatments. Johnson et al. (2009) suggested that the repeated entry attempts and/or lamprey attaching to the face of the dam for prolonged periods of time during high velocity treatments indicated that lamprey had difficulty entering the fishway during this condition. Their results also indicated a likely tradeoff between fishway attraction and entrance efficiency; more lamprey were attracted to the entrances during high compared to low velocity conditions but disproportionately fewer passed during high flow treatments. Caudill et al. (2009) evaluated the effects of reduced nighttime velocities at Bonneville Dam PH2 in 2009 and reported that entrance efficiencies for radio-tagged lamprey were significantly higher during low velocity treatments (34%) than during control treatments (24%). Boggs et al. (2009) conducted an evaluation of nighttime flow reductions at McNary Dam in 2009; preliminary analysis to date shows that no significant difference between test and control treatments was detected for lampreys approaching the fishway. It is important to note that results from downriver studies may not be directly comparable to results from work conducted at Wells Dam since the studies on the lower Columbia River rely on tagging more robust, better-conditioned lampreys earlier in the migration season as compared to the smaller, weaker fish that migrate higher up in the Basin in the late summer and fall.

## 4.5 Study Limitations

The major hindrance in the 2009 flow reduction evaluation was the low numbers of lamprey available to be monitored at Wells Dam. Lamprey abundance based on window counts at Bonneville Dam was historically low in 2009 (8,622, or 18% of the average counts over the last 10 years); only 9 lampreys (28% of the ten year average) were counted at Wells Dam in 2009 (Dart Website 2010).

Eleven lampreys were observed with DIDSON monitoring, only five of which interacted with the sill and could be used to analyze velocity reduction treatment effects related to entrance efficiency. Because of the small sample size, effects of treatments on lamprey passage could not be assessed conclusively.

## 4.6 Effects on Anadromous Salmonid Passage

Measures to enhance adult lamprey passage at Wells Dam cannot compromise anadromous salmonids passage efficiencies. During study hours 393 steelhead, 110 Chinook, 18 sockeye, and 2 coho salmon observed at the count window. These observations accounted for 1.5%, 0.2%, < 0.1%, and < 0.1% of the annual run for each species, respectively. Steelhead observations were most frequent, and ranged from 0 to 44 fish during the four-hour daily treatment period. Interestingly, more steelhead were observed during reduced head differential; however, differences among treatment levels were statistically indistinguishable (Kruskal-Wallis Rank Sums, $P = 0.24$). Chinook observations were less frequent, and also statistically indistinguishable among treatment levels ($P = 0.78$). Coho and sockeye observations were practically negligible, but statistically indistinguishable among treatment levels. It does not appear, based on this initial study effort, that nocturnal velocity reductions had any effect on passage of salmon and steelhead.

## 4.7 Recommendations

Despite low sample size, the 2009 study demonstrated the effectiveness of DIDSON sampling for assessing lamprey entrance efficiencies. To improve our understanding of the dynamics of lamprey fishway entrance efficiencies, we offer the following recommendations:

1. Conduct additional lamprey entrance investigations at Wells Dam: lamprey abundance was very low in 2009 and as a result of low sample size, lamprey entrance efficiencies relative to velocity reduction treatments could not be assessed. The study should be repeated until sufficient observations are obtained to allow rigorous statistical analysis.

2. Increase treatment duration: to help bolster sample size in future studies, it may be beneficial to increase the treatment duration to include additional hours for analysis of treatment effects. Instead of limiting the treatment duration to four hour periods as was done in 2009, consideration should be given to increasing treatment periods to six or eight hour periods. Provided that extending treatment periods does not deter salmonid passage, this option enhances the ability to detect additional lamprey.

3. Eliminate the low treatment condition: to further increase statistical power it is recommended that the low velocity treatment be eliminated. During the low velocity operation only one fish was observed to enter the fishway after encountering the sill. This may be attributed to the relatively slow entrance velocities that are observed during this operation. Velocities may be too slow to adequately attract sufficient adult lamprey to the entrance thereby making statistical inferences about this operation difficult. By eliminating one of the three treatments, the effective sample size of the remaining two treatments (high and medium) will increase. Further, operations for passage of adult salmon are unlikely to be affected by the medium treatment condition during nighttime hours while concerns exist about continuing the low treatment condition due to the resultant lack of attraction water and any potential impacts on anadromous salmonids. The two downstream neighboring projects (Rocky Reach Dam and Rock Island Dam) currently utilize 1.0' of head differential (medium condition) at their fishway entrances.

4. Increase vertical coverage upstream of the entrances: the DIDSON deployment in 2009 allowed for 1.3 m of vertical coverage above the sill, or about 26% of the wetted entrance area. Sample coverage along the vertical plane could be doubled if a similar deployment as was used in 2009 is employed with an additional DIDSON mounted above the original one in each fishway. This would result in more than 50% coverage of the entire wetted entrance area. Increased vertical coverage would allow for testing the hypothesis that lamprey may be entering the fishway higher in the water column and not encountering the sill during reduced velocity treatments.

5. Continue to assess potential effects on salmonid passage: it does not appear that velocity reduction treatments negatively affected salmonid passage based on this initial study. However, it is important to continue to monitor and evaluate potential effects of nocturnal fishway entrance head differential treatments on anadromous salmonid passage.

6. Characterize fishway entrance velocities: to date fishway entrance velocities at Wells Dam have been estimated based on flow field models; flows at the entrances have never been directly measured. To characterize flow field dynamics during normal

and reduced velocity treatments, we recommend deploying an Acoustic Doppler Current Profiler (ADCP) to measure velocity conditions at the fishway entrances. Results from ADCP sampling will allow for a better understanding of adult lamprey passage relative to accurate estimates of flow velocities at the entrances.

## 5.0 ACKNOWLEDGMENTS

The authors thank Ray Robertson for his extensive field efforts to ensure DIDSON functionality and data collection. Mike Bruno, Dub Simmons, Dan Stolp, Jason Watson and other Wells Dam employees were integral in developing infrastructure and operational changes to conduct the study. Wells Dam Fish Enumerators Sylvia Robertson, Betty Walters, Tanya Gibson, and Terry Hackenmiller assisted in data storage and provided adult lamprey counts. Molly Hallock, Rolf Wielick, David Allison, and John Skalski provided excellent technical support for the study plan. Lastly, Beau Patterson, Shane Bickford, and Mary Mayo provided edits to improve the quality of this report.

## 6.0 REFERENCES

Belcher, E. O., B. Matsuyama and G.M. Trimble. 2001. Object identification with acoustic lenses. . Page 6-11 in Conference Proceedings MTS/IEEE Oceans, volume 1, session 1. . Honolulu, Hawaii, 5-8 November 2001.

Boggs, C., T. Clabough, C. Caudill and M. Moser. 2009. Adult Pacific lamprey passage and behavior at McNary Dam: general passage metrics and preliminary evaluation of reduced nighttime entrance velocities, 2009. Abstract from the U. S. Army Corps of Engineers Northwest Division's Anadromous Fish Evaluation Program Annual Research Review, 1-3 December, 2009.

Caudill, C., E. Johnson, M. Keefer, T. Clabough, and M. Moser. 2009. Effects of water velocity on fishway entrance success by adult Pacific lamprey and fish use summaries at Bonneville Dam, 2009. Abstract from the U. S. Army Corps of Engineers Northwest Division's Anadromous Fish Evaluation Program Annual Research Review, 1-3 December, 2009.

Close, D., M. Fitzpatrick, and H. Li. 2002. The ecological and cultural importance of a species at risk of extinction, Pacific Lamprey. North American Journal of Fisheries Management 27(7):19-25.

Close, D.A., M.S. Fitzpatrick, C.M. Lorion, H.W. Li, and C.B. Schreck. 2003. Effects of intraperitoneally implanted radio transmitters on the swimming performance and physiology of Pacific lamprey. North American Journal of Fisheries Management 23:1184-1192.

Daigle. W. R., C. A. Peery, S. R. Lee and M. L. Moser. 2005. Evaluation of adult Pacific lamprey passage and behavior in an experimental fishway at Bonneville Dam. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho. Technical Report 2005-1.

DART (Data Access in Real Time). 2008. Columbia River Adult Passage (USACE, NWD). Columbia Basin Research, School of Aquatic and Fishery Sciences, University of Washington, Seattle. Retrieved February 2008 at http://www.cbr.washington.edu/dart/.

Ho, B., C. Peery, E. Johnson, and C.C. Caudill. 2008. Relationship between energetic status and migratory behavior and success in Pacific Lamprey: Preliminary results. Presented at the United States Army Corps of Engineers' Anadromous Fish Evaluation Program Annual Review. December 8-11, 2008. Portland, Oregon.

Johnson, G. E., F. Khan, J. B. Hedgepeth, R. P. Mueller, C. L. Rakowski, M. C. Richmond, J. A. Serkowski and J. R. Skalski. 2006. Hydroacoustic evaluation of juvenile salmonid passage at The Dalles Dam sluiceway, 2005. Report submitted to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon by Battelle, Pacific Northwest National Laboratory, Richland, Washington.

Johnson, E. L., C. A. Peery, M. L. Keefer, C. C. Caudill, and M. L. Moser. 2009. Effects of lowered nighttime velocities on fishway entrance success by Pacific lamprey at Bonneville Dam and fishway use summaries for lamprey at Bonneville and The Dalles Dam, 2007. Technical report submitted to the U.S. Army Corps of Engineers, Portland District by the Idaho Cooperative Fish and Wildlife Research Unit.

Keefer, M. L., W. R. Daigle, C. A. Peery, and M. L. Moser. 2008. Adult Pacific lamprey bypass structure development: tests in an experimental fishway, 2004-2006. Technical Report 2008-10 of Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho to the U.S. Army Corps of Engineers.

Keefer, M.L., C.T. Boogs, C.A. Peery, and M.L. Moser. 2009. Adult Pacific lamprey migration in the lower Columbia River: 2007 radiotelemetry and half-duplex PIT tag studies. Report for study code ADS-P-00-8, prepared for the U.S. Army Corps of Engineers, Portland District.

LGL and Douglas PUD. 2008. Adult Pacific lamprey passage and behavior study (Aquatic Issue 6.2.1.3). Wells Hydroelectric Project, FERC No. 2149. Prepared for Public Utility District No. 1 of Douglas County. East Wenatchee, Washington.

Mesa, M.G., J.M. Bayer and J.G. Seelye. 2003. Swimming performance and physiological responses to exhaustive exercise in radio-tagged and untagged Pacific lampreys. Transactions of the American Fisheries Society 132: 483 - 492.

Moser, M.L., A.L. Matter, L.C. Stuehrenberg, and T.C. Bjornn. 2002a. Use of an extensive radio receiver network to document Pacific Lamprey (Lampetra tridentata) entrance efficiency at fishways in the Lower Columbia River, USA. Hydrobiologia 483:45-53.

Moser, M.L., R.W. Zabel, B.J. Burke, L.C. Stuehrenberg, and T.C. Bjornn. 2005. Factors affecting adult Pacific lamprey passage rates at hydropower dams: using "time to event" analysis of radio telemetry data. Pages 61-70 in M.T. Spedicato, G. Lembo, and G. Marmulla, editors. Aquatic telemetry: advances and applications. Proceedings of the Fifth Conference on Fish Telemetry held in Ustica, Italy 9-13 June 2003.

Moser, M.L, J.M. Butzerin, and D.B. Dey. 2007. Capture and collection of lampreys: the state of the science. Reviews in Fish Biology and Fisheries 17:45-56.

Nass, B.L., C. Sliwinski, D. Robichaud. 2005. Assessment of Adult Pacific Lamprey Migratory Behavior at Wells Dam Using Radio-telemetry Techniques, 2004. Report prepared by LGL Limited, Sidney, B.C. Canada, for Public Utility District No. 1 of Douglas County, WA.

Ploskey, G.R., M.A. Weiland, C.R. Schilt, P.N. Johnson, M.E. Hanks, D. Patterson, J.R. Skalski and J. Hedgepeth. 2005. Hydroacoustic evaluation of fish passage through Bonneville Dam in 2004. Final Report to the U.S. Army Corps of Engineers, Portland District. Contract DE-AC05-76RLO1830.

Robichaud, D., B. Nass, and Douglas PUD. 2009. Adult Pacific lamprey passage and behavior study (adult lamprey passage study). Wells Hydroelectric Project, FERC No. 2149. Second year final report. Prepared for Public Utility District No. 1 of Douglas County. East Wenatchee, Washington. Prepared for Public Utility District No. 1 of Douglas County. East Wenatchee, Washington.

# DRAFT 2010 ASSESSMENT OF ADULT PACIFIC LAMPREY RESPONSE TO VELOCITY REDUCTIONS AT WELLS DAM FISHWAY ENTRANCES (2010 DIDSON STUDY REPORT)

# ASSESSMENT OF ADULT PACIFIC LAMPREY RESPONSE TO VELOCITY REDUCTIONS AT WELLS DAM FISHWAY ENTRANCES
# (DIDSON Study Report)

## WELLS HYDROELECTRIC PROJECT

## FERC NO. 2149

June 2011

Prepared by:

P.N. Johnson
LGL Limited
Stevenson, Washington

and

B. Le
Long View Associates
Portland, Oregon

and

B. Patterson
Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

for

Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

# Table of Contents

## List of Tables

## List of Figures

# ABSTRACT

Studies at hydroelectric projects on the Columbia River have demonstrated that high velocity conditions at fishway entrances designed to attract salmonids can be an obstacle to migrating adult lamprey. Operational modifications that create lowered velocities at fishway entrances can result in increased fishway entrance efficiency rates for lamprey. To test the effect of velocity reductions on lamprey entrance efficiency at Wells Dam, Dual-frequency Identification Sonar (DIDSON) was used to passively assess adult Pacific lamprey passage behavior in response to operational modifications at the Wells Dam fishway entrances in 2009 and 2010.

DIDSON units were deployed at Wells Dam fishway entrances during the peak of historic Pacific lamprey migration in 2009 (20 August to 24 September) and 2010 (7 August to 30 September). DIDSON was used to sample lamprey behavior and upstream passage events along the entire width of the fishway entrances and 1.3 m of vertical coverage above the sills (about 26% of the wetted vertical opening). Lamprey passage was examined relative to variable head differential treatments and entrance velocities. In 2009 three head differential treatments were tested: existing high (0.48 m; or 3.0 m/sec), moderate (0.31 m; or 2.4 m/sec) and low condition (0.15 m; or 1.8 m/sec). In 2010 only two of the 2009 treatments were used: existing high, and the moderate head differential conditions. Treatments were grouped in 3-day blocks and lasted four hours each evening in 2009 (21:00 through 00:59). In 2010 the treatments were paired and lasted eight hours each evening (17:00 through 00:59). Data collected during the treatment periods were reviewed and all lamprey observations were described.

Combining both years, a total of seven lamprey observations were recorded where lamprey were observed to encounter the entrance sill heading upstream (N = 5 in 2009; and N = 2 in 2010). Five of these seven observations were in the east fishway and two were in the west fishway. Overall, five of the seven observations showed successful entry into the fishways (71%). During reduced head differential treatments, five observations were recorded with four of the five resulting in successful entry (80% efficiency). Three of three observations with the moderate head differential condition resulted in successful entry (100% entrance efficiency). During high head differential conditions, one of the two lamprey observed entered a fishway (50% entrance efficiency).

Four lamprey exhibited attach and burst behaviors (one during low, two during moderate and one during high head differential conditions), all of which resulted in successful entry into the fishways. One of three lampreys that did not exhibit the former behavior successfully entered the fish way, under the moderate treatment condition.

Extremely low Columbia River basin lamprey runs in 2009 and 2010 resulted in few fish observed at Wells Dam (the ninth and last hydroelectric project on the Columbia River [river mile 516] with fish passage). Low sample sizes precluded statistical evaluation of these results. Nonetheless, operational modifications implemented in these two years of study suggest that entrance efficiency may be increased with lower head conditions.

Pooling observations that occurred during reduced head differential treatments shows 80% (4 of 5) entrance efficiency compared to 50% (1 of 2) under the current operating condition (high condition).  Study results suggest that reduced head differentials show promise in providing an environment conducive to upstream passage of lamprey.

Despite the low numbers of lamprey observed during the two years of study, DIDSON was shown to be a non-invasive alternative technology for assessing fish behavior at fishway entrances.  In addition to reduced fishway entrance head differentials, fish in the current study likely benefited from the absence of tag burden and can be considered representative of the run at large.

Given the presence of anadromous salmonids that are protected under the Endangered Species Act (ESA), measures to enhance adult lamprey passage at Wells Dam cannot compromise the effective passage of these ESA-listed fish.  Analyses of test effects on salmonid passage indicate that no differences in counts were detected among treatment levels in either year.  It does not appear, based on these analyses, that velocity reductions to enhance lamprey passage had any negative effect on the passage of salmon and steelhead.

This study was initiated under early implementation of measures identified in the Wells Pacific Lamprey Management Plan (PLMP) to identify and address any adverse Wells Hydroelectric Project (Project)-related impacts on the passage of adult Pacific lamprey. The PLMP is one of six Aquatic Resource Management Plans contained within the Aquatic Settlement Agreement (Aquatic Settlement) developed in support of the relicensing of the Wells Project.  Similar to all management plans under the Aquatic Settlement, the PLMP was developed in close coordination with agency and tribal natural resource managers to direct the implementation of measures to protect, mitigate and enhance aquatic resources found within the Wells Project.

# INTRODUCTION

The Pacific lamprey (*Entosphenus tridentatus*) is an anadromous member of the jawless fish family (Petromyzontidae) that inhabits marine and freshwater systems from southern California to the Aleutian Islands in Alaska. Historically, Pacific lamprey were widely distributed throughout Washington State and served as an important ecological and cultural resource to the region (Close et al. 2002). Construction of hydroelectric and irrigation projects without fish passage facilities and the development of elaborate fishways specifically designed for salmon and steelhead in the Columbia River Basin (Basin), has limited the ability of migrating adult lamprey to reach upstream spawning locations, presumably contributing to Basin-wide population declines observed since 2004 (Close et al. 2002; Robichaud et al. 2009).

Research of lamprey passage behavior was initiated at Wells Dam in 2004 (Nass et al. 2005). Subsequent investigations of lamprey behavior and passage efficiency took place in 2007 and 2008 (LGL and Douglas PUD 2008; Robichaud et al. 2009). The 2007-2008 studies identified the following:

- Entrance efficiencies ranged from 14% in 2007 to 33% in 2008, for a two-year average of 27%.
- Lower fishway passage efficiency was 33% over both years, although 2008 trapping operations that resulted in complete exclusion of passage in the middle portion of the fishway may have significantly biased these results.
- Upper fishway passage efficiency was 100% and passage times were relatively fast (median passage times = 6.7 h) indicating that little or no passage impediments exist in this portion of the Wells fishways.
- A majority of lamprey may be uncounted at Wells Dam as 73% (11/15) of radio-tagged lamprey ascending the upper fishway bypassed the adult counting stations.
- No fallbacks were observed over all study years including in 2004.
- Due to low sample sizes, only two unobstructed complete passage events were recorded (31.5 h and 32.7 h). These passage times are excellent compared to studies at other Columbia Basin dams where median passage times reported were up to 7.6 days (Keefer et al. 2009).
- Overall, results indicate that potential passage impediments are restricted to the entrance and lower fishway.

Despite high passage rates and passage efficiency through the upper portions of Wells Project fishways (LGL and Douglas PUD 2008; Robichaud et al. 2009), radio-tagged adult lamprey exhibited difficulty negotiating fishway entrances at Wells Dam. This impediment has been attributed to the hydraulic conditions at fishway entrances, designed to attract migrating anadromous salmonids into the fishways. Specifically, velocities resulting from the head differential between the fishway collection gallery and tailrace are suspected to impede lamprey entrance. The standard head differential at Wells Dam fishways, as required by National Oceanic and Atmospheric Administration (NOAA)

Fisheries, is 0.48 m (1.5 ft) ± 0.06 m (0.2 ft). Swimming performance of adult lamprey has been reported at 0.9 m/s (sustained swimming) to 2.1 m/s (burst speeds) (Mesa et al. 2003; Daigle et al. 2005). High velocity conditions are typical of fishway entrances in dams throughout the Basin, and have been identified as a key area for improving passage efficiency of adult lamprey through hydroelectric projects.

Physical monitoring at Wells Dam suggests lamprey entrance efficiency should be enhanced under reduced velocity conditions. Fishway entrance velocities ranged from 1.9 m/s to 2.6 m/s and averaged 2.3 m/s under the 0.48m head differential. Conditions at the fishway entrance sill, typically used by lamprey as an attachment point prior to burst entry into the fishway, ranged from 2.1 m/s to 2.4 m/s under the 0.48m head differential (NHA 2011). Under the majority of normal operating conditions, fishway entrance velocities exceed lamprey burst speed capability. Fishway entrance velocities ranged from 1.5 m/s to 2.1 m/s and averaged 1.8 m/s under the 0.31m head differential operating condition (NHA 2011). All measured fishway entrance velocities under this reduced head differential operating condition are within the burst speed swimming performance range for Pacific lamprey.

Radio-telemetry (RT) has been the most widely used technology to assess adult lamprey behavior in the Basin over the last two decades. Although results from RT studies have been useful in identifying passage impediments, recent studies utilizing increased sample sizes and advances in tag technology indicate that the base assumption of RT – that tagged fish are representative of untagged fish – has been consistently violated. Moser et al. (2007) found that there was a significant long-term effect of tagging on lamprey performance and that effects are perhaps more prevalent than the literature suggests. Keefer et al. (2009) also identified issues with RT when 63% of Passive Integrated Transponders (PIT)-tagged lampreys were found to ascend The Dalles Dam fishway from the top of Bonneville Dam fishways compared to 25% of RT-tagged fish. Together, tag burdens associated with RT technology appear to be in excess of acceptable limits that would biologically compromise migrating adult lamprey, and thus, other monitoring technology may be more appropriate for this species.

Both Moser et al. (2007) and Keefer et al. (2009) found that negative effects of RT tag implantation were particularly evident in smaller lamprey, with passage success often positively correlated with fish size. Thus, tag effects are predictably greater at upstream locations where lamprey have expended more bioenergetic reserves and are therefore typically smaller in size than those sampled downstream. For example, fish used in RT studies at Wells Dam averaged 65 cm (total length) and 0.39 kg, 7.2% and 30.4% smaller, respectively, than mean values reported at Bonneville Dam (river km 235) in 2001 and 2002 studies. Even more importantly, the girth of lamprey radio-tagged in 2007 and 2008 at Wells Dam averaged 10.2 cm (9.0-12.0 cm), compared to a majority of fish tagged at Bonneville Dam in the 12.5 to 14.9 cm girth range (Moser et al. 2005; Robichaud et al. 2009). Thus, lamprey at Wells may be 20-30% smaller in girth compared to lamprey at the first hydroelectric project in the Basin. Even these data may under-represent the energetic costs incurred by lamprey which reach Wells Dam; Keefer et al. (2009) found that upstream passage by Columbia River basin Pacific lamprey was strongly size dependent, suggesting that lamprey that reach Wells Dam are likely among the largest lamprey that pass Bonneville Dam. If that is indeed the case, lamprey at Wells may have lost 60-70% of their total body mass during passage from Bonneville Dam to Wells Dam.

Given the significant negative effects of RT on adult lamprey, combined with the small size and low numbers of fish typically observed at Wells Dam, alternative techniques to monitor lamprey behavior were investigated. Dual-frequency Identification Sonar (DIDSON) was identified as a promising alternative technology, due to the ability to estimate lamprey entrance efficiencies in a completely non-invasive manner. DIDSON does not require trapping, handling or tagging of study animals, increasing the likelihood that samples will be representative of the population at-large.

The goal of this study was to identify fishway operations that could be used long-term to improve the hydraulic conditions for entry of adult lamprey into the fishways at Wells Dam, without impacting passage of anadromous salmonids.

# MATERIALS AND METHODS

## *DIDSON*

DIDSON is a multi-beam sonar system capable of capturing near-video quality streaming images of fish moving through its $29^{o}$ x $12^{o}$ field-of-view (Belcher et al. 2001). DIDSON was designed to bridge the gap between existing sonar which can detect acoustic targets at long ranges but cannot record the shape or size of targets, and video technologies which can record fish in clear water at close range but are limited at low light levels or when turbidity is high. DIDSON has high resolution and a fast frame rate that allows it to substitute for optical systems, and is superior to optical systems in turbid water and dark conditions. It has been demonstrated to be effective for monitoring movement and behavior of fish in passageways at hydroelectric facilities (e.g., Ploskey et al. 2005; Johnson et al. 2006).

## *Fishway Operations*

<u>2009 Operational Methods</u>

The head differential treatment schedule and treatment conditions differed between the two years of study. Treatments at Wells Dam in 2009 were paired across fish ladders and randomized in eleven three-day blocks. There were three treatments, including the existing high condition (0.48 m), a moderate condition (0.31 m), and a low condition (0.15 m). Head differentials for these treatments create average calculated water velocities of approximately 3.0, 2.4, and 1.8 m/s, respectively. Negotiations with the

Anadromous Fish Agreement and Habitat Conservation Plan (HCP) Coordinating Committee and analysis of passage data from past RT studies and fishway counts of both steelhead and adult lamprey indicated that treatments occurring during 4-hour blocks each evening (21:00 through 00:59) would provide the highest probability of increasing lamprey sampling events while minimizing any potential impacts to anadromous salmonid passage. Blocked treatments in 2009 began on 21August and ended on 23 September. One-day unblocked treatments occurred on 20-21 August and 23-24 September (Table 1).

Table 1. Head differential treatment schedule for 2009 velocity reduction tests at Wells Dam. Treatments were grouped in three-day blocks with treatments consistent across both east and west fishways.

| Block No. | Treatment Period (21:00 - 00:59) | Head Differential Treatment (m) | Block No. | Treatment Period (21:00 - 00:59) | Head Differential Treatment (m) |
|---|---|---|---|---|---|
| | 20 - 21 Aug | 0.15 | | | |
| 1 | 21 - 22 Aug | 0.31 | 7 | 8 - 9 Sep | 0.31 |
| | 22 - 23 Aug | 0.46 | | 9 - 10 Sep | 0.46 |
| | 23 - 24 Aug | 0.15 | | 10 - 11 Sep | 0.15 |
| 2 | 24 - 25 Aug | 0.31 | 8 | 11 - 12 Sep | 0.31 |
| | 25 - 26 Aug | 0.46 | | 12 - 13 Sep | 0.46 |
| | 26 - 27 Aug | 0.15 | | 13 - 14 Sep | 0.15 |
| 3 | 27 - 28 Aug | 0.46 | 9 | 14 - 15 Sep | 0.15 |
| | 28 - 29 Aug | 0.31 | | 15 - 16 Sep | 0.31 |
| | 29 - 30 Aug | 0.15 | | 16 - 17 Sep | 0.46 |
| 4 | 30 - 31 Aug | 0.15 | 10 | 17 - 18 Sep | 0.15 |
| | 31 Aug - 1 Sep | 0.46 | | 18 - 19 Sep | 0.46 |
| | 1 - 2 Sep | 0.31 | | 19 - 20 Sep | 0.31 |
| 5 | 2 - 3 Sep | 0.15 | 11 | 20 - 21 Sep | 0.46 |
| | 3 - 4 Sep | 0.31 | | 21 - 22 Sep | 0.15 |
| | 4 - 5 Sep | 0.46 | | 22 - 23 Sep | 0.31 |
| 6 | 5 - 6 Sep | 0.15 | | 23 - 24 Sep | 0.46 |
| | 6 - 7 Sep | 0.31 | | | |
| | 7 - 8 Sep | 0.46 | | | |

2010 Operational Methods

In 2010 head differential treatments were paired across fish ladders and randomized in 27 two-day blocks. There were two treatments, including the existing high condition (0.48 m), and a moderate condition (0.31 m). Continued negotiations with the HCP Coordinating Committee and additional analysis of fishway counts and passage data indicated that treatments occurring during 8-hour blocks (17:00 through 00:59) each evening would provide the highest probability of increasing the sample size of lamprey sampling events while maintaining minimal impacts to anadromous salmonid passage. Blocked treatments in 2010 began on 7 August and ended on 30 September (Table 2).

Table 2. Head differential treatment schedule for 2010 velocity reduction tests at Wells Dam. Treatments were paired in two-day blocks with treatments consistent across both east and west fishways.

| Pair No. | Treatment Period (17:00 - 00:59) | Head Differential Treatment (m) | Pair No. | Treatment Period (17:00 - 00:59) | Head Differential Treatment (m) |
|---|---|---|---|---|---|
| 1 | 7 - 8 Aug<br>8 - 9 Aug | 0.31<br>0.46 | 15 | 4 - 5 Sep<br>5 - 6 Sep | 0.31<br>0.46 |
| 2 | 9 - 10 Aug<br>10 - 11 Aug | 0.31<br>0.46 | 16 | 6 - 7 Sep<br>7 - 8 Sep | 0.31<br>0.46 |
| 3 | 11 - 12 Aug<br>12 - 13 Aug | 0.46<br>0.31 | 17 | 8 - 9 Sep<br>9 - 10 Sep | 0.46<br>0.31 |
| 4 | 13 - 14 Aug<br>14 - 15 Aug | 0.31<br>0.46 | 18 | 10 - 11 Sep<br>11 - 12 Sep | 0.46<br>0.31 |
| 5 | 15 - 16 Aug<br>16 - 17 Aug | 0.31<br>0.46 | 19 | 12 - 13 Sep<br>13 - 14 Sep | 0.31<br>0.46 |
| 6 | 17 - 18 Aug<br>18 - 19 Aug | 0.31<br>0.46 | 20 | 14 - 15 Sep<br>15 - 16 Sep | 0.31<br>0.46 |
| 7 | 19 - 20 Aug<br>20 - 21 Aug | 0.46<br>0.31 | 21 | 16 - 17 Sep<br>17 - 18 Sep | 0.31<br>0.46 |
| 8 | 21 - 22 Aug<br>22 - 23 Aug | 0.31<br>0.46 | 22 | 18 - 19 Sep<br>19 - 20 Sep | 0.46<br>0.31 |
| 9 | 23 - 24 Aug<br>24 - 25 Aug | 0.46<br>0.31 | 23 | 20 - 21 Sep<br>21 - 22 Sep | 0.31<br>0.46 |
| 10 | 25 - 26 Aug<br>26 - 27 Aug | 0.31<br>0.46 | 24 | 22 - 23 Sep<br>23 - 24 Sep | 0.46<br>0.31 |
| 11 | 27 - 28 Aug<br>28 - 29 Aug | 0.31<br>0.46 | 25 | 24 - 25 Sep<br>25 - 26 Sep | 0.31<br>0.46 |
| 12 | 29 - 30 Aug<br>30 - 31 Aug | 0.31<br>0.46 | 26 | 26 - 27 Sep<br>27 - 28 Sep | 0.46<br>0.31 |
| 13 | 31 Aug - 1 Sep<br>1 - 2 Sep | 0.31<br>0.46 | 27 | 28 - 29 Sep<br>29 - 30 Sep | 0.31<br>0.46 |
| 14 | 2 - 3 Sep<br>3 - 4 Sep | 0.31<br>0.46 | | | |

## *Data Collection*

In each year two DIDSON units were deployed with the aid of commercial divers, one each inside the east and west fish ladder entrances (Figure 1). Aluminum mounting assemblies were used to fasten the units to the walls adjacent to the entrances (Figures 2 and 3). The units were placed 6.1 m from the entrances at the elevation of the entrance sills and aimed to allow complete horizontal coverage of the sill, a distance of about 2.4 m (Figure 4). This orientation permitted 1.3 m of vertical coverage above sill elevation, which equates to about 26% vertical coverage of the water column at each entrance.

Each DIDSON system consisted of the sonar head, 46 m DIDSON cable, DIDSON topside switch box, Toshiba laptop computer, Ethernet cable and 1 GB external hard drive. The laptops were loaded with DIDSON software version 5.23, which was used to set data collection parameters and operate the sonar. GoToMyPC software was loaded on each laptop to allow for remote monitoring of the systems to insure functionality and avoid the need for constant monitoring by technicians. All topside electronics were housed in hard plastic lockable cabinets located on the tailrace deck (Figure 5).

Figure 1. Diver being lowered into the west side fish ladder prior to deployment of the DIDSON. Also shown is an aluminum plate with a pipe attached hanging from the man basket. This plate was mounted on the wall adjacent to the ladder entrance; another plate (not shown), with the DIDSON attached to it, was then fastened to the pipe.

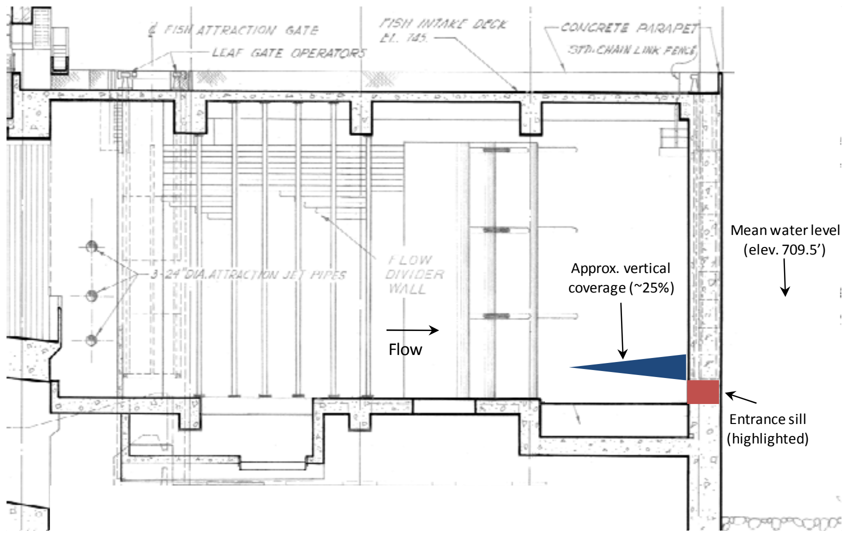



Figure 2. Profile view of fish ladder collection gallery at Wells Dam showing approximate location of DIDSON field-of-view relative to the entrance sill. The east and west fish ladders are mirror replicates of each other.

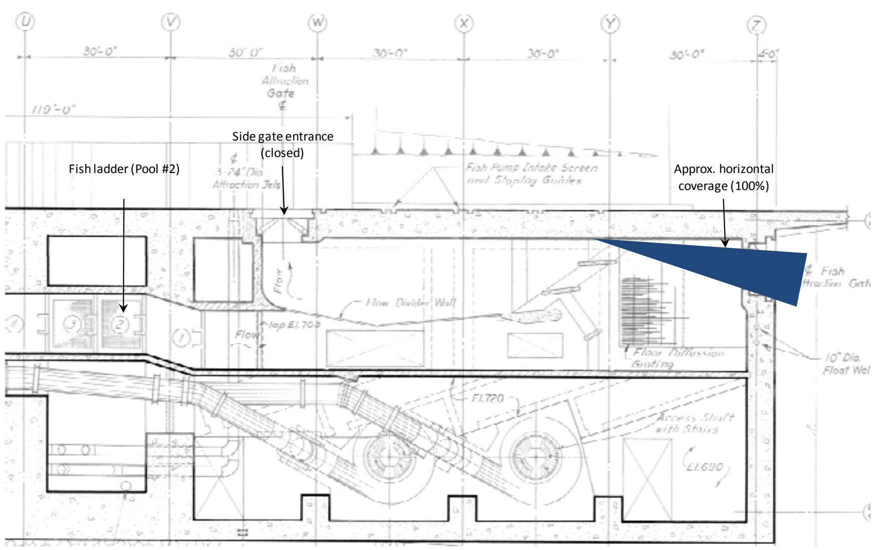



Figure 3. Plan view of fish ladder collection gallery at Wells Dam showing approximate location of DIDSON field-of-view relative to the entrance sill. The east and west fish ladders are mirror replicates of each other.

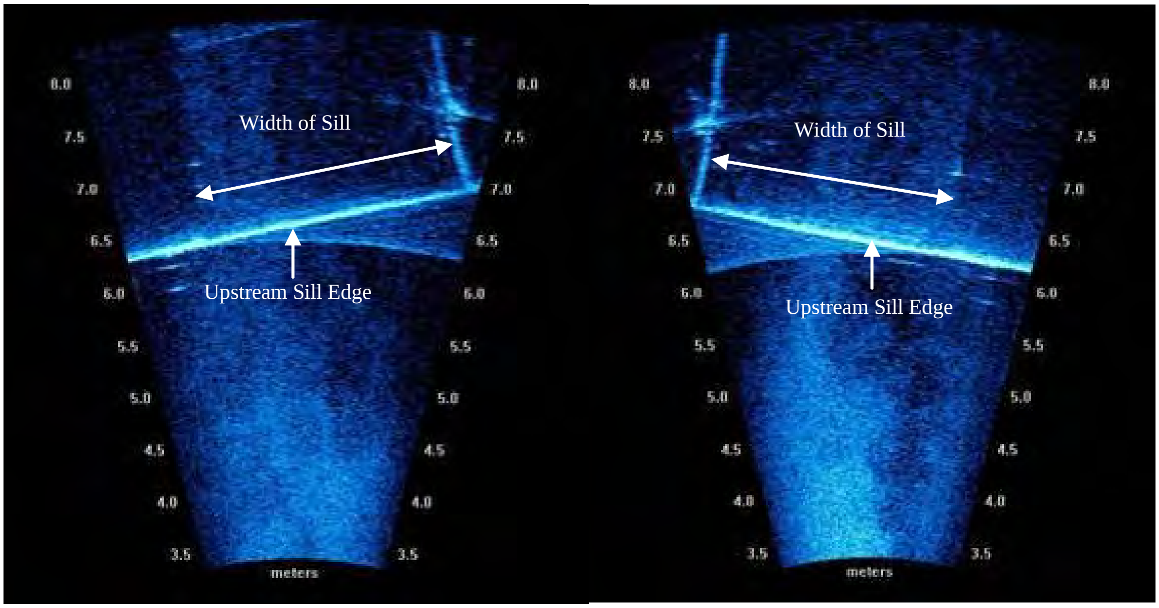



Figure 4. Still images of DIDSON fields-of view for west (left) and east (right) fish ladder deployments. Location and width of sills are shown. Note range markers are in 0.5 m increments.

All DIDSON data were collected using the high frequency mode (1.8 MHz). Data were collected at 10 frames per second using a 5 m-long window length with the window starting at 3.33 m from the sonar heads. Data were collected in successive 10-minute files and ported directly to external hard drives. External hard drives were exchanged at least every three days and data were archived to additional external hard drives.

Figure 5. Cabinet used to house the electronics for the DIDSON system at the west side fish ladder. The DIDSON sonar is shown in the foreground attached to an aluminum bracket.

In 2009 the DIDSON unit in the west fish ladder operated continuously for 35 days between 20 August and 24 September. Twelve days into the study (2 September), an operating malfunction caused by a dead battery on the CPU board occurred in the east fish ladder DIDSON unit. Immediately following the determination that a new unit was needed, the manufacturer shipped the soonest available DIDSON. The unit was received and a dive team deployed on 12 September to exchange DIDSON units. Normal data collection resumed prior to the onset of the treatment period that same day. In 2010 the DIDSON units operated continuously for 54 days from 7 August through 30 September with the exception of two treatment periods lost (14 - 15 August and 15 - 16 August) due to power failures.

## *Data Processing*

Data were processed to determine the presence and behavior of lamprey observed in the DIDSON field-of-view (FOV). Treatment schedules and window counts were ignored to avoid any bias while reviewing data. Data files collected during the treatment periods were processed by reviewing the files with the DIDSON playback software. The software has controls allowing for pausing and viewing data in forward and reverse at different speeds. Each data file was initially reviewed at 30 to 40 frames per second (3 to 4 times the rate in which data were collected). When a lamprey was thought to be observed, the review speed was slowed down to 10 frames per second and reviewed again to determine whether the target in question was a lamprey. Criteria used for separating lamprey from salmonids and other fish included observance of serpentine swimming behavior and the absence of linearity to the body shape (see Figure 6).

For each lamprey observed, the following variables were noted: entrance location, date, time of initial and final observance in the FOV, whether the fish encountered and approached the sill heading upstream, and fate (where fate refers to whether the lamprey was observed to enter or not enter the fishway gallery). For all observations where fish were seen to encounter the sill heading upstream, the data were summarized by calculating lamprey entrance efficiency as the number of fish that entered the fishway relative to the number of fish observed. This calculation of lamprey entrance efficiency differs from the way this metric is calculated in radio-telemetry studies. In such studies, entrance efficiency is defined as the proportion of fish that approached a fishway that subsequently entered it. Failed attempts by an individually tagged fish prior to successful passage are not factored into the metric calculation.

## *Test Effects on Anadromous Salmonid Passage*

Effects of head differential treatments on salmonid passage was assessed by analyzing window count data for Chinook, coho, and sockeye salmon and steelhead during the 2009 and 2010 test periods. Count data were adjusted for fishway residence time to reflect estimated time of entrance into the fish ladders based on radio-telemetry studies at Wells Dam: 1 hour for Chinook salmon (Murauskas and Nass 2008); 6 hours for sockeye

(English et al. 1998); and 6 hours for steelhead (English et al. 2001). For coho, adjustments of both 1 and 6 hours were assessed since estimates of fishway residence time for this species are unknown. Kruskal-Wallis Rank Sums Tests were used to compare salmonid counts among treatment periods in 2009. In 2010, Mann-Whitney Tests with Tied Ranks were used to compare salmonid counts between treatment periods.

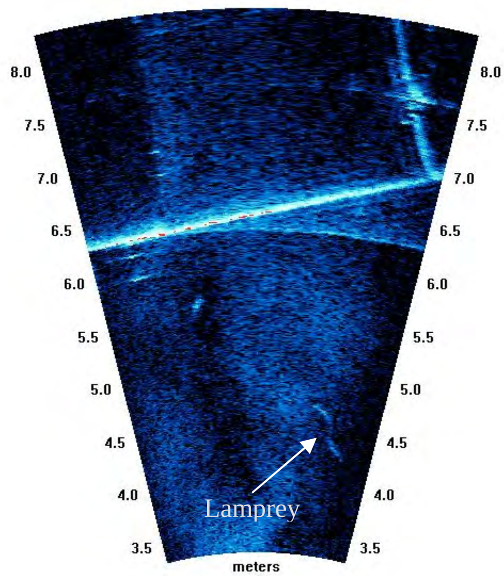



Figure 6. Snapshot image of DIDSON field-of-view showing an adult Pacific lamprey inside the Wells Dam west side fish ladder.

# RESULTS

A total of seven lamprey observations across the two study years were recorded where the fish were seen to encounter the entrance sill heading upstream. The majority (71%; five of seven) of the observations occurred in 2009, with four in the east fishway (Table 3). Overall, five of the seven observations showed successful entry into the fishways. During lowered head differential treatments (low and moderate treatments combined) five observations were recorded with four of the five resulting in successful entry. One of two lamprey observations during high head differential treatments was seen entering a fishway.

All four observations of lamprey that showed attach and burst behaviors (one during low, two during moderate, and one during high head differential treatments) resulted in successful entry into the fishways. Conversely, only one of the three observations of lamprey that did not exhibit attach and burst behaviors resulted in successful entry. The only successful free entrance event observed occurred during the moderate treatment condition (1 foot head differential).

Table 3. Observations of lamprey where they were seen to encounter the entrance sill heading upstream at the Wells Dam fishways in 2009 and 2010[1].

| Entrance Location | Treatment | Date | Initial Time | Duration in FOV | Behavior | Fate |
|---|---|---|---|---|---|---|
| West | Low | 20-Aug-09 | 21:44:22 | 0:18 | Free Swimming | No Entry |
| West | Low | 20-Aug-09 | 21:57:24 | 2:25 | Attach / Burst | Entry |
| West | Moderate | 22-Aug-09 | 0:52:09 | 0:04 | Free Swimming | Entry |
| East | High | 18-Sep-09 | 21:35:31 | 0:09 | Free Swimming | No Entry |
| East | High | 18-Sep-09 | 22:19:47 | 10:44 | Attach / Burst | Entry |
| East | Moderate | 29-Aug-10 | 23:13:50 | 0:09 | Attach / Burst | Entry |
| East | Moderate | 29-Aug-10 | 23:16:13 | 0:15 | Attach / Burst | Entry |

[1] Entrance location refers to the fishway in which the observation occurred. Treatment denotes the head differential condition associated with each observation. Initial time is the time noted at the beginning of each observation. Duration in FOV refers to amount of time (in minutes and seconds) each lamprey was present in the DIDSON field-of-view. Behavior indicates whether the lamprey was shown to swim freely while heading upstream towards the sill or if the lamprey exhibited attach and burst behaviors. Fate depicts whether the lamprey was observed to enter or not enter the fish ladder gallery.

## *Detailed Observations of Lamprey Behaviors*

The following detailed descriptions of lamprey behaviors include only those fish that were observed to interact with the sill since only these were fish used in the analysis for evaluating entrance efficiency relative to treatment condition.

- 20 August 2009, 21:44, West, Low Treatment: Initially observed in the gallery about 2 m from the sill moving downstream swimming laterally to the flow; passed over the sill and exited the gallery leaving the sample volume. This fish (assuming it is the same fish) reappeared near the upstream edge on the east side of the sill a couple seconds later before drifting down near the downstream edge of the sill where it appeared to struggle to keep its position which suggests non-volitional movement. This fish then exited the sample volume at the downstream maximum range of the DIDSON beam.
- 20 August 2009, 21:57, West, Low Treatment: Initially observed attaching itself to the downstream edge on the west side of the sill where it stayed for over two minutes. This fish detached itself and passed upstream over the sill and into the gallery. It exited the sample volume about 0.25 m upstream of the sill.
- 22 August 2009, 00:52, West, Moderate Treatment: Initially observed outside the gallery about 1 m from the sill swimming upstream. This fish moved slightly westward before passing over the sill and entering the gallery. It exited the sample volume about 2.5 m upstream of the sill.

- 18 September 2009, 21:35, East, High Treatment: Initially observed over the sill near the east edge swimming erratically, suggesting non-volitional movement. It maintained position over the sill for a short while before moving downstream and exiting the sample volume at maximum downstream range.
- 18 September 2009, 22:19, East, High Treatment: Initially observed attached to the top near the center of the sill where it stayed for over 10 minutes. It detached from the sill and moved slightly to the west where it reattached itself briefly, detaching again and moving slightly to the east before swimming upstream over the sill and into the gallery. This fish exited the sample volume about 1 m upstream of the sill.
- 29 August 2010, 23:13, East, Moderate Treatment: Initially observed attached to top of sill near the upstream edge slightly to the left of center. It detached and moved slightly downstream before swimming over the sill and into the gallery. This fish exited the sample volume about 2 m upstream of the sill edge.
- 29 August 2010, 23:16, East, Moderate Treatment: Initially observed above the sill moving slightly downstream before it attached to the top of the sill about 0.3 m from the upstream edge. It detached and moved eastward and slightly downstream before swimming over the sill and entering the gallery. This fish exited the sample volume about 1 m upstream of the sill edge.

## *Effects on Anadromous Salmonid Passage*

During the 2009 study, 393 steelhead, 110 Chinook salmon, 18 sockeye, and 2 coho salmon were observed at the count window. These observations accounted for 1.5%, 0.2%, < 0.1%, and < 0.1% of the annual run for each species, respectively. Steelhead observations were most frequent, and ranged from 0 to 44 fish during the four-hour daily treatment period. For steelhead, differences among treatment levels were statistically indistinguishable (Kruskal-Wallis Rank Sums, $P = 0.24$). Chinook observations were less frequent, and also statistically indistinguishable among treatment levels ($P = 0.78$). Coho and sockeye observations were practically negligible, but statistically indistinguishable among treatment levels.

In 2010, 2,082 Chinook salmon, 970 steelhead, 88 sockeye, and 19 coho salmon (assuming 6-hour residence time) were observed at the count window during head differential testing. These observations accounted for 5.5%, 7.6%, < 0.1%, and 1.6% of the annual run for each species, respectively. Chinook observations were most frequent and ranged from 8 to 134 fish during the eight-hour treatment period. For all species, the number of observations were statistically indistinguishable between treatment levels (Mann-Whitney Test with Tied Ranks) for Chinook $0.05 < P\ (U \geq 378 \text{ or } U \leq 351) < 0.90$; for steelhead $0.05 < P\ (U \geq 401.5 \text{ or } U \leq 327.5) < 0.90$; for sockeye $0.05 < P\ (U \geq 399 \text{ or } U \leq 330) < 0.90$; and for coho $0.05 < P\ (U \geq 408 \text{ or } U \leq 321) < 0.90$.

# DISCUSSION

## *Entrance Efficiency*

Test results from the head differential treatment studies conducted in 2009 and 2010 indicate that lamprey entrance efficiency at the Wells Dam ladder entrances may be improved by lowering velocities in those fishways at night. Pooled data from the two years of study showed a higher relative entrance efficiency with lowered velocities (80%, four of five fish) compared with existing high velocity conditions (50%, one of two fish). Despite the small sample sizes involved, these results show potential for increasing entrance efficiency through operational modifications at Wells Dam. The encouraging results indicate the potential for improving lamprey entrance efficiency through velocity reductions.

## *Comparison to Other Studies*

It is not straightforward to contrast these study results to previous investigations at Wells Dam since the data used to calculate entrance efficiency differ between RT and DIDSON methods. Typically, passage metrics are calculated in RT studies based on individual fish passing the dam (i.e., the number of failed attempts by an individual fish prior to successful passage is not factored into the metric calculation; Robichaud et al. 2009). Since individual fish cannot be identified with DIDSON, entrance efficiency is calculated based on the ratio of successful entrances to total attempted entrances (successful + failed). This is an important distinction to make clear in order to avoid false comparisons among different methods of calculating passage metrics. Nonetheless the 80% estimate for entrance efficiency during reduced velocity treatments shows improvement over what has been previously reported at Wells Dam using RT methods (27-30%) (Nass et al. 2005; LGL and Douglas PUD 2008; Robichaud et al. 2009).

Previous studies at Wells Dam using RT reported an estimated entrance efficiency of 30% based on fish tagged and released downstream at Rocky Reach Dam (Nass et al. 2005). RT studies conducted in 2007 and 2008 at Wells Dam reported an average entrance efficiency over both years of 27% (6 entered of 22 that approached) (LGL and Douglas PUD 2008; Robichaud et al. 2009). Although speculative due to low sample sizes and behavioral/physiological concerns inherent in RT methods, these results provide minimum estimates of lamprey entrance efficiency during high velocity conditions at Wells Dam.

High flow velocities at fishway entrances in the Columbia River designed to attract adult salmonids often impede upstream passage of Pacific lamprey (Moser et al. 2002a; 2005; Daigle et al. 2005). Caudill et al. (2009) evaluated the effects of reduced nighttime velocities at Bonneville Dam Powerhouse 2 (PH2) in 2009 and reported that entrance efficiencies for radio-tagged lamprey were significantly higher during low velocity treatments (34%) than during control treatments (24%). Similarly, Johnson et al. (2009) demonstrated that lamprey entrance efficiency (the number that successfully entered of those that approached an entrance) increased during low velocity compared to high velocity treatments at Bonneville Dam PH2's north and south entrances. Johnson et al. (2009) suggested that the repeated entry attempts and/or lamprey attaching to the face of the dam for prolonged periods of time during high velocity treatments indicated that lamprey had difficulty entering the fishway during this condition. Their results also indicated a likely tradeoff between fishway attraction and entrance efficiency; more lamprey were attracted to the entrances during high compared to low velocity conditions but disproportionately fewer passed during high flow treatments.

It is important to note that results from downriver studies may not be directly comparable to results from work conducted at Wells Dam since the studies on the lower Columbia River rely on tagging more robust, better-conditioned lamprey earlier in the migration season as compared to the fish that migrate higher up in the Basin in the late summer and fall and have expended more of their energetic reserves.

## *Behavioral Observations*

Observations of lamprey movements as they approached the sill included free-swimming and attach and burst behaviors. Results suggest that the latter behavior may improve entrance efficiency. All lamprey that were observed attaching to the sills (n=4) were shown to subsequently enter the fishways, whereas two of the three free-swimming fish did not successfully enter into the fishways. The duration of sill attachment varied with velocity treatment for the four lamprey observations, where attach and burst behavior was exhibited. During lowered velocity treatments attachment time ranged from 9 seconds to 2 minutes and 20 seconds. The single observation that occurred during a high velocity treatment lasted over 10 minutes and 30 seconds. It is uncertain whether these differing attachment durations are related to treatment conditions. However, it is reasonable to assume that the lamprey stayed attached longer as a result of the higher velocity conditions it encountered as compared to the other fish. During high velocity conditions, one of two fish entered successfully, after a prolonged attachment to the entrance sill.

## *Study Limitations*

Low numbers of lamprey at Wells Dam during the study limit the evaluation of lamprey response to flow reductions in the fishways. Lamprey abundance based on window counts at Bonneville Dam was very low in 2009 (8,622) and even lower in 2010 (6,234). These counts at Bonneville Dam comprise 20% and 15% of the previous 10-year average for 2009 and 2010, respectively. Wells Dam counts indicated that only nine lampreys passed in 2009 and two lamprey passed in 2010. Seven total lampreys were observed to interact with the sill heading upstream across both study years. Due to the small sample size, effects of treatments on lamprey passage could not be assessed conclusively.

Another potential limiting factor in the study was the relatively narrow vertical coverage with the DIDSON fields-of-view. The entire sill entrance width was fully imaged but only about 26% of the vertical water column at the entrances was sampled (at both fishways).

Additionally, DIDSON cannot be used to determine the fate of individual fish since unique identifiers cannot be detected with this technology. The inability to identify individual fish also has ramifications for comparing lamprey passage efficiency results based on DIDSON to studies involving RT.

## *Benefits of DIDSON*

DIDSON is effective non-invasive tool for assessing lamprey passage through a confined area (e.g., a fishway entrance) in terms of sample coverage and reliability. Despite the processing time needed to review the DIDSON footage (~ 3.5 hours per sampling date), the passive sampling method proved to be relatively efficient with data downloads occurring every two to three days. In comparison, the first year of RT research at Wells Dam used onsite lamprey trapping, which required daily visits over a 10-week period. Only six adult lampreys were captured, with a total bycatch of 493 other fishes. Analyses later indicated that the presence of the traps and associated floor exclusion grating to capture lamprey for tagging induced a significant delay and drop back within the lower ladder, thereby influencing the outcome of the 2007 and 2008 studies (LGL and Douglas PUD 2008).

Recent research has indicated that laboratory studies often cited to justify the use of RT technology for lamprey research (e.g., Close et al. 2003; Mesa et al. 2003) did not identify the significance of surgical implantation effects on lamprey performance in field applications. Keefer et al. (2009) found that overall passage efficiency at Bonneville Dam was 22% for large bodies radio-tagged lamprey (n = 298), compared to 52% for run-at-large HD PIT-tagged fish (n = 610). Keefer et al. (2009) also identified performance issues with RT when 63% of PIT-tagged lamprey were found to ascend The Dalles Dam fishway from last detections at the top of Bonneville Dam fishways, compared to 25% of RT-tagged fish. Moser et al. (2007) found that radio-tagged lamprey at lower Columbia dams had approach times and passage success rates that were significantly related to percent tag mass (relative to lamprey mass) and percent tag girth (relative to lamprey diameter). Based on results of their field study (N > 800 fish), Moser et al. (2007) concluded that,

> "*the effect of prolonged swimming with relatively large transmitters may have resulted in eventual abandonment of migration or even death…*"

At Wells Dam, at least 24% of radio-tagged lamprey in 2008 displayed either a lack of movement (potential tag shed or mortality) or an absence of detections (indicating movement out of the study area or tag failure). These data indicate tagging had a considerable negative effect on lamprey swimming performance. After removing these fish from the analysis, radio-tagged lamprey released in the tailrace had an entrance efficiency of 27% at Wells Dam (N=22) over two years of study (2007 and 2008).

The use of DIDSON technology to sample lamprey behavior avoids potential biases introduced by exposing study fish to trapping, handling, chemical immobilization, surgery, and tag implantation. Although DIDSON sampling is unsuitable for some applications, due to the inability to distinguish among similar species, Pacific lamprey are readily identifiable since they are the only fish present at Wells Dam with their diagnostic shape and swimming behavior. The ability to sample individual fish behaviors in their natural environment through unobtrusive sampling provides researchers with a better understanding of naturally-occurring adult lamprey behavior. The relatively small numbers of lamprey that pass Wells Dam underscores the importance of non-invasive procedures to minimize study impacts on the spawning population.

## *Effects on Anadromous Salmonid Passage*

Measures to enhance adult lamprey passage at Wells Dam cannot compromise the passage efficiencies of ESA-listed anadromous salmonids. Analysis of test effects on salmonid passage indicate that although substantial proportions of the Chinook salmon and steelhead runs in 2010 passed during the hours of head-differential testing, no differences in counts were detected between treatment and control operating levels in either year. It does not appear, based on these analyses, that velocity reductions had any effect on passage of salmon and steelhead.

## *Recommendations*

Despite the low sample size obtained in the two years of study, this investigation demonstrated the effectiveness of DIDSON sampling for assessing lamprey entrance efficiencies. To improve our understanding of the dynamics of lamprey fishway entrance behavior and to increase the knowledge base regarding lamprey passage and migration, we offer the following recommendations:

1. Consider additional lamprey entrance investigations at Wells Dam when substantially higher adult numbers are observed at Bonneville Dam. Lamprey abundance was very low in both study years and as a result of low sample size, lamprey entrance efficiencies relative to velocity reduction treatments could not be statistically assessed.

2. If additional lamprey entrance efficiency studies are warranted, continue to assess potential effects on salmonid passage. It does not appear that velocity reduction treatments negatively affected salmonid passage based on this study. However, it is important to continue to monitor and evaluate potential effects of nocturnal fishway entrance head differential treatments on anadromous salmonid passage.

# ACKNOWLEDGMENTS

The authors thank Ray Robertson for his extensive field efforts to ensure DIDSON functionality and data collection. Mike Bruno, Dub Simmons, Dan Stolp, Jason Watson and other Wells Dam employees were integral in developing infrastructure and operational changes to conduct the study. Wells Dam Fish Enumerators Sylvia Robertson, Betty Walters, Tanya Gibson, and Terry Hackenmiller assisted in data storage and provided adult lamprey counts. Molly Hallock, Rolf Wielick, David Allison, and John Skalski provided excellent technical support for the study plan. Lastly, Andrew Gingerich provided editorial review that improved the quality of this report.

# REFERENCES


Belcher, E. O., B. Matsuyama and G.M. Trimble. 2001. Object identification with acoustic lenses. Page 6-11 in Conference Proceedings MTS/IEEE Oceans, volume 1, session 1. . Honolulu, Hawaii, 5-8 November 2001.

Boggs, C., T. Clabough, C. Caudill and M. Moser. 2009. Adult Pacific lamprey passage and behavior at McNary Dam: general passage metrics and preliminary evaluation of reduced nighttime entrance velocities, 2009. Abstract from the U. S. Army Corps of Engineers Northwest Division's Anadromous Fish Evaluation Program Annual Research Review, 1-3 December, 2009.

Caudill, C., E. Johnson, M. Keefer, T. Clabough, and M. Moser. 2009. Effects of water velocity on fishway entrance success by adult Pacific lamprey and fish use summaries at Bonneville Dam, 2009. Abstract from the U. S. Army Corps of Engineers Northwest Division's Anadromous Fish Evaluation Program Annual Research Review, 1-3 December, 2009.

Close, D., M. Fitzpatrick, and H. Li. 2002. The ecological and cultural importance of a species at risk of extinction, Pacific Lamprey. North American Journal of Fisheries Management 27(7):19-25.

Close, D.A., M.S. Fitzpatrick, C.M. Lorion, H.W. Li, and C.B. Schreck. 2003. Effects of intraperitoneally implanted radio transmitters on the swimming performance and physiology of Pacific lamprey. North American Journal of Fisheries Management 23:1184-1192.

Daigle. W. R., C. A. Peery, S. R. Lee and M. L. Moser. 2005. Evaluation of adult Pacific lamprey passage and behavior in an experimental fishway at Bonneville Dam. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho. Technical Report 2005-1.

DART (Data Access in Real Time). 2011. Columbia River Adult Passage (USACE, NWD). Columbia Basin Research, School of Aquatic and Fishery Sciences, University of Washington, Seattle. Last retrieved March 2011 at http://www.cbr.washington.edu/dart/.

English, K.K., R.F. Alexander, B.L. Nass and S.A. Bickford. 1998. Assessment of adult sockeye and summer chinook passage times at Wells Dam and evaluation of fishway gate alterations, 1997. Report prepared by LGL Limited, Sidney, BC, for Public Utility District No.1 of Douglas County, WA.

English, K.K, C. Sliwinski, B.L. Nass and J.R. Stevenson. 2001. Assessment of adult steelhead migration through the Mid-Columbia River using radio-telemetry techniques, 1999-2000. Report prepared by LGL Limited, Sidney, BC, for Public Utility District No.1 of Douglas County, Public Utility District No.1 of Chelan County, and Public Utility District No.2 of Grant County, WA.

Johnson, G. E., F. Khan, J. B. Hedgepeth, R. P. Mueller, C. L. Rakowski, M. C. Richmond, J. A. Serkowski and J. R. Skalski. 2006. Hydroacoustic evaluation of juvenile salmonid passage at The Dalles Dam sluiceway, 2005. Report submitted to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon by Battelle, Pacific Northwest National Laboratory, Richland, Washington.

Johnson, E. L., C. A. Peery, M. L. Keefer, C. C. Caudill, and M. L. Moser. 2009. Effects of lowered nighttime velocities on fishway entrance success by Pacific lamprey at Bonneville Dam and fishway use summaries for lamprey at Bonneville and The Dalles Dam, 2007. Technical report submitted to the U.S. Army Corps of Engineers, Portland District by the Idaho Cooperative Fish and Wildlife Research Unit.

Keefer, M.L., C.T. Boogs, C.A. Peery, and M.L. Moser. 2009. Adult Pacific lamprey migration in the lower Columbia River: 2007 radiotelemetry and half-duplex PIT tag studies. Report for study code ADS-P-00-8, prepared for the U.S. Army Corps of Engineers, Portland District.

LGL and Douglas PUD. 2008. Adult Pacific lamprey passage and behavior study (Aquatic Issue 6.2.1.3). Wells Hydroelectric Project, FERC No. 2149. Prepared for Public Utility District No. 1 of Douglas County. East Wenatchee, Washington.

Mesa, M.G., J.M. Bayer and J.G. Seelye. 2003. Swimming performance and physiological responses to exhaustive exercise in radio-tagged and untagged Pacific lampreys. Transactions of the American Fisheries Society 132: 483 - 492.

Moser, M.L., A.L. Matter, L.C. Stuehrenberg, and T.C. Bjornn. 2002a. Use of an extensive radio receiver network to document Pacific Lamprey (Lampetra tridentata) entrance efficiency at fishways in the Lower Columbia River, USA. Hydrobiologia 483:45-53.

Moser, M.L., P.A. Ocker, L.C Stuehrenberg, and T.C. Bjornn. 2002b. Passage efficiency of adult lampreys at hydropower dams on the lower Columbia River, USA. Transactions of the American Fisheries Society 131:956-965.

Moser, M.L., R.W. Zabel, B.J. Burke, L.C. Stuehrenberg, and T.C. Bjornn. 2005. Factors affecting adult Pacific lamprey passage rates at hydropower dams: using “time to event” analysis of radio telemetry data. Pages 61-70 in M.T. Spedicato, G. Lembo, and G. Marmulla, editors. Aquatic telemetry: advances and applications. Proceedings of the Fifth Conference on Fish Telemetry held in Ustica, Italy 9-13 June 2003.

Moser, M.L, J.M. Butzerin, and D.B. Dey. 2007. Capture and collection of lampreys: the state of the science. Reviews in Fish Biology and Fisheries 17:45-56.

Murauskas, J. and B. L. Nass. 2008. Evaluation of summer Chinook passage times through the Wells Dam fishway collection gallery, 2007. Report prepared by LGL Limited for Public Utility District No. 1 of Douglas County, E. Wenatchee WA.

Northwest Hydraulic Consultants. 2011. Memorandum from A. Ball and L. Larson to R. Wieliek, May 5, 2011, Subject: Wells Dam Fishway Entrance Velocity Measurements.

Nass, B.L., C. Sliwinski, D. Robichaud. 2005. Assessment of Adult Pacific Lamprey Migratory Behavior at Wells Dam Using Radio-telemetry Techniques, 2004. Report prepared by LGL Limited, Sidney, B.C. Canada, for Public Utility District No. 1 of Douglas County, WA.

Ploskey, G.R., M.A. Weiland, C.R. Schilt, P.N. Johnson, M.E. Hanks, D. Patterson, J.R. Skalski and J. Hedgepeth. 2005. Hydroacoustic evaluation of fish passage through Bonneville Dam in 2004. Final Report to the U.S. Army Corps of Engineers, Portland District. Contract DE-AC05-76RLO1830.

Robichaud, D., B. Nass, and Douglas PUD. 2009. Adult Pacific lamprey passage and behavior study (adult lamprey passage study). Wells Hydroelectric Project, FERC No. 2149. Second year final report. Prepared for Public Utility District No. 1 of Douglas County. East Wenatchee, Washington. Prepared for Public Utility District No. 1 of Douglas County. East Wenatchee, Washington.

# 2011 WELLS DAM FISHWAY ENTRANCE VELOCITY MEASUREMENTS MEMO

# Memorandum

Northwest Hydraulic Consultants
16300 Christensen Road, Suite 350
Seattle, WA 98188
206.241.6000
206.439.2420 (fax)

DATE: May 5th, 2011 PROJECT: 21823

TO: Rolf Wieliek

COMPANY/AGENCY: Jacobs

FROM: André Ball and Lisa Larson

SUBJECT: Wells Dam Fishway Entrance Velocity Measurements

This memorandum summarizes field velocity testing at the Wells Dam West Fishway entrance conducted by Northwest Hydraulic Consultants (NHC) with the assistance of Douglas PUD (District) personnel on March 1st and 2nd, 2011. The purpose of the field tests was to provide field measurements of water velocity at the fishway entrance under different operating conditions. The District intends to use this data to assess the existing entrance conditions and to assist with the evaluation of the potential effects of operational changes and structural modifications on lamprey and salmonid passage through the fishway entrances. To assist with the development of these future modifications, a numerical model of the fishway entrance may be developed; and, the field data collected would be used to verify the numerical model.

The West Fishway collection gallery extends downstream from the main dam to the west of the spillway, and the main entrance is located perpendicular to the tailrace channel (Photo 1). The fishway entrance includes a set of vertical gates that swing outward and extend below the water surface to a sill located at elevation 693.0 ft (Photo 2). Collecting field data over a range of fishway entrance conditions was required; therefore, the test plan included collecting velocity measurements at the four different operating conditions shown below:

- Test 1: “Low” Tailwater, 1.5’ Fishway Entrance Head Drop
- Test 2: “Low” Tailwater, 1.0’ Fishway Entrance Head Drop
- Test 3: “High” Tailwater, 1.5’ Fishway Entrance Head Drop
- Test 4: “High” Tailwater, 1.0’ Fishway Entrance Head Drop

The test plan called for the “High” and “Low” tailwater conditions to vary by at least 10 feet. The fishway entrance head drop is measured as the difference between the “Collection Chamber” water surface elevation and the tailwater elevation.

Velocity measurements were collected using an array of three Nortek Vectrino Acoustic Doppler Velocimeters (ADVs), which collect high-frequency point velocity measurements in 3-dimensions. The ADVs were attached to a specialized trolley that was designed by Jacobs Engineering and constructed by a local fabricator. Wells Project staff assisted with the testing and deployment of the testing trolley. During testing, the trolley was lowered into the bulkhead gate slot by a crane (Photo 3). The ADVs were mounted to the trolley on three supporting arms (Photo 4 and Figure

1), which extended upstream into the fishway entrance and held the probes aligned with the upstream edge of the fishway entrance sill.

The ADVs were used to collect data along the left (east) side, center, and right (west) side of the fishway entrance simultaneously at a given elevation. The crane was used to move the trolley to selected elevations throughout the water column. A measuring tape was affixed to trolley to measure the relative depth. The height of the ADVs (when the trolley was lowered to the lowest depth) was known based on the trolley dimensions and ADV mounting locations. The fishway entrance is 8 feet wide, and the water depth at the entrance sill ranged from 22.9 feet to 14.4 feet during Tests 2 and 3, respectively. Due to distance requirements between the trolley, ADV instruments, and solid surfaces, velocity measurement points on the perimeter of the entrance were located approximately 7.5 inches from the sides and sill of the entrance. The 'left' and 'right' ADVs collected data 7.5 inches away from the edges of the fishway entrance, and the 'center' ADV was located in line with the center of the fishway entrance. Similarly, the lowest point at which the ADVs were able to collect data along the sill was approximately 7.5 inches above the entrance sill.

To allow for multiple tests in one day and varying tailwater elevations, river operations were modified for the testing period. These modified river operations were facilitated by the District and required communication and coordination with all of the mid-Columbia hydroelectric projects, and especially Chief Joseph Dam (USACE project upstream) and Rocky Reach Dam (Chelan PUD project downstream). In order to facilitate an efficient testing process and to minimize the duration of modified river operations, the trolley and the ADVs were set up and tested on the afternoon of Tuesday March 1st. This initial testing ensured that the equipment would be ready when the desired tailwater conditions were achieved. The equipment and crane were left in place until the river operations were set up for the test conditions. All four fishway entrance-velocity tests were completed between 2:45 a.m. and 6:30 a.m. on the morning of March 2nd (Photos 5-8).

Personnel on site assisting with the tests included:

André Ball, Engineer, NHC

Gavin Post, Engineer, NHC

Adrian Strain, Engineer, NHC

Tom Kahler, Biologist, Douglas PUD

Shane Scroggie, Operator, Douglas PUD

Steve Nieuwenhuis, Mechanic, Douglas PUD

Tim Harvey, Mechanic, Douglas PUD

Rich Miller, Mechanic, Douglas PUD

The Wells Dam operator targeted the four test-plan conditions described above and sought to maintain a constant tailwater elevation. Automated systems controlled the fishway auxiliary water supply to match any fluctuations in the tailwater elevations to maintain the desired head differential. Nevertheless, slight fluctuations in the head differentials occurred during testing due to the typical lag time in the automated system that coordinates river flows and auxiliary water supply flows. The average operating conditions that were achieved are shown below in Table 1.

**Table 1. Wells Dam Fishway Velocity Testing Operating Conditions**

| Test Number | Start Time | End Time | Average Collection Chamber Elevation | Average Tailwater Elevation | Average Fishway Entrance Head Drop |
|---|---|---|---|---|---|
| | | | ft | ft | ft |
| 1 | 02:47 | 03:14 | 707.8 | 706.3 | 1.5 |
| 2 | 03:21 | 03:42 | 707.4 | 706.4 | 1.0 |
| 3 | 05:29 | 05:57 | 715.9 | 714.4 | 1.5 |
| 4 | 05:59 | 06:24 | 715.5 | 714.5 | 1.0 |

Table 2 summarizes the averages of the velocity magnitudes collected at each distinct point during the testing. “Left” and “Right” are in reference to standing at the fishway and looking downstream. Table 3, provided at the end of the report, is an expanded version of Table 2 and provides the X, Y, and Z velocity components.

**Table 2. Wells Dam West Fishway Entrance Velocity Measurements Summary**

| Test 1 | | | |
|---|---|---|---|
| Elevation | Left | Center | Right |
| ft | Velocity Magnitude (ft/s) | | |
| **703.71** | 6.8 | 6.2 | 7.6 |
| **701.71** | 6.9 | 6.4 | 7.8 |
| **699.71** | 7.7 | 7.2 | 8.3 |
| **697.71** | 8.1 | 7.6 | 8.6 |
| **695.71** | 8.4 | 7.5 | 8.5 |
| **693.71** | 8.0 | 7.3 | 7.9 |

| Test 2 | | | |
|---|---|---|---|
| Elevation | Left | Center | Right |
| ft | Velocity Magnitude (ft/s) | | |
| **703.63** | 5.8 | 5.3 | 6.3 |
| **701.63** | 5.8 | 5.4 | 6.5 |
| **699.63** | 5.9 | 5.5 | 6.5 |
| **697.63** | 6.2 | 5.7 | 6.5 |
| **695.63** | 6.4 | 5.6 | 6.5 |
| **693.63** | 6.1 | 5.7 | 6.0 |

| Test 3 | | | |
|---|---|---|---|
| Elevation | Left | Center | Right |
| ft | Velocity Magnitude (ft/s) | | |
| **711.96** | 7.1 | 6.6 | 8.1 |
| **708.96** | 7.4 | 6.8 | 8.3 |
| **705.96** | 7.2 | 6.8 | 8.3 |
| **702.96** | 7.6 | 7.2 | 8.6 |
| **699.96** | 7.7 | 7.2 | 8.3 |
| **696.96** | 7.9 | 7.3 | 8.1 |
| **693.63** | 7.8 | 7.0 | 7.5 |

| Test 4 | | | |
|---|---|---|---|
| Elevation | Left | Center | Right |
| ft | Velocity Magnitude (ft/s) | | |
| **711.96** | 5.5 | 5.0 | 6.3 |
| **708.96** | 5.6 | 5.2 | 6.3 |
| **705.96** | 5.8 | 5.5 | 6.9 |
| **702.96** | 5.8 | 5.4 | 6.5 |
| **699.96** | 5.4 | 5.0 | 5.8 |
| **696.96** | 5.7 | 5.3 | 6.0 |
| **693.71** | 6.0 | 5.3 | 5.6 |

The velocity data were post processed to remove any erroneous readings or bad data. In general, the ADV data time series obtained at each location had auto-correlations between 80% and 85%. This high correlation is a good indication that the ADVs were collecting quality data. In addition, the velocities are in the range that would be expected for a fishway entrance with the range of head differentials evaluated. Variation in the point velocities was expected since the attraction flow approaching the entrance is not completely uniform.

Figures 2 through 5 provide graphical representations of the resultant velocity magnitudes. All four sets of test results show the highest velocities along the right side of the entrance, the next highest along the left side, and the lowest velocities in the center. At most, the variation between the right and center velocities is about 1.5 ft/s, and this variation is most prominent at the higher elevations. At elevations closer to the sill, there is less lateral variation in the velocities and in some cases the velocities on the left side are greater than the right.

A typical cross-section velocity distribution through a uniform channel shows lower velocities along boundary surfaces than at the center due to boundary roughness; however. since the velocity measurements were collected at the upstream edge of the entrance slot, boundary roughness is not applicable to the measured data. The higher velocities along the sides, relative to the center, may be caused by the increased acceleration around the upstream corners of the slot as the flow contracts into the slot entrance. The asymmetrical distribution of velocities when comparing the left side and right side measurements is likely due to the fact that the AWS diffuser screens are located in the floor and along the right wall of the collection chamber.

Figure 6 shows a plan view of the average velocity magnitude and direction in the XY plane for all three ADVS during Tests 1 through 4. All four tests show similar flow directions. Flow entering the left side of the entrance slot is aligned roughly 18 degrees towards the center while flow entering the right side of the slot is roughly 45 degrees towards the center. Flow entering the center of the slot is aligned 12 degrees off the centerline towards the left side. The asymmetrical alignment of flow can also be seen in the wake of the ADV support arms shown in Photo 3. Given that there are AWS diffusers to the right of the fishway entrance and that there is a solid wall to the left of the entrance, it is not surprising that the discharge alignment is not perfectly symmetrical.

In summary, velocity measurements were collected at the Wells Dam West Fishway entrance. This information was collected to provide prototype velocity data for the development of velocity maps to assist with lamprey and anadromous salmonid passage evaluations at the site.

Table 3. Wells Dam West Fishway Entrance Velocity Components and Magnitudes

| Test 1: Tailwater 706.3', Head Drop 1.5 ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation | Left | | | | Center | | | | Right | | | |
| | Velocity Magnitude (ft/s) | | | | Velocity Magnitude (ft/s) | | | | Velocity Magnitude (ft/s) | | | |
| ft | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag |
| **703.71** | 1.8 | 6.6 | -0.3 | 6.8 | -1.5 | 6.0 | -0.5 | 6.2 | -5.8 | 4.8 | -0.4 | 7.6 |
| **701.71** | 2.0 | 6.6 | -0.3 | 6.9 | -1.6 | 6.1 | -0.4 | 6.4 | -6.2 | 4.7 | -0.2 | 7.8 |
| **699.71** | 2.9 | 7.1 | 0.2 | 7.7 | -1.6 | 7.0 | -0.5 | 7.2 | -6.1 | 5.5 | 0.7 | 8.3 |
| **697.71** | 2.6 | 7.7 | -0.2 | 8.1 | -1.5 | 7.4 | 0.0 | 7.6 | -5.8 | 6.2 | 1.0 | 8.6 |
| **695.71** | 2.1 | 8.1 | -0.3 | 8.4 | -1.3 | 7.3 | 0.9 | 7.5 | -5.8 | 6.0 | 0.9 | 8.5 |
| **693.71** | 3.4 | 7.2 | 0.5 | 8.0 | -0.5 | 6.9 | 2.3 | 7.3 | -4.5 | 6.1 | 1.8 | 7.9 |

| Test 2: Tailwater 706.4', Head Drop 1.0 ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation | Left | | | | Center | | | | Right | | | |
| | Velocity Magnitude (ft/s) | | | | Velocity Magnitude (ft/s) | | | | Velocity Magnitude (ft/s) | | | |
| ft | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag |
| **703.63** | 1.5 | 5.5 | 0.4 | 5.8 | -1.2 | 5.1 | -0.5 | 5.3 | -4.7 | 4.2 | -0.5 | 6.3 |
| **701.63** | 1.7 | 5.6 | -0.2 | 5.8 | -1.4 | 5.2 | -0.3 | 5.4 | -5.3 | 3.8 | -0.2 | 6.5 |
| **699.63** | 2.1 | 5.5 | 0.2 | 5.9 | -1.3 | 5.3 | -0.3 | 5.5 | -4.9 | 4.2 | 0.6 | 6.5 |
| **697.63** | 1.9 | 5.8 | -0.2 | 6.2 | -1.1 | 5.6 | 0.1 | 5.7 | -4.5 | 4.6 | 1.0 | 6.5 |
| **695.63** | 1.6 | 6.1 | -0.3 | 6.4 | -1.1 | 5.4 | 0.9 | 5.6 | -4.1 | 4.9 | 0.8 | 6.5 |
| **693.63** | 2.6 | 5.5 | 0.3 | 6.1 | -0.5 | 5.3 | 1.9 | 5.7 | -3.4 | 4.8 | 1.4 | 6.0 |

| Test 3: Tailwater 714.4', Head Drop 1.5 ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation | Left | | | | Center | | | | Right | | | |
| | Velocity Magnitude (ft/s) | | | | Velocity Magnitude (ft/s) | | | | Velocity Magnitude (ft/s) | | | |
| ft | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag |
| **711.96** | 2.2 | 6.6 | -1.1 | 7.1 | -1.9 | 6.2 | -0.4 | 6.6 | -5.9 | 5.5 | -1.0 | 8.1 |
| **708.96** | 2.8 | 6.7 | -0.2 | 7.4 | -1.2 | 6.7 | -0.1 | 6.8 | -6.1 | 5.3 | -1.8 | 8.3 |
| **705.96** | 1.9 | 6.9 | 0.1 | 7.2 | -2.1 | 6.4 | -0.4 | 6.8 | -6.6 | 4.6 | -1.9 | 8.3 |
| **702.96** | 3.0 | 7.0 | -0.3 | 7.6 | -1.6 | 7.0 | -0.5 | 7.2 | -6.3 | 5.5 | 1.3 | 8.6 |
| **699.96** | 3.0 | 7.0 | 0.4 | 7.7 | -1.4 | 7.1 | -0.1 | 7.2 | -5.5 | 6.1 | 1.0 | 8.3 |
| **696.96** | 2.5 | 7.4 | -0.1 | 7.9 | -1.1 | 7.1 | 0.5 | 7.3 | -5.3 | 6.0 | 0.4 | 8.1 |
| **693.63** | 3.3 | 7.0 | 0.3 | 7.8 | -0.6 | 6.5 | 2.4 | 7.0 | -4.2 | 5.9 | 1.7 | 7.5 |

| Test 4: Tailwater 714.5', Head Drop 1.0 ft | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elevation | Left | | | | Center | | | | Right | | | |
| | Velocity Magnitude (ft/s) | | | | Velocity Magnitude (ft/s) | | | | Velocity Magnitude (ft/s) | | | |
| ft | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag | Avg. Vx | Avg. Vy | Avg. Vz | Avg. Vmag |
| **711.96** | 1.8 | 5.1 | -0.5 | 5.5 | -1.3 | 4.8 | -0.1 | 5.0 | -4.6 | 4.2 | -0.7 | 6.3 |
| **708.96** | 1.8 | 5.2 | 0.1 | 5.6 | -1.0 | 5.1 | -0.1 | 5.2 | -4.6 | 4.0 | -1.1 | 6.3 |
| **705.96** | 1.7 | 5.5 | -0.1 | 5.8 | -1.8 | 5.1 | -0.3 | 5.5 | -5.7 | 3.5 | -1.5 | 6.9 |
| **702.96** | 2.1 | 5.3 | -0.1 | 5.8 | -1.2 | 5.2 | -0.4 | 5.4 | -4.8 | 4.1 | 1.0 | 6.5 |
| **699.96** | 2.0 | 4.9 | 0.3 | 5.4 | -0.9 | 4.9 | -0.2 | 5.0 | -3.8 | 4.3 | 0.8 | 5.8 |
| **696.96** | 1.9 | 5.3 | -0.1 | 5.7 | -0.9 | 5.2 | 0.3 | 5.3 | -4.0 | 4.4 | 0.4 | 6.0 |
| **693.71** | 2.5 | 5.4 | 0.1 | 6.0 | -0.6 | 4.9 | 1.8 | 5.3 | -3.2 | 4.4 | 1.3 | 5.6 |

Photo 1: Wells Dam shown with the West fishway entrance in the foreground. (This photo was taken by Jacobs Engineering during the trolley testing in Feb 2011)

Photo 2: Looking upstream at the de-watered West fishway entrance during maintenance. In this photo the two gates are closed. (Archival Photo from Douglas PUD)

Photo 3: Looking down on the ADV trolley shown inserted in the bulkhead gate slots. (This photo was taken by Jacobs Engineering during the trolley testing in Feb 2011)

Photo 4: ADVs shown mounted on the support arms prior to being lowered into the water for testing. (Photo by Douglas PUD)

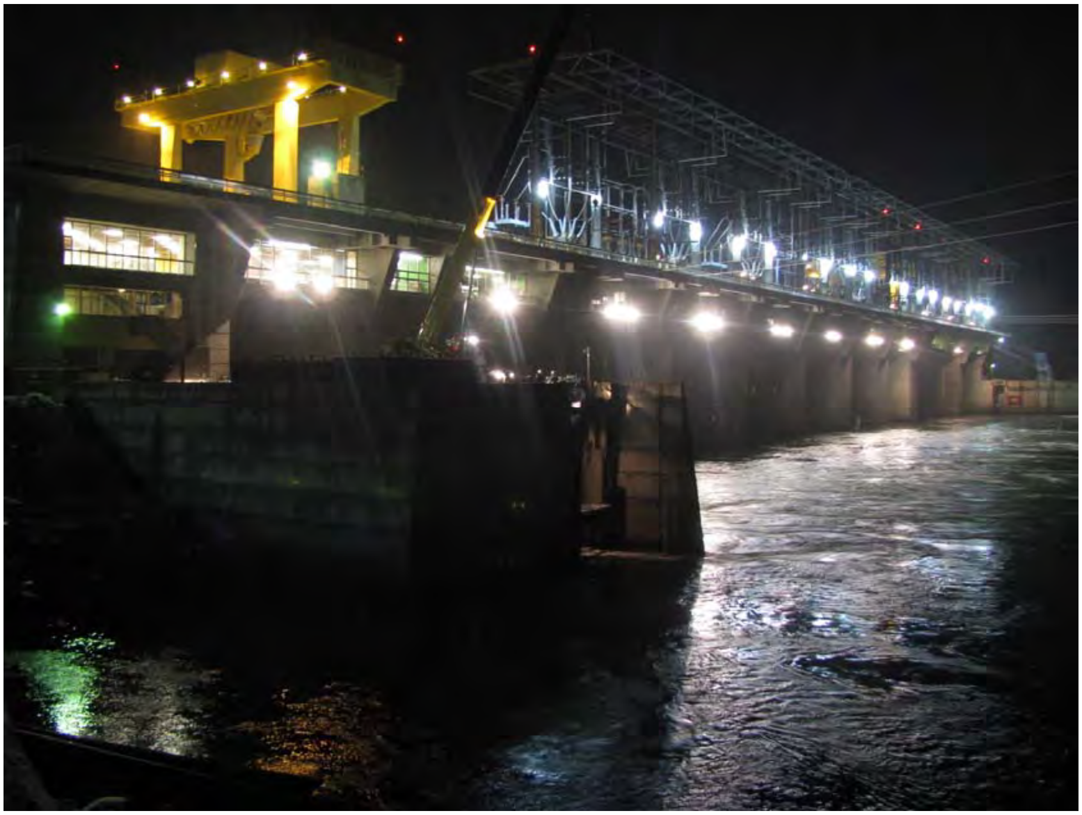
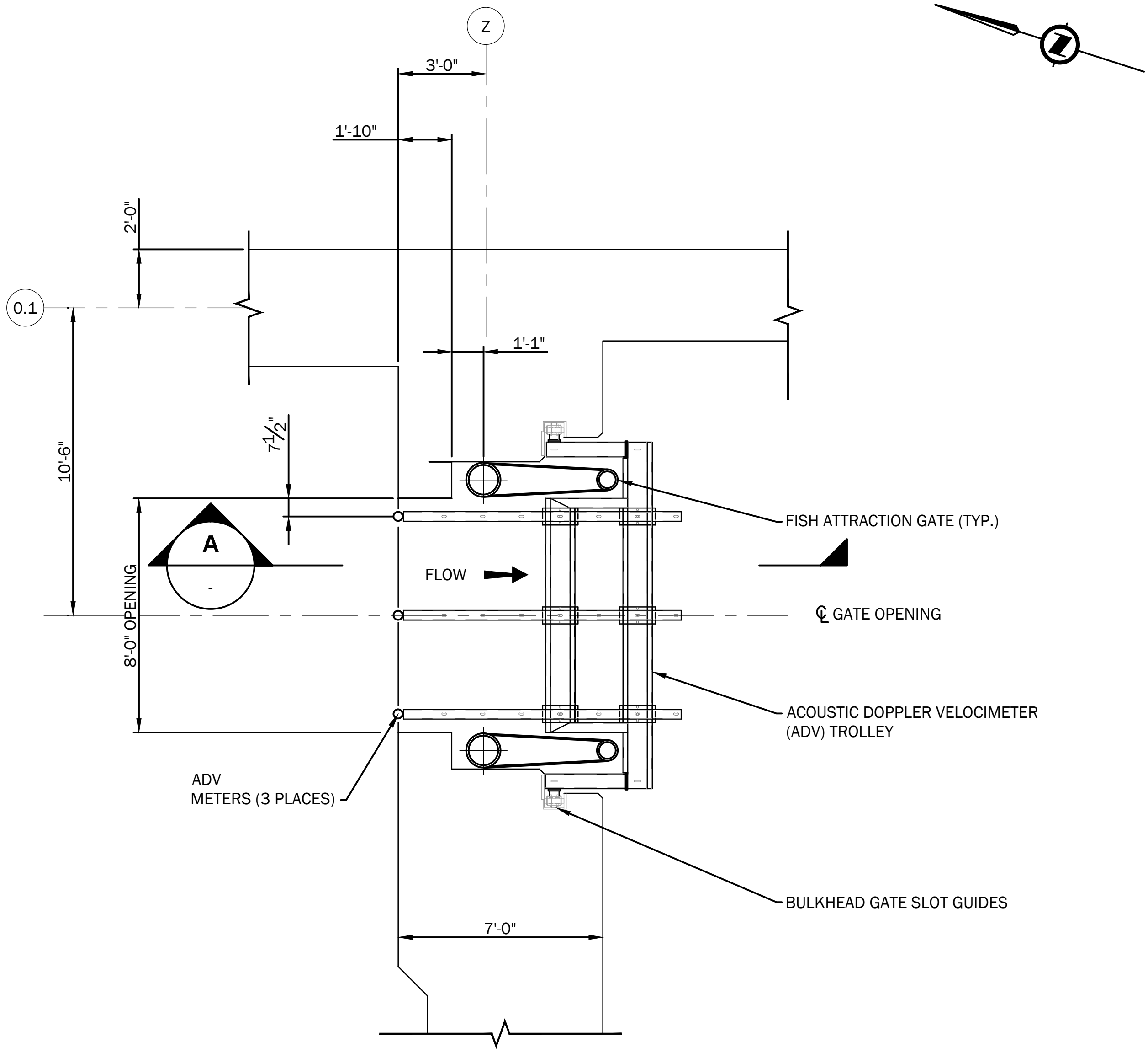


Photo 5: Wells Dam on morning March 2nd, 2011 during the velocity testing. (Photo by NHC)


Photo 6: Tailwater gage used to record the tailwater level. The Collection Chamber gage is in the background to the left. The difference between these two readings indicates the head drop across the fishway entrance. (Photo by NHC)

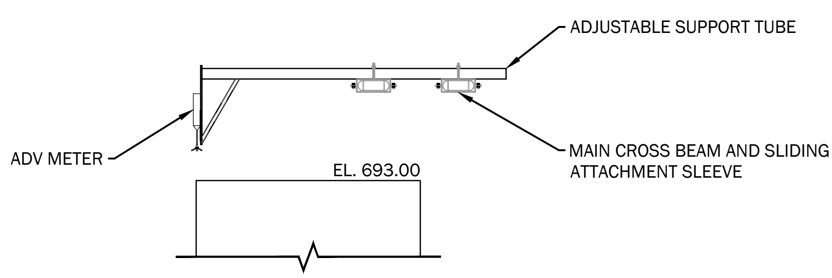
Photo 7: This photo shows the low tailwater condition used for Tests 1 and 2, roughly El. 706.5'.
(Photo by NHC)

Photo 8: The high tailwater condition testing was concluded at dawn on March 2nd. The ADVs were controlled via a laptop under the tent shown on the left. (Photo by NHC)




## ADV TROLLEY - PLAN AT EL. 693.00 (WEST FISH)

SCALE: 1" = 6'-0" (prototype)




A
-

## DETAIL

SCALE: 1" = 6'-0" (prototype)

nhc
northwest
hydraulic
consultants

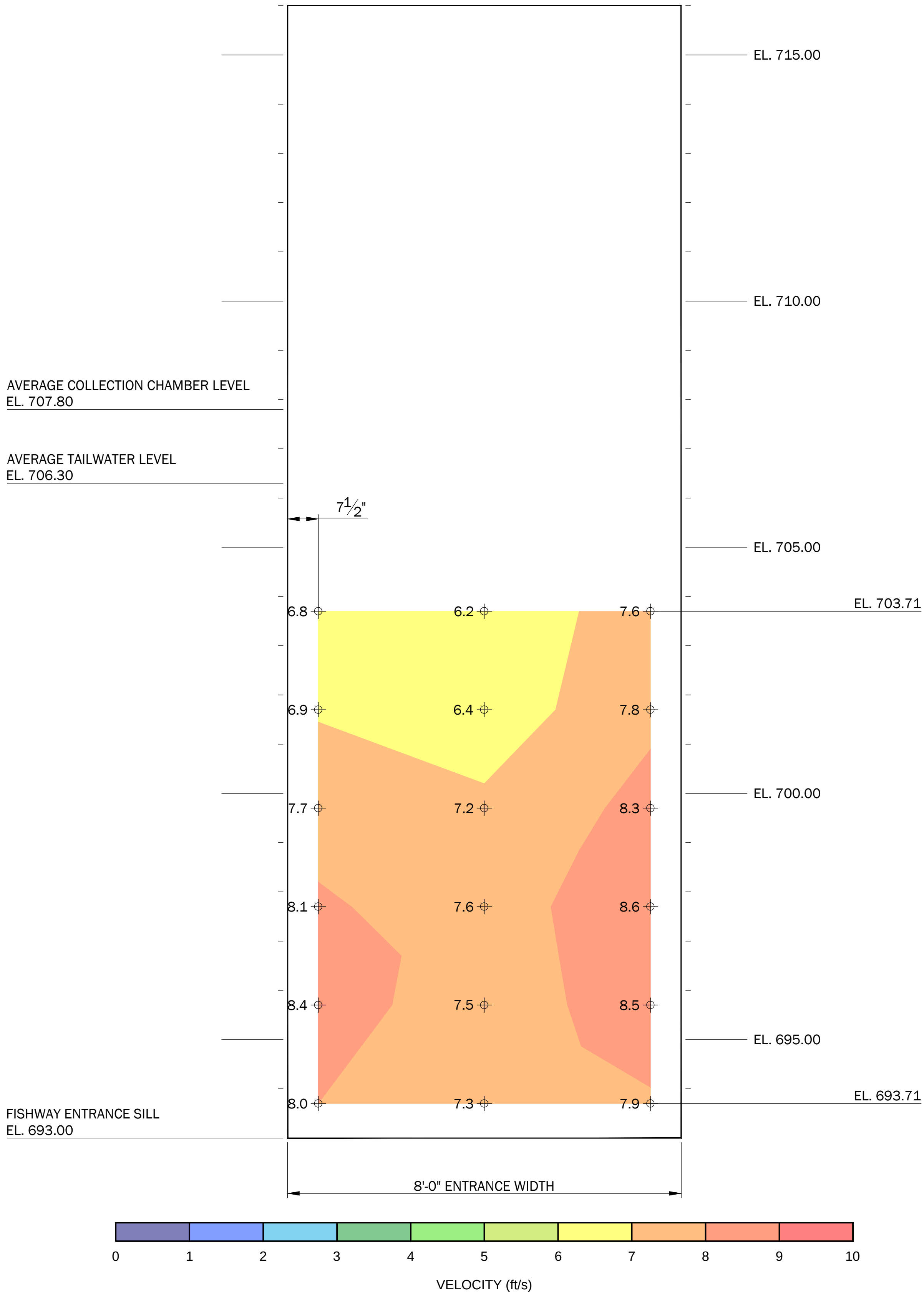
WELLS HYDROELECTRIC PROJECT
FISHWAY LADDER ENTRANCE VELOCITY TESTING

**West Fishway Entrance Velocities**
**ADV Testing Trolley Configuration**

| SCALE: | 1" = 6'-0" | REVISION NO: | 0 | DRAWN BY: | JAB | DATE: | 31-MAR-2011 | DRAWING NO: | 21823-002 |
|---|---|---|---|---|---|---|---|---|---|

16300 Christensen Road, Suite 350 Seattle, Washington 98188
Office: 206.241.6000 Fax: 206.439.2420 www.nhcweb.com

**FIGURE 1**




**nhc** northwest hydraulic consultants

WELLS HYDROELECTRIC PROJECT
FISHWAY LADDER ENTRANCE VELOCITY TESTING

**West Fishway Entrance Velocities**

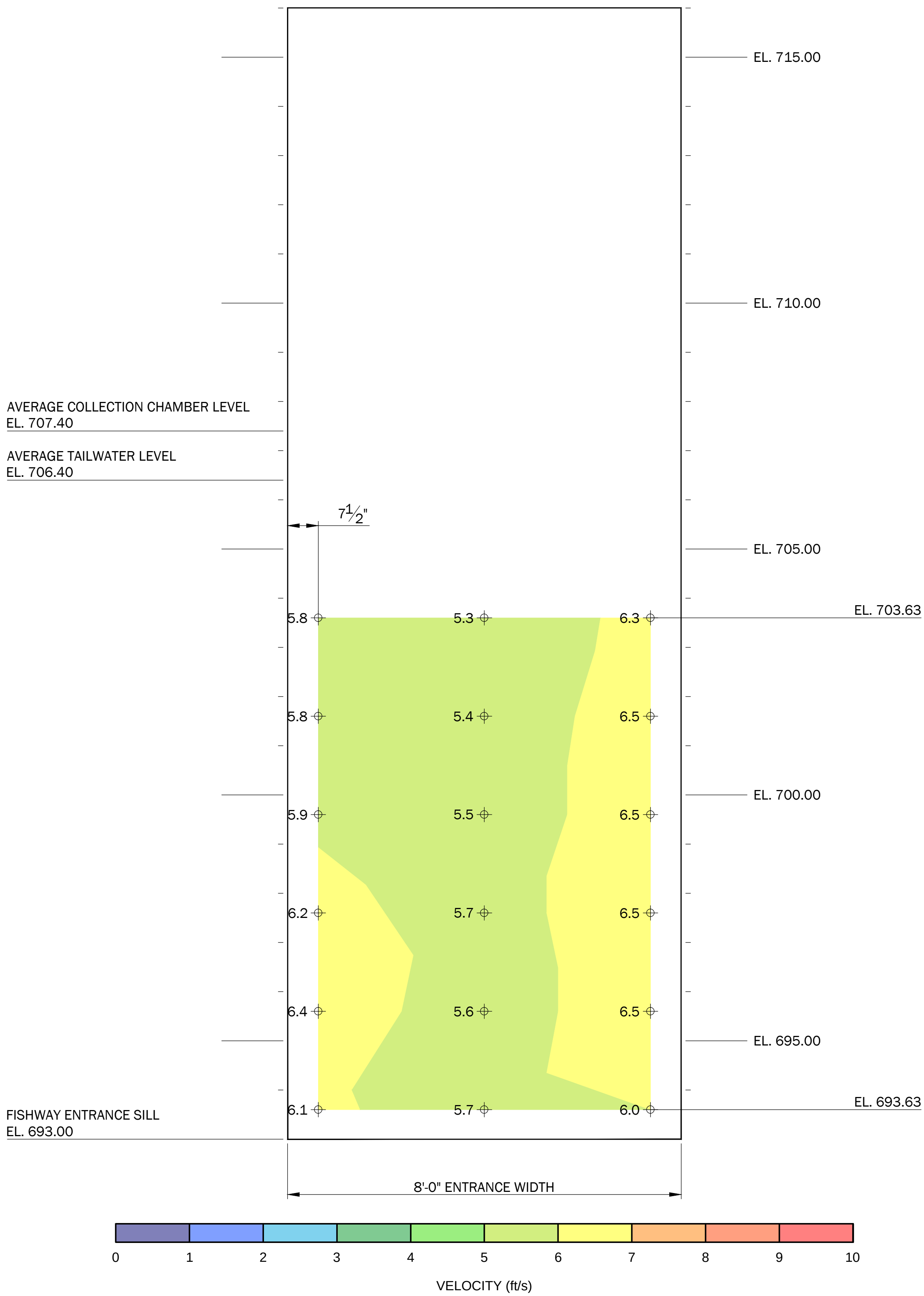
**Test 1**

**Tailwater Elevation 706.3 ft. with Head Drop of 1.5 ft.**

| SCALE: | N.T.S. | REVISION NO: | 0 | DRAWN BY: | JAB | DATE: | 30-MAR-2011 | DRAWING NO: | 21823-001 |
|---|---|---|---|---|---|---|---|---|---|

16300 Christensen Road, Suite 350 Seattle, Washington 98188
Office: 206.241.6000 Fax: 206.439.2420 www.nhcweb.com

**FIGURE 2**




nhc northwest hydraulic consultants

DOUGLAS COUNTY P.U.D.

WELLS HYDROELECTRIC PROJECT
FISHWAY LADDER ENTRANCE VELOCITY TESTING

**West Fishway Entrance Velocities**

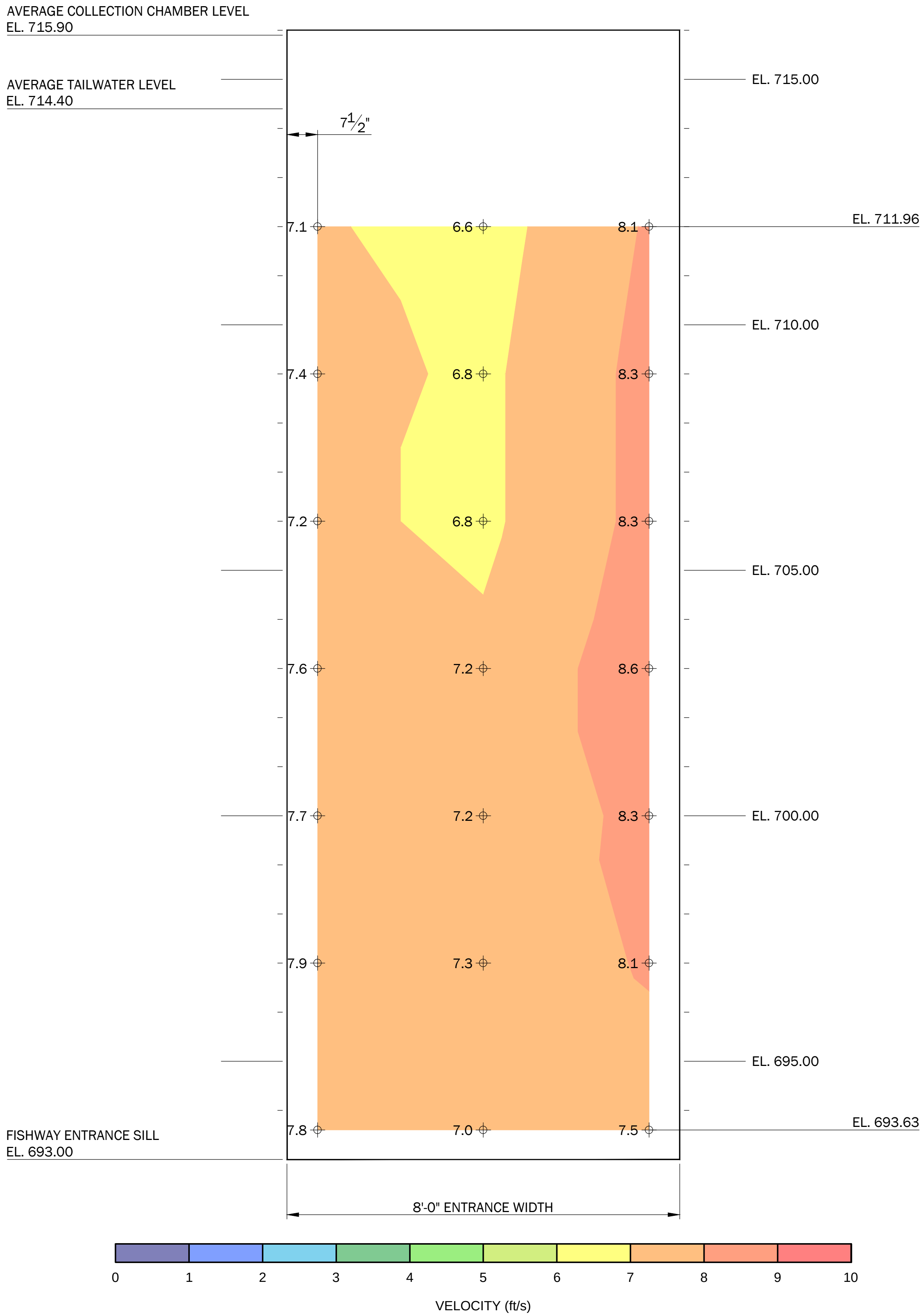
**Test 2**

**Tailwater Elevation 706.4 ft. with Head Drop of 1.0 ft.**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *SCALE:* | N.T.S. | *REVISION NO:* | 0 | *DRAWN BY:* | JAB | *DATE:* | 30-MAR-2011 | *DRAWING NO:* | 21823-001 |

16300 Christensen Road, Suite 350 Seattle, Washington 98188
Office: 206.241.6000 Fax: 206.439.2420 www.nhcweb.com

**FIGURE 3**




northwest hydraulic consultants

WELLS HYDROELECTRIC PROJECT
FISHWAY LADDER ENTRANCE VELOCITY TESTING

**West Fishway Entrance Velocities**

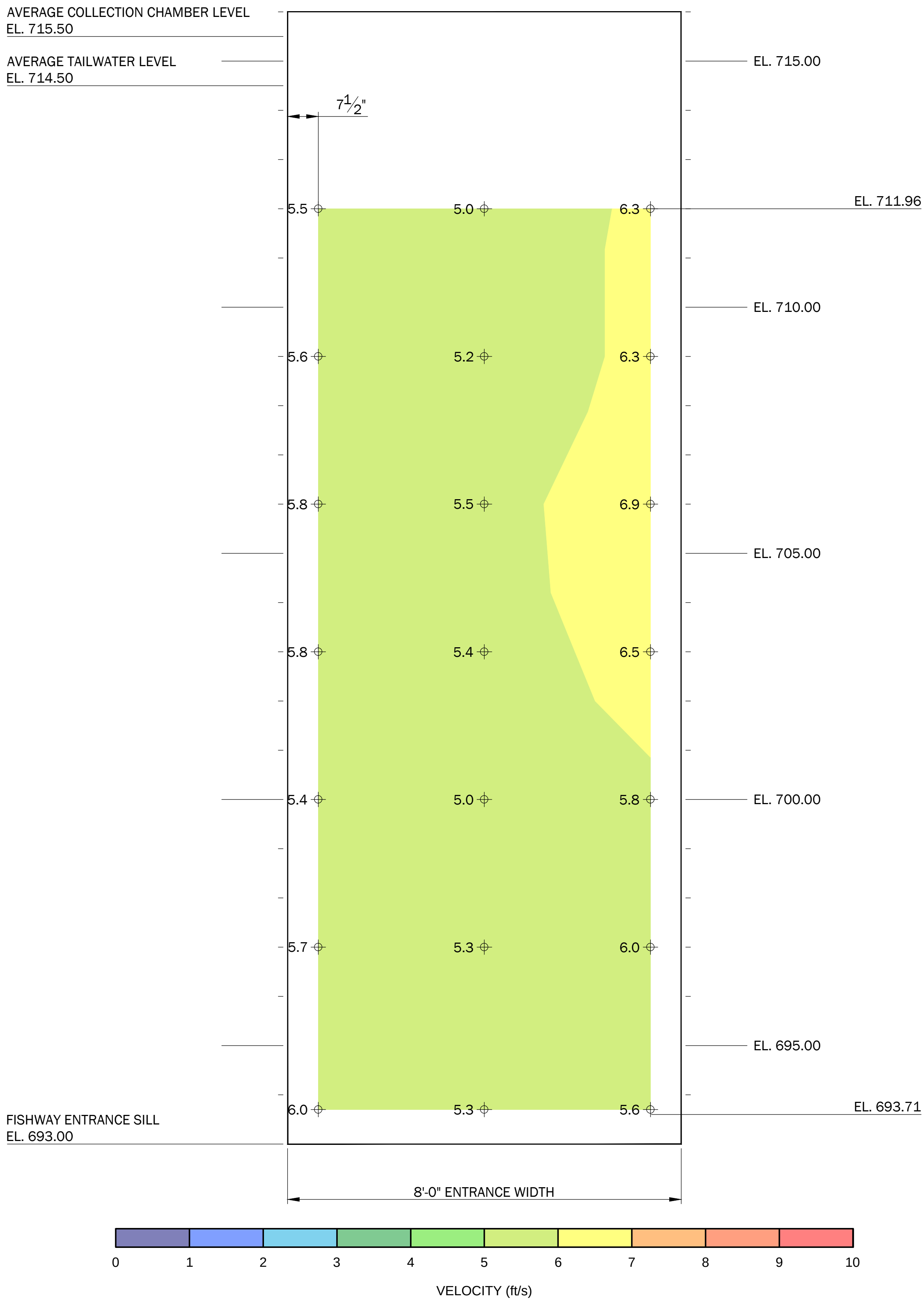
**Test 3**

**Tailwater Elevation 714.4 ft. with Head Drop of 1.5 ft.**

| SCALE: | N.T.S. | REVISION NO: | 0 | DRAWN BY: | JAB | DATE: | 30-MAR-2011 | DRAWING NO: | 21823-001 |
|---|---|---|---|---|---|---|---|---|---|

16300 Christensen Road, Suite 350 Seattle, Washington 98188
Office: 206.241.6000 Fax: 206.439.2420 www.nhcweb.com

**FIGURE 4**




northwest hydraulic consultants

WELLS HYDROELECTRIC PROJECT
FISHWAY LADDER ENTRANCE VELOCITY TESTING

**West Fishway Entrance Velocities**

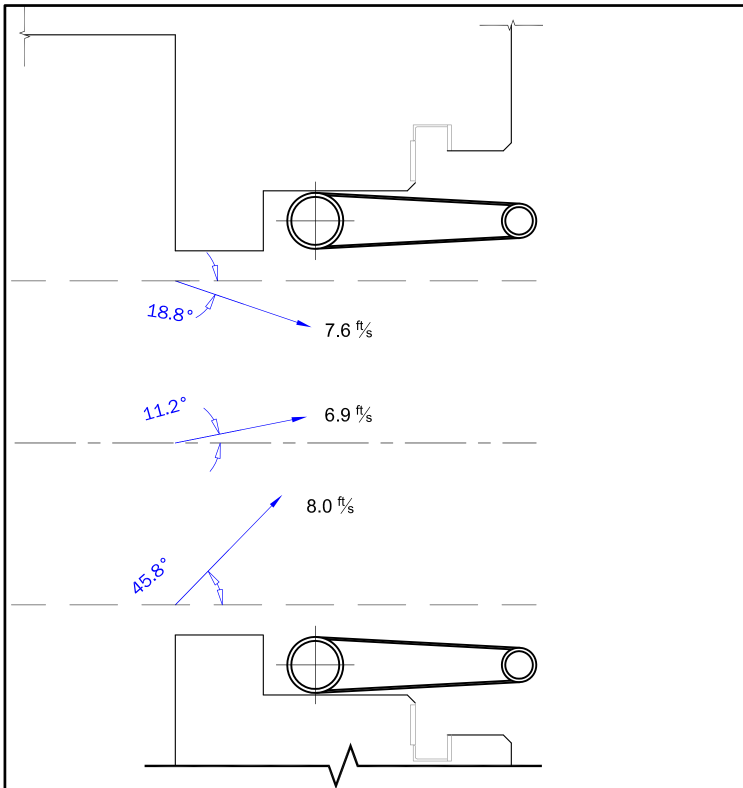
**Test 4**

**Tailwater Elevation 714.5 ft. with Head Drop of 1.0 ft.**

| SCALE: | N.T.S. | REVISION NO: | 0 | DRAWN BY: | JAB | DATE: | 30-MAR-2011 | DRAWING NO: | 21823-001 |
|---|---|---|---|---|---|---|---|---|---|

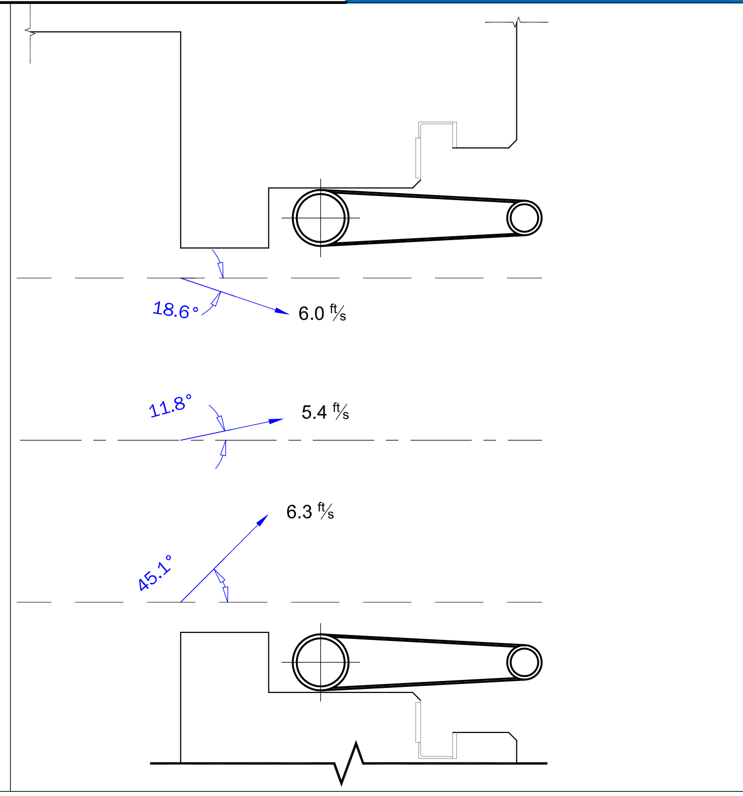
16300 Christensen Road, Suite 350 Seattle, Washington 98188
Office: 206.241.6000 Fax: 206.439.2420 www.nhcweb.com

**FIGURE 5**



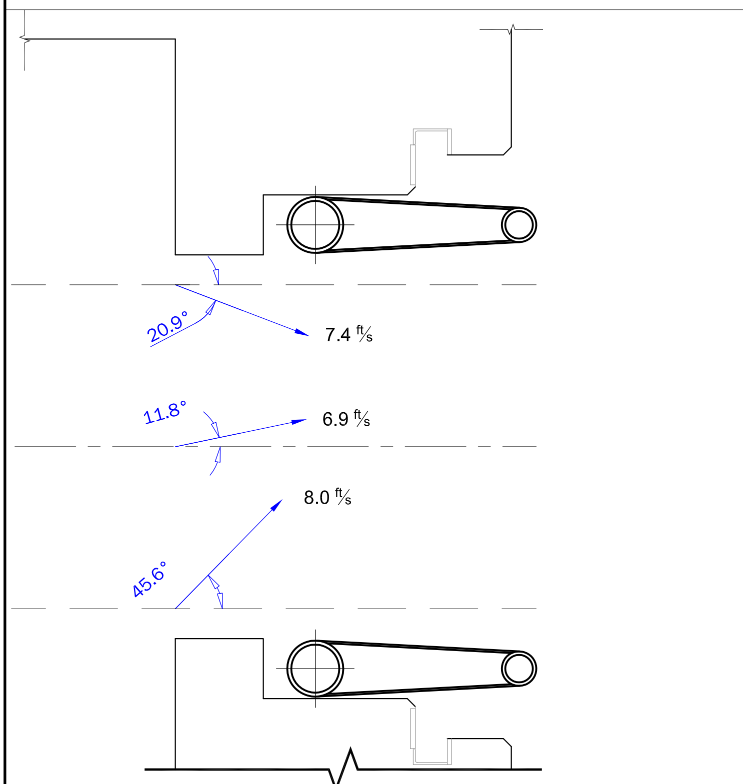

**TEST 1 - Tailwater 706.3' , Head Drop 1.5 ft**

SCALE: 1" = 4'-0" (prototype)



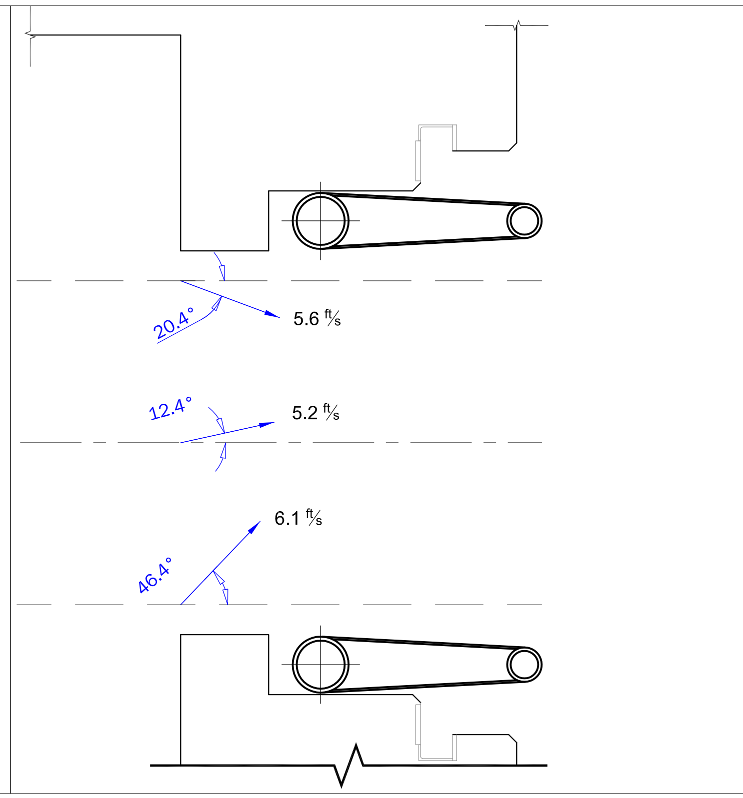

**TEST 2 - Tailwater 706.4' , Head Drop 1.0 ft**

SCALE: 1" = 4'-0" (prototype)




**TEST 3 - Tailwater 714.4' , Head Drop 1.5 ft**

SCALE: 1" = 4'-0" (prototype)




**TEST 4 - Tailwater 714.5' , Head Drop 1.0 ft**

SCALE: 1" = 4'-0" (prototype)

nhc northwest hydraulic consultants

WELLS HYDROELECTRIC PROJECT
FISHWAY LADDER ENTRANCE VELOCITY TESTING

**West Fishway Entrance Velocities**

**Average XY Velocity Magnitudes and Directions**

| SCALE: | 1" = 4'-0" | REVISION NO: | 0 | DRAWN BY: | ALS/JAB | DATE: | 31-MAR-2011 | DRAWING NO: | 21823-003 |
|---|---|---|---|---|---|---|---|---|---|

16300 Christensen Road, Suite 350 Seattle, Washington 98188
Office: 206.241.6000 Fax: 206.439.2420 www.nhcweb.com

**FIGURE 6**

# 2011WELLS PROJECT TOTAL DISSOLVED GAS ABATEMENT PLAN (GAP) ANNUAL REPORT

# Wells Hydroelectric Project
# Total Dissolved Gas Abatement Plan

## *2011 Annual Report*

Prepared by:

Bao Le
Long View Associates
Portland, OR

And

Beau Patterson and Andrew Gingerich
Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, WA 98802-4331

Prepared for:

Pat Irle
Hydropower Projects Manager
Washington Department of Ecology
15 W. Yakima Avenue, Suite 200
Yakima, WA 98902-3452

**December 2011**

This page intentionally left blank

TABLE OF CONTENTS

This page intentionally left blank

# LIST OF FIGURES



# LIST OF TABLES



# LIST OF APPENDICES

This page intentionally left blank

# 1 INTRODUCTION

The 2011 Wells Hydroelectric Project Gas Abatement Plan (GAP) was approved by the Washington State Department of Ecology (Ecology) on March 31, 2011 (Appendix 1 and Appendix 2). The GAP and its associated measures are intended to meet state water quality standards for total dissolved gas (TDG). This annual report concludes the 2011 monitoring season and describes the background, operations, and results of GAP implementation at the Wells Project in 2011.

## 1.1 Project Description

The Wells Hydroelectric Project (Wells Project) is owned and operated by Public Utility District No. 1 of Douglas County (Douglas PUD) and is located at river mile (RM) 515.6 on the Columbia River in the State of Washington (**Figure 1**). Wells Dam is located approximately 30 river miles downstream from the Chief Joseph Hydroelectric Project, owned and operated by the United States Army Corps of Engineers (USACE), and 42 miles upstream from the Rocky Reach Hydroelectric Project, owned and operated by Public Utility District No. 1 of Chelan County. The nearest town is Pateros, Washington, which is located approximately 8 miles upstream from the Wells Dam.

The Wells Project is the chief generating resource for Douglas PUD. It includes ten generating units with a nameplate rating of 774,300 kW and a peaking capacity of approximately 840,000 kW. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. The hydrocombine is 1,130 feet long, 168 feet wide and has a top of dam elevation of 795 feet above mean sea level (msl). Upstream fish passage facilities are located on both sides of the hydrocombine.

The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir. The Wells Project boundary extends 1.5 miles up the Methow River and 15.5 miles up the Okanogan River. The surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet and usable storage of 97,985 acre-feet at the normal maximum water surface elevation of 781 feet msl.

## 1.1 Fixed Monitoring Station Locations

Fixed monitoring stations for TDG are located above and below Wells Dam. The forebay station (WEL) is located midway across the deck of Wells Dam (47° 56’ 50.28” N, 119° 51’ 54.78” W). The tailrace station (WELW) is located on the left bank of the Columbia River 2.6 miles downstream of Wells Dam (47° 54’ 46.86” N, 119° 53’ 45.66” W). Hach® HYDROLAB MiniSonde instruments equipped with TDG and temperature probes are deployed approximately 15 feet below normal surface water elevation and are calibrated monthly (example in Appendix 3). Data from both stations are automatically transmitted by radio to Wells Dam, stored, and forwarded to the USACE. Weather data are recorded by Global Water, Inc. instrumentation, including an electronic barometer located on the deck of Wells Dam at 810 feet elevation.


**Figure 1.** Location of the Wells Project.

## 1.2 Regulatory Framework

Washington Administrative Code (WAC) Chapter 173-201A identifies the Water Quality Standards (WQS) for surface waters in Washington State. The WQS state that TDG measurements shall not exceed 110% saturation at any point of measurement in any state water body. The WQS provide for two exceptions to this rule: (1) during natural flood flows, (2) for spill over dams to increase survival of downstream migrating juvenile salmon, when a project is operated consistent with an Ecology-approved plan (i.e., GAP).

Natural flood flows are identified by periods in which river flow volume exceeds the highest seven consecutive days average observed during a ten-year period, called the 7Q-10 flow. The 7Q-10 flow for the Wells Project is 246,000 cubic feet per second (cfs), based on the hydrologic records from 1930 to 1998 and the USGS Bulletin 17B, “Guidelines for Determining Flood Flow Frequency” (Pickett et al. 2004). When river flow volume exceeds 7Q-10 flows, the WQS permit exceedance of the 110% TDG saturation standard.

Ecology may also approve an exception to the 110% upper criterion for TDG saturation during the outmigration of juvenile salmon; fish passage spill is used to facilitate project passage survival. The TDG exception is considered by Ecology on a per-application basis and must be accompanied by an approved GAP (WAC 173-201A-200(1) (f) (ii)). On the Columbia and Snake rivers, the TDG exception for fish passage has three standards during the fish passage (spill) season: (1) TDG shall not exceed 125% saturation in the tailrace of the project as measured in any one-hour period; (2) TDG shall not exceed 120% saturation in the tailrace of the project based on the average of the twelve highest consecutive hourly readings in any one day (12C-High[1]); and, (3) TDG shall not exceed 115% saturation in the forebay of the next downstream project based on the average of the twelve highest consecutive hourly readings in any one day.

## 1.3 2011 Gas Abatement Plan Approach

### *1.3.1 Operational*

Based on the success of 2009 and 2010 operations associated with implementation of the Wells Project Spill Playbook (Spill Playbook), those operations were implemented again in 2011 with minor modification as described below.

In February 2011, Douglas PUD conducted an additional technical analysis of the 2010 Spill Playbook (after in-season changes) and confirmed that continued implementation would be appropriate for 2011 with additional minor modifications. The 2011 Spill Playbook is attached as Appendix 4 and additional recommendations for 2011 operations, from a TDG management perspective, included:

1. Minimize spill.
2. Forced Spill (≤ 53.0 kcfs). Switch the priority for forced spill less than 53 kcfs from spillbay 7 to spillbay 5. Units 4 and 5 should be operated to support spill from spillbay 5.
3. If spill exceeds 53 kcfs, or is predicted to exceed 40 kcfs for more than 8 hours, remove the JBS barriers in spillbay 6.
4. When spill exceeds 30 kcfs in spillbay 5 and JBS barriers have been removed in spillbay 6, shift at least 15.0 kcfs from spillbay 5 to spillbay 6 (i.e., 27.2 kcfs and 15.0 kcfs through spillbays 5 and 6, respectively). Support spill through spillbays 5 and 6 by operating units 4, 5 and 6.
5. Reinstall the JBS barriers if total spill is predicted to remain below 40 kcfs for more than four days.
6. Operate the powerhouse to maximize release through the center units (3-6, 8, and 7 if operational) when forced spill is occurring.

Modifications were based on previous adaptive operational results, model predictions, and operational contingencies for unplanned unit outages. During the 2011 flood flow periods, the Wells Project was an 8 unit plant, due to a longer than expected rebuild for Unit 7, and unplanned mechanical breakdown of Unit 4.

---

[1] Ecology currently uses the methodology described in Appendix 5 for determining 12C-High TDG values in the tailrace and forebay of Columbia Basin hydroelectric projects.

### 1.3.2 Structural

No permanent structural modifications were proposed or conducted in the 2011 monitoring season.

### 1.3.3 Consultation

Douglas PUD will direct all correspondence to the Hydropower Projects Manager, Department of Ecology, Central Region Office, Water Quality Program, 15 W. Yakima Avenue, Suite 200, Yakima, Washington 98902.

# 2 OPERATIONS

## 2.1 Description of Fish-Spill Season Flow

The 2011 Fish Spill Season was April 12th through August 26th at Wells Dam. As required, TDG data was monitored during this period and transmitted to the USACE, Northwest Division on a real-time basis (www.nwd-wc.usace.army.mil). Historical data is available for download. Data from 1995 to 2011 (17 years) show that average monthly flows between April and August range from 53.4 to 300.3 kcfs at the Wells Project. During this time period, flows tend to be greater and more variable in June (mean 172.5 kcfs, SD ±53.97), and lowest and least variable in August (107.5 kcfs, SD ±23.67, Table 1). Flows at the run-of-river Wells Project are determined by upstream storage release changes at Grand Coulee hydroelectric project, and minimally by tributary runoff.

**Table 1.** Monthly total river discharge (kcfs) from the Wells Project (April-August), 1995-2011.

| Month | April | May | June | July | August |
|---|---|---|---|---|---|
| **Mean Monthly Average (kcfs)** | 115.8 | 147.2 | 172.5 | 134.3 | 107.5 |
| **Minimum Monthly Average (kcfs)** | 62.9 | 55.2 | 84.5 | 53.4 | 70.4 |
| **Maximum Monthly Average (kcfs)** | 177.4 | 251.9 | 300.3 | 206.6 | 152.1 |
| **Standard Deviation (kcfs)** | ±35.69.0 | ±44.12 | ±53.97 | ±37.26 | ±23.67 |

Columbia River flows at Wells Dam in 2011 were the third-highest on record. Average monthly river flow at the Wells Project was 27.9% higher in April and 59.2% higher in July than the 16-year average for respective months. The average flow in 2011 was 45.0% (59.4 kcfs) higher than the previous 16-year average (Table 2). Flows for all months during the spill season were higher than the monthly 16-year average. The maximum hourly flow observed during the spill season was 327.8 kcfs on June 5 and flows frequently exceeded the 7Q-10 value of 246.0 kcfs. The average monthly flow for all of June exceeded the 7Q-10 value for the Wells Project. Of the 137 days during the spill season, there were 34 instances (24.8% of the monitoring period) where daily average flows at the Wells Project exceeded the 7Q-10 value.

**Table 2.** Average monthly river flow volume (kcfs) during the TDG monitoring season at the Wells Project in 2011 compared to the previous 16-year average (1995-2010), by month.

| Month | 1995-2010 Mean | 2011 Mean | Percent Difference from 16-Year Average |
|---|---|---|---|
| April | 113.9 | 145.7 | +27.9% |
| May | 143.5 | 206.0 | +43.6% |
| June | 167.1 | 259.0 | +55.0% |
| July | 129.8 | 206.6 | +59.2% |
| August | 105.5 | 139.9 | +32.6% |
| All | 132.0 | 191.4 | +45.0% |

## 2.2 Fish Spill Program

Wells Dam is a hydrocombine, where the spillbays are located directly above the turbine water passages. Research at Wells Dam in the mid-1980s demonstrated that a modest amount of spill could be used to effectively guide a high proportion of the downstream migrating juvenile salmon away from the turbines and into a surface oriented bypass system. A JBS was subsequently developed at Wells in the late 1980s. The Wells Dam JBS was engineered based on biological research and hydraulic modeling, and utilizes constricting flow barriers deployed in five of the eleven spillbays to effectively attract and safely guide fish through the project. The Wells Project JBS has since proven to be the most efficient system on the mainstem Columbia River, providing high levels of fish protection that has met approval of fisheries agencies and tribes (Skalski et al. 1996). The survival performance measures contained within the Federal Energy Regulatory Commission (FERC) approved Anadromous Fish Agreement and HCP have been consistently exceeded, with a three-year survival average of 96.2% for juvenile steelhead and Chinook salmon (Bickford et al. 2001). The results from a fourth year of survival study at Wells Dam in 2010 (Bickford et al. 2011) confirmed past study results by documenting that survival through the entire Wells Project is in excess of 96.4% for juvenile spring migrating anadromous fish (see Section 3.1.2 below).

## 2.3 Fish Spill Quantities and Duration

The Wells Dam JBS uses up to 2,200 cfs per spillbay, though one or more of the flow barriers may be removed to provide adequate spill capacity to respond to plant load rejection. Under normal conditions, however, the JBS will use roughly six to eight percent of the total river flow for fish guidance. The increased spill has a small influence on TDG production (~0-2%) while providing a safe, non-turbine passage route for over 92% of the spring and 96% of the summer migrating juvenile salmonids. The JBS has been operated on a fixed schedule between April 12th and August 26th since 2003 but the HCP CC retains annual operating oversight that includes the potential to operate the JBS as early as April 1st and as late as August 31st to ensure that 95% of the spring and summer migration of juvenile salmonids is provided a safe, non-turbine passage route past Wells Dam. In 2011, Douglas PUD evaluated past performance of the Wells Dam JBS operating dates relative to observed annual run timing (at the Rocky Reach Bypass) for both spring and summer migrants. With that data, a request was made to and granted by the HCP CC to revise operating dates in 2012 to start April 9th and end August 19th.

Except for April, average monthly spill (calculated from daily averages) at the Wells Project in 2011 was higher than the previous 16-year average. Average spill volume ranged from 10.0 kcfs in April to 112.3 kcfs in June (Table 3). Hourly spill exceeded the JBS spill volume almost continuously from May 11th to July 20th, 2011. On June 5Th forced spill reached 185.5 kcfs, the maximum hourly value for the 2011 season. These high spill events in June were attributed to both flow volumes in excess of the Project's hydraulic capacity, and flows in excess of the power system needs and/or transmission system capacity.

**Table 3.** Average monthly spill (kcfs) during the TDG monitoring season at the Wells Project in 2011 compared to the 16-year average (1995-2010), by month.

| | 1995-2010 | | 2011 | |
|---|---|---|---|---|
| **Month** | **Mean** | **Std Dev** | **Mean** | **Std Dev** |
| April | 14.0 | 13.1 | 10.0 | 0.2 |
| May | 18.8 | 23.8 | 54.0 | 47.1 |
| June | 30.5 | 38.8 | 112.3 | 26.0 |
| July | 11.8 | 12.0 | 50.8 | 29.2 |
| August | 7.7 | 4.5 | 10.8 | 2.1 |
| Spill Season | 17.0 | 24.1 | 51.8 | 46.9 |

# 3 IMPLEMENTATION RESULTS

## 3.1 Fisheries Management

### *3.1.1 Fish Passage Efficiencies*

No fish passage efficiency studies were conducted at the Wells Project in 2011. However, three years of bypass efficiency studies have shown the Wells Dam JBS to be the most efficient juvenile salmonid collection system in the Columbia River with fish passage efficiencies up to 92% for spring migrants and up to 96% for summer migrants (comprised of steelhead, spring Chinook, and sockeye salmon, and summer/fall Chinook salmon, respectively; Skalski et al. 1996).

#### *3.1.2 Survival Studies*

No survival studies were conducted at the Wells Project in 2011. In preparation for a future subyearling Chinook run-timing and behavior study, Douglas PUD conducted a pilot study to: evaluate the feasibility of capturing wild subyearling Chinook using seining techniques; identify capture locations; and determine whether it is possible to capture enough subyearlings to confidently evaluate migration behavior and timing. Over 13,000 wild subyearling Chinook salmon were captured and tagged in the Project area during these efforts.

These small salmon were outfitted with a PIT tag that allows them to be detected at downstream hydroelectric projects. In subsequent years Douglas PUD expects to estimate survival of these fish when migrating past Wells Dam using similar techniques, toward the goal of demonstrating steady progress in complying with the HCP passage survival standards for subyearling summer/fall Chinook. To date, over 2,200 of these fish have been observed at lower river Projects including Rocky Reach, McNary, John Day, and Bonneville Dam.

In spring 2010, Douglas PUD conducted a survival verification study with yearling Chinook salmon, a required 10-year follow-up study to confirm whether the Wells Project continues to achieve survival standards of the Wells Anadromous Fish Agreement and HCP. Approximately 80,000 PIT-tagged yearling summer Chinook were released over a 30 day period in 15 replicates. Study results indicated that juvenile Chinook survival from the mouth of the Okanogan and Methow rivers averaged 96.4% over the 15 replicate releases of study fish, and confirms the results from the three previous years of study documenting that fish survival through the Wells Project continues to exceed the 93% Juvenile Project Survival Standard required by the HCP (Bickford et al., 2011).

## 3.2 Biological Monitoring

In 2011, Columbia River flows at Wells Dam were the third highest on record with total river flow past Wells Dam almost twice the long-term historic average. As a result of high flows, high volumes of forced spill throughout the Mid-Columbia system have resulted in prolonged, elevated TDG levels.

The 2011 Wells Project GAP includes the National Marine Fisheries Service (NMFS) recommendation to sample for Gas Bubble Trauma (GBT) in juvenile salmon when hourly tailrace TDG levels exceed 125% saturation (NMFS 2000).

In response to elevated TDG levels in the tailrace and as required by the 2011 Wells Project GAP, biological monitoring was initiated by Douglas PUD on May 21st and continued daily as TDG levels above and below Wells Dam remained above requisite monitoring thresholds. Daily observations continued until Monday May 30th, 2011 when Ecology (Pat Irle Pers. Comm.) approved a three day/week sampling schedule when TDG levels are sustained above 125%. Douglas PUD continued to monitor TDG conditions and biological responses into late July.

Over the course of the biological monitoring period five juvenile anadromous fish species were examined, including spring and summer Chinook, steelhead, sockeye and coho. Douglas and Chelan PUD biologists sampled juveniles on 28 days over a two month span (May 21 to July 21). An average of 44 ±25.7 (standard deviation) juveniles were sampled on each of these days, across a TDG range of 120-134% (daily mean; Rocky Reach forebay). In total, staff examined 1,234 juvenile fish across this TDG spectrum. In addition, Douglas PUD staff and WDFW examined 474 adult Chinook salmon captured at Wells Dam fish ladders during broodstock collection activities with only one confirmed occurrence of GBT despite sampling fish when TDG was between 125-137% in the Wells tailrace (Gingerich and Patterson, 2011 draft; Appendix 5).

Overall, GBT expression in juvenile salmonids examined at Rocky Reach was variable, and appeared to track TDG concentrations reasonably well. GBT expression was confounded by species specific sensitivities to levels of TDG coupled with changes to the species run composition during the spill season. Juvenile salmonids expressed varied amount of GBT by species. Coho expressed the highest incidence of GBT with steelhead and yearling Chinook expressing intermediate GBT and sockeye and subyearling Chinook appearing to be the most resilient to high TDG concentrations. Throughout the season, adult fish sampled at Wells Dam appeared to have little symptoms of GBT, even when TDG was above 130% in the Wells tailrace (Gingerich and Patterson, 2011 draft).

## 3.3 Water Quality Forums

Douglas PUD has actively participated in regional water quality forums with Ecology, WDFW, NMFS, Tribal Agencies, the US Fish and Wildlife Service, the USACE, and other Mid-Columbia PUDs (i.e., Grant and Chelan counties). These meetings, ranging from the Trans-boundary Gas Group to Columbia Basin meetings with the USACE, allow for regional coordination for monitoring, measuring, and evaluating water quality in the Columbia Basin. Douglas PUD will continue its involvement in water quality meetings for further coordination with other regional water quality managers.

## 3.4 Physical Monitoring

### *3.4.1 Overview*

TDG monitoring at the Wells Project has occurred since 1984 when forebay stations were first established. TDG monitoring in the tailrace of Wells Dam began in 1997 by actively collecting data at four points across the width of the river. Based on these data, the location for a fixed monitoring station was established in 1998. Subsequent analysis verified that both monitoring station locations are appropriate and representative of the river conditions, particularly during high flows (EES et al. 2007; Politano et al. 2009). TDG monitoring at the Wells Project currently encompasses the fish passage season and a majority of all forced spill, beginning April 12$^{Th}$ and continuing until August 26$^{th}$. As part of Douglas PUD's Quality Assurance/Quality Control (QA/QC) measures, the TDG sensors are serviced monthly for maintenance and calibration. Data is collected at 15-minute intervals at the Wells Project over the entire fish spill season.

#### *3.4.2 Data Evaluation and Analyses*

Hourly TDG monitoring data were retrieved from the USACE, Northwest Division for three monitoring locations: the forebay of Wells Dam, tailrace of Wells Dam, and forebay of Rocky Reach Dam (RRH). The data were partitioned to include only readings obtained during the fish spill season (April 12st to August 26th). Data were stratified by monitoring site, ascending date, and ascending time. The Ecology-approved 12C-High method (Appendix 6) was used to obtain TDG measurements for comparison to numeric criteria and evaluation of compliance.

Hourly TDG measurements during the 2011 monitoring period (April 12-August 26) ranged from 102.0% to 129.9% in the forebay of Wells Dam, from 104.1% to 138.8% in the tailrace of Wells Dam[2], and from 103.8% to 135.4% in the forebay of Rocky Reach Dam (Table 4).

**Table 4.** Hourly sampling events (n) and resulting TDG (percent saturation) at the forebay of Rocky Reach Dam, the forebay of Wells Dam (WEL), and the tailrace of Wells Dam (WELW) by month, 2011.

| | Wells Dam Forebay | | | | Wells Dam Tailrace | | | | Rocky Reach Dam Forebay | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **n** | **Min** | **Mean** | **Max** | **n** | **Min** | **Mean** | **Max** | **n** | **Min** | **Mean** | **Max** |
| April | 447 | 102.0 | 104.6 | 108.9 | 448 | 104.1 | 106.8 | 111.2 | 453 | 103.8 | 106.6 | 109.2 |
| May | 716 | 105.2 | 114.2 | 127.1 | 717 | 106.8 | 118.9 | 138.8 | 744 | 105.2 | 117.0 | 134.5 |
| June | 718 | 114.5 | 122.3 | 129.9 | 656 | 117.2 | 130.3 | 138.4 | 720 | 110.4 | 128.0 | 135.4 |
| July | 741 | 113.4 | 116.4 | 119.8 | 741 | 113.2 | 122.0 | 131.0 | 744 | 105.1 | 119.5 | 127.6 |
| August | 608 | 108.2 | 111.9 | 116.0 | 608 | 109.6 | 113.1 | 125.0 | 624 | 108.9 | 111.9 | 115.8 |

Monthly average 12C-High TDG saturation measurements in 2011 during the monitoring period ranged from 102.4% to 129.1% in the forebay of Wells Dam, from 105.4% to 138.8% in the tailrace of Wells Dam, and from 105.6% to 134.5% in the forebay of Rocky Reach Dam. Maximum values were observed in June and July, and minimum values were observed in April and May and again in August (

[2] On June 11, from 0900-2000, values as high as 150.3% were reported, which at the time caused considerable alarm. By 2100 June 11, the WELW sensor was nonfunctioning. Subsequent investigation indicated a debris mobilization event had damaged the deployment conduit and sensor. These high readings were judged to be spurious and a result of damage to the probe, confirmed by the lack of a corresponding spike in values downstream in the Rocky Reach forebay. (See Fig. 2)

Table 5; Appendix 7).

**Table 5.** Descriptive statistics of daily 12-C High TDG measurements (percent saturation) from Wells Dam forebay (WEL) and tailrace (WELW) and the forebay from Rocky Reach Dam (RRH) during the 2011 monitoring season.

| | Wells Dam Forebay | | | | Wells Dam Tailrace | | | | Rocky Reach Forebay | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Min** | **Max** | **Mean** | **Std Dev** | **Min** | **Max** | **Mean** | **Std Dev** | **Min** | **Max** | **Mean** | **Std Dev** |
| April | 102.4 | 107.4 | 105.00 | 1.3 | 105.4 | 109.2 | 107.4 | 1.1 | 105.6 | 109.0 | 107 | 1.0 |
| May | 106.5 | 126.9 | 114.5 | 6.9 | 108.7 | 137.7 | 119.3 | 8.6 | 107.3 | 133.7 | 117.6 | 8.6 |
| June | 115.2 | 129.1 | 122.8 | 3.1 | 115.4 | 135.3 | 127.5 | 4.1 | 122.3 | 134.5 | 128.7 | 3.0 |
| July | 114.2 | 119.5 | 116.9 | 1.5 | 114.6 | 129.2 | 122.7 | 4.0 | 114.0 | 126.8 | 120.2 | 3.8 |
| August | 109.0 | 115.5 | 112.3 | 2.0 | 111.7 | 117.4 | 113.8 | 1.5 | 110.2 | 115.2 | 112.3 | 1.8 |
| All | 102.4 | 129.1 | 115.2 | 6.6 | 105.4 | 137.7 | 119.6 | 9.1 | 105.6 | 134.5 | 118.1 | 8.5 |

During the 2011 monitoring season, the TDG criterion for the forebay of Wells Dam was exceeded 75 of 137 days (55.0%). At the request of Ecology, Douglas PUD conducted an in-season evaluation of the 2011 fish passage season to assess compliance with the TDG waiver water quality standards, TDG physical monitoring and biological monitoring for GBT at Wells Dam (Patterson and Gingerich, 2011).

The evaluation indicated that flows in 2011 at Wells Dam were the third-highest on record. Compared to the 10-year average, spill started early, peaked early and total river flow past Wells Dam has been almost twice the long-term historic average. As a result of these high flows, high volumes of forced spill have resulted in prolonged, elevated levels of total dissolved gas throughout the Columbia River system (Figure 2). The evaluation found that the primary source of this elevated TDG entering the Mid-Columbia has been from the operation of federal projects upstream of Wells Dam; primarily Chief Joseph and Grand Coulee dams. Although spill deflectors at the Chief Joseph Dam strip some dissolved gases from the flow below Grand Coulee, TDG levels in the Wells Dam forebay were consistently above the 115% forebay compliance criteria. At Grand Coulee Dam, spill operations produced TDG levels above 120% beginning in mid-May and sustained these levels until mid-July. TDG levels in the Grand Coulee Dam tailrace consistently exceeded 135% from late May to mid-June and peaked above 140% in early June.

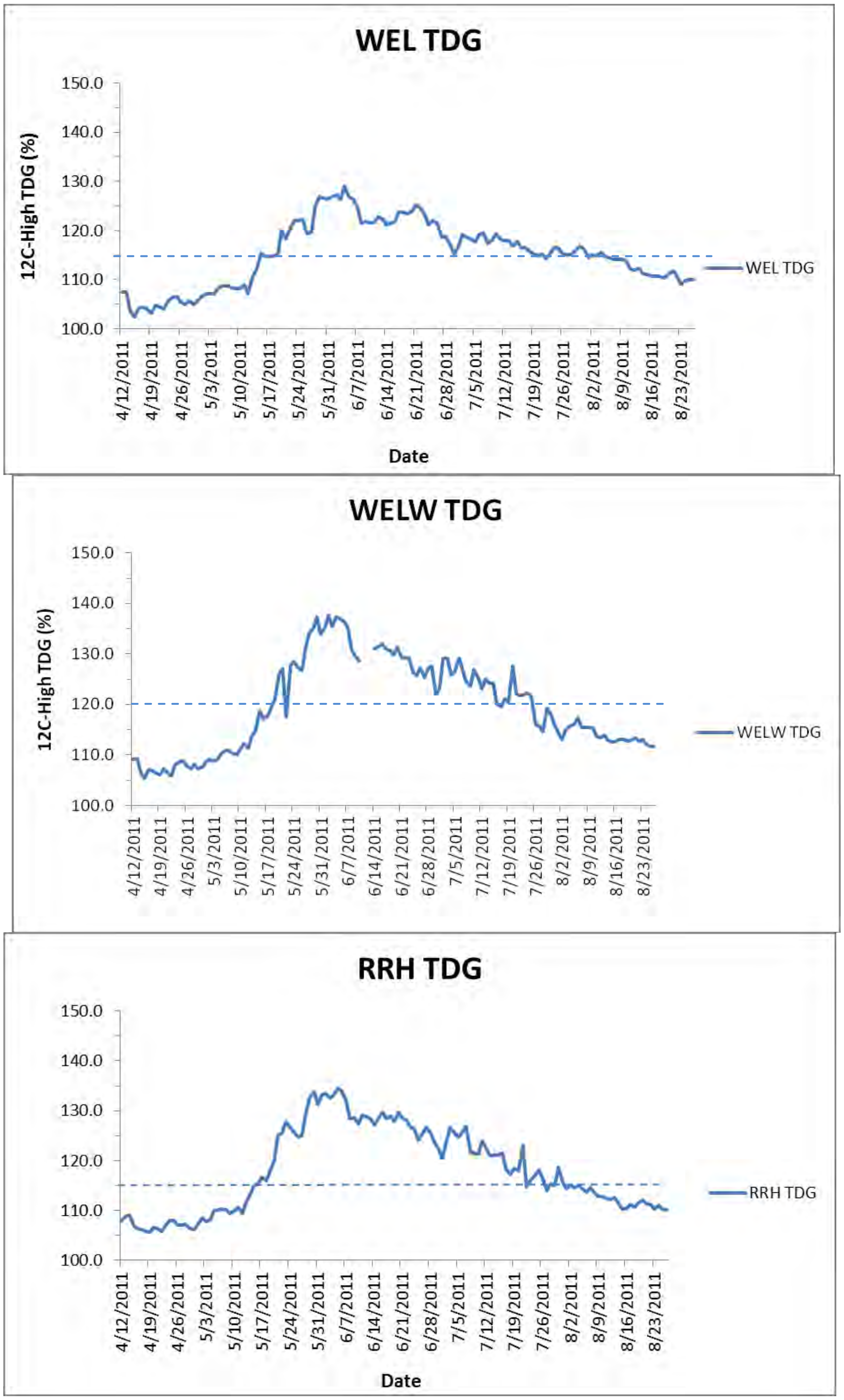



**Figure 2.** Daily 12-C High TDG measurements (percent saturation) from Wells Dam forebay (WEL) and tailrace (WELW) and the forebay from Rocky Reach Dam (RRH) during the 2011 monitoring season. Reference lines are at the 120% and 115% compliance marks.

At Wells Dam, there are three compliance criteria for the 2011 fish passage waiver that must be met in association with operation at the Wells Project as described in the 2011 GAP: 1) average TDG in the tailrace cannot exceed 125% for one hour or 2) 120% for 12 continuous hours (12C-High), and 3) TDG in the downstream Rocky Reach forebay cannot exceed 115% 12C-High. These compliance criteria are waived when flows exceed the 10-year flood flow volume (7Q-10 = 246 kcfs) or when incoming water is out of compliance (>115% TDG 12C-High) in the Wells Dam forebay.

***Wells Tailrace 125% hourly standard***

In the Wells Dam tailrace, the hourly average TDG value exceeded 125% for 996 hours on 51 of 137 days during the spill season. On 96% of the days where hourly TDG values exceeded 125% (49 of 51 days), hourly average flow values exceeded 246 kcfs (7Q-10 flood flows at Wells Dam). On the remaining 2 days when flows were less than 246 kcfs, TDG in the Wells forebay exceeded 115%.

Of the 67 days when Wells forebay 12C-High TDG was below 115% and flows were below 7Q-10, measured values show the highest hourly average did not exceed 125% on 65 days. On July 21, the tailrace (WELW) sensor went offline due to an equipment malfunction. A calculated estimate of TDG based upon the spill/flow equation for Wells Dam, using the highest hourly spill percentage of 23% at 181.8 kcfs, generated a maximum hourly TDG between 117.7 – 121.2% (n = 11 July hourly observations 23-24% spill percentage, 187-226.8 kcfs).

Measured compliance with this standard was 97.0% (65/67 days), with probable compliance of 100%.

***Wells Tailrace 120% 12C-High standard***

The 12C-High TDG value in the tailrace exceeded 120% on 65 of 137 days. Of those 65 days, daily average flows were above 246 kcfs/ 7Q-10 flood flow for 31 days. On the remaining 34 days, when daily average flows were less than 246 kcfs, 12C-High TDG in the Wells forebay exceeded 115% on 32 days. The remaining 2 days had 12C-High Wells forebay TDG slightly below 115% (114.2-114.8%). In total, there were 74 days (137-63=74 days) where flows were below 7Q-10 and incoming Wells forebay TDG was less than the 115% criterion.

Measured compliance with this standard was 97.3% (72/74 days).

***Rocky Reach Forebay 115% 12C-High standard***

The 12C-High TDG value in the Rocky Reach forebay exceeded 115% on 77 of 137 days. Of the 77 days when the standard was exceeded in the Rocky Reach forebay, daily average flows exceeded 7Q-10 on 34 days. Of the remaining 43 days, Wells forebay exceeded 115% TDG on 39 days. On the 4 days when incoming TDG in the Wells forebay was below 115%, the Wells Project exceeded the TDG standard in the Rocky Reach forebay. These exceedances occurred May 16-18 and July 20. In total, there were 64 days (137-73=64 days) where flows were below 7Q-10 and incoming Wells forebay TDG was less than the 115% criterion.

Compliance with this standard was 93.8% (60/64 days).

At the Wells Project, average compliance for all three TDG standards was 96.0% during the 2011 fish passage season. This is exceptionally high compliance, given that it was the third highest flow year on record, and with two turbine units off line due to unscheduled maintenance.

#### 3.4.3 Compliance During Non-Fish Passage Period

During the non-fish passage period (January 1 to April 11 and August 27 to December 31), TDG is not measured at the Wells forebay and tailrace fixed monitoring stations. Non-spill flows at Wells Dam (through the turbine units and fishways) generate little to no additional dissolved gas. Spill outside the fish passage adjustment period is uncommon, but was higher in 2011 than most years. During the non-fish passage period to date, January 1-April 11 and August 27-October 31, spill occurred during 236 hourly periods, representing 5.9% of the non-fish spill period through October 31. Spill volumes ranged from 0.4 to 67.8 kcfs.

# 4 DISCUSSION OF GAS ABATEMENT MEASURES

## 4.1 Operational

In 2011, high spring and early summer river flows throughout the Columbia River basin resulted in flows at Wells Dam that were the third-highest on record. Spill at the Wells Project started early, peaked early and has been almost twice the long-term historic average. Average monthly discharge at Wells Dam was greater in all spill season months (April to August) than the 16-year averages (1995-2010). In the months of May, June and July, average monthly discharge was above 200 kcfs. In addition, the June monthly average was above the 7Q-10 flood flows of 246.0 kcfs (Table 2); a threshold above which the Wells Project is not required to meet with Washington State WQS for TDG. During spill season, there were a total of 34 days (24.8%) when daily average flows at Wells Dam were above 7Q-10 flood flows. As a result of high flows, increased spill volumes throughout the Mid-Columbia system resulted in prolonged, elevated levels of TDG. An in-season TDG analysis conducted by Douglas PUD per request by Ecology identified that the operation of Grand Coulee Dam was the primary source of elevated TDG entering Wells Dam and the Mid-Columbia system (Figure 3).

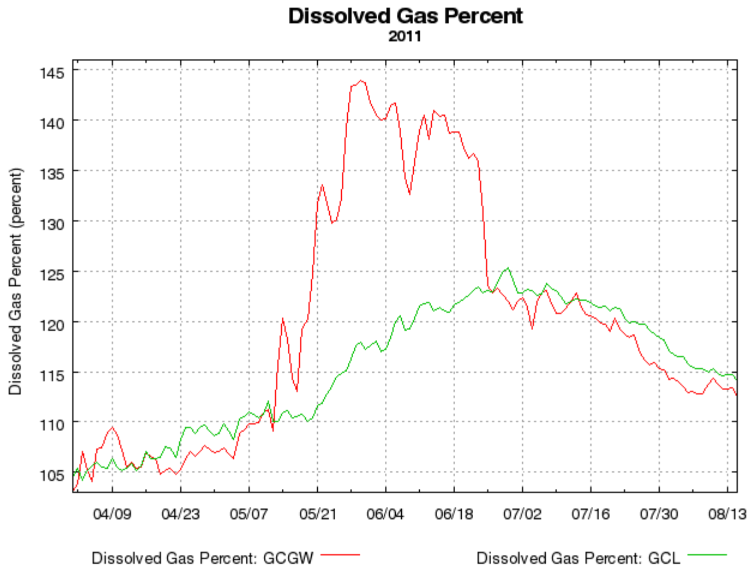



**Figure 3.** Columbia River TDG above and below Grand Coulee Dam, April 1 – August 15 2011. GCL (also known as "FDRW") is located in the Grand Coulee Dam forebay at RM 597. GCGW is located in the Grand Coulee Dam tailwater at RM 591, approximately six miles downstream.

At Grand Coulee Dam, spill operations produced TDG levels ranging from 120% to above 140% between mid-May and mid-July. Although spill onto deflectors at the downstream Chief Joseph Dam (the next downstream facility) strips some dissolved gases from the flow below Grand Coulee, TDG levels in the Wells Dam forebay were consistently above the 115% forebay compliance criteria. During the spill season, incoming waters to Wells Dam were above the 115% TDG waiver criteria a total of 75 out of 137 days (54.7%). Compliance with the TDG standards is not required when water reaching the Project forebay exceeds the TDG standard of 115%.

Since the completion of spill deflectors at Chief Joseph Dam in 2008, there has been a shift in federal spill operations to upstream facilities resulting in a significant increase in the amount of spill at Grand Coulee and Chief Joseph dams. This recent increase in the amount of spill has resulted in a dramatic increase in the volume of water that is supersaturated with TDG entering the Mid-Columbia system. This mass influx of supersaturated water has resulted in significantly higher TDG concentrations observed in the forebay of Wells Dam.

Douglas PUD implemented the Ecology approved GAP during the entire 2011 spill season utilizing the lessons learned during previous years of spill study at the Wells Project. The 2011 spill playbook was an important element in managing TDG at Wells during the 2011 fish passage season. During periods when Wells Project flows were below the 7Q-10 flood flows and forebay TDG levels were within compliance with the TDG standard (<115%), Douglas PUD's average compliance rate for all three TDG waiver standards was 97.5%. These results are exceptional, considering that river flows were the third highest on record, and that Wells Dam had two units out of service from the beginning of the spill season, until July 26.

## 4.2 Structural

No permanent structural modifications were proposed or conducted in the 2011 monitoring season. Removal of the bypass barrier structures in Spillway 6 was implemented consistent with the 2011 Spill Playbook.

# 5 CONCLUSIONS

With the operation of spill deflectors at Chief Joseph Dam in recent years and shifting spill operations by the USACE to this facility and Grand Coulee Dam upstream, there has been an increasing trend of flows with higher levels of TDG entering the Wells Project. In 2011, large volumes of spill at Grand Coulee Dam resulted in a high frequency of flows with TDG levels out-of-compliance (<115%) entering the Wells Project. Additionally, there were numerous days (34) when flows at Wells Dam were above the 7Q-10 flood flow. In consideration of these conditions, Douglas PUD, through the implementation of its spill playbook, achieved 97.5% compliance with the TDG waiver standards. Furthermore, an evaluation of the TDG performance at Wells Dam, regardless of regulatory conditions (i.e., 7Q-10 flood flows and <115% forebay TDG), indicate that spill at Wells Dam increased TDG values by 4.8% when comparing the data collected in the Wells forebay and Wells tailrace. When incoming forebay TDG values ranged from 115% to 130%, spill at Wells Dam increased TDG by 7.1%.

If Chief Joseph Dam could attain the non-fish passage WQS criteria of 110%, then the Wells Project would be able to fully comply with the WQS standard. Regardless of these observations, TDG performance at Wells Dam was exceptional in 2011 given the extreme levels of flow recorded and number of turbine units unavailable during the fish passage spill season. These results support the continued implementation of the spill playbook to manage TDG production through operational means, and suggest future operational performance should result in even higher rates of TDG standards compliance in future years under more normal 90% unit availability.

# 6 REFERENCES

Bickford, S. A., J. R. Skalski, R. Townsend, S. McCutcheon, R. Richmond, R. Frith and R. Fechhelm. 2001. Project survival estimates for yearling summer steelhead migrating through the Wells Hydroelectric Facility, 2000.

Bickford, S. A., T. Kahler, R. Townsend, J. R. Skalski, R. Richmond, S. McCutcheon and R. Fechhelm. 2011. Project survival estimates for yearling Chinook migrating through the Wells Hydroelectric Project, 2010 (2010 spring migrant survival verification study).

EES Consulting, Carroll, J., ENSR, and Parametrix. 2007. Total Dissolved Gas Production Dynamics Study. Wells Hydroelectric Project. FERC No. 2149. Prepared by EES Consulting, Joe Carroll, ENSR, and Parametrix. Environmental Protection Agency (EPA). 1976. Quality Criteria for Water. PB-263943.

Gingerich, A., and B. Patterson. 2011 Draft. Douglas PUD Gas Bubble Trauma Biological Monitoring. 2011. Wells Hydroelectric Project. FERC No. 2149. Public Utility District No. 1 of Douglas County, East Wenatchee, WA.

National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.

Patterson B., and A. Gingerich. 2011. Memorandum to Pat Irle, Washington Department of Ecology re: Evaluation of TDG at Wells Dam, 2011 mid-season analysis. August 17, 2011.

Pickett, P., H. Rueda, M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Washington Department of Ecology, Olympia, WA. U.S. Environmental Protection Agency, Portland, OR. June 2004. Publication No. 04-03-002.

Politano, M., A. Arenas Amado and L. Weber. 2009. An Investigation into the Total Dissolved Gas Dynamics of the Wells Project (Total Dissolved Gas Evaluation). Report prepared by IIHR-Hydroscience & Engineering, University of Iowa, Iowa City, Iowa.

Skalski, J. R., G.E. Johnson, C.M. Sullivan, E. Kudera, and M.W. Erho. 1996. Statistical evaluation of turbine bypass efficiency at Wells Dam on the Columbia River, Washington. Canadian Journal of Fisheries and Aquatic Sciences 53:2188-2198.

# APPENDICES

**Appendix 1. Wells Project 2011 Gas Abatement Plan**

# 2011 TOTAL DISSOLVED GAS ABATEMENT PLAN

# WELLS HYDROELECTRIC PROJECT


Prepared by:

Bao Le
Long View Associates
Portland, Oregon

And

Beau Patterson
Public Utilities District No. 1 of Douglas County
East Wenatchee, Washington


Prepared for:

Pat Irle
Hydropower Projects Manager
Washington Department of Ecology
Yakima, Washington 98902-3452

**April 2011**

This page intentionally left blank

# Table of Contents

# List of Figures



# List of Tables



# List of Appendices

This page intentionally left blank

# Executive Summary

Under the Water Quality Standards (WQS) Chapter 173-201A of the Washington Administrative Code (WAC) criteria developed by the Washington Department of Ecology (Ecology), Total Dissolved Gas (TDG) measurements shall not exceed 110 percent at any point of measurement in any state water body. The standards state that a dam operator is not held to the TDG standards when the river flow exceeds the seven-day, 10-year-frequency flood (7Q10). In addition to allowances for natural flood flows, the TDG criteria may be adjusted to aid fish passage over hydroelectric dams when consistent with an Ecology-approved gas abatement plan. On a per-application basis, Ecology has approved a TDG adjustment to allow spill for juvenile fish passage past Columbia and Snake river dams (WAC 173-201A-200(1)(f)(ii)).

On the Columbia and Snake rivers there are three separate standards for the fish passage related TDG adjustment. TDG shall not exceed 125 percent in the tailrace of a dam, as measured in any one-hour period. TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream, as measured as an average of the 12 highest consecutive hourly readings in any one day (24-hour period). The increased levels of spill, resulting in elevated TDG levels, are intended to allow increased fish passage without causing more harm to fish populations than what would be caused by turbine fish passage. This TDG adjustment provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS) (NMFS 2000).

The goal of the Wells Total Dissolved Gas Abatement Plan (Gas Abatement Plan) is to implement a long-term strategy to achieve compliance with the Washington State WQS criteria for TDG in the Columbia River at the Wells Hydroelectric Project (Wells Project) while continuing to provide safe passage for downstream migrating juvenile salmonids. Public Utility District No. 1 of Douglas County (Douglas PUD), which owns and operates the Wells Project, is submitting this Gas Abatement Plan to Ecology for approval as required for receipt of a TDG adjustment at Wells Dam.

This page intentionally left blank

# 1.0 Introduction and Background

The Wells Hydroelectric Project Gas Abatement Plan (GAP) provides details on operational and structural measures to be implemented in 2011 by Public Utility District No. 1 of Douglas County, Washington (Douglas PUD) at Wells Dam under the FERC license for Project No. 2149. These measures are intended to result in compliance with the modified Washington State water quality standards (WQS) for total dissolved gas (TDG) allowed under the TDG adjustment.

The goal of the GAP is to implement a long-term strategy to achieve compliance with the Washington State WQS for TDG in the Columbia River at the Wells Hydroelectric Project (Wells Project), while continuing to provide safe passage for downstream migrating juvenile salmonids. Douglas PUD is the owner and operator of the Wells Project and is submitting this GAP to the Washington Department of Ecology (Ecology) for approval as required for receipt of a TDG adjustment for fish passage.

Previously, Ecology has approved GAPs and issued a TDG exemption for the Wells Project. Douglas PUD submitted a GAP that was approved on March 27, 2003 for one year. In 2004, an extension was granted by Ecology. On March 31, 2005, Ecology approved Douglas PUD's 2005 GAP allowing a TDG adjustment in support of fish passage through February 2008. Since 2008, Douglas PUD has submitted GAPs for the fish passage season annually. The most recent GAP was approved by Ecology in 2010 (Appendix 1).

This GAP contains three sets of information. Section 1.0 summarizes the background information related to regulatory and project specific TDG information at the Wells Project. Proposed Wells Project operations and activities related to TDG management are contained in Sections 2.0 and 3.0. Section 4.0 provides a summary of compliance and physical monitoring plans, quality assurance and quality control procedures, and reporting.

## *1.1 Project Description*

The Wells Project is located at river mile (RM) 515.6 on the Columbia River in the State of Washington (Figure 1). Wells Dam is located approximately 30 river miles downstream from the Chief Joseph Hydroelectric Project, owned and operated by the United States Army Corps of Engineers (USACE); and 42 miles upstream from the Rocky Reach Hydroelectric Project owned and operated by Public Utility District No. 1 of Chelan County (Chelan PUD). The nearest town is Pateros, Washington, which is located approximately 8 miles upstream from the Wells Dam.

The Wells Project is the chief generating resource for Douglas PUD. It includes ten generating units with a nameplate rating of 774,300 kW and a peaking capacity of approximately 840,000 kW. The spillway consists of eleven spill gates that are capable of spilling a total of 1,180 kcfs. The crest of the spillway is approximately five and a half feet above normal tailwater elevation and two feet below tailwater elevation when plant discharge is 219 kcfs. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. Fish passage facilities reside on both sides of the hydrocombine, which is 1,130 feet long, 168 feet wide, with a dam top elevation of 795 feet above mean sea level (msl). The juvenile fish bypass (JBS) system was developed by Douglas PUD and uses a barrier system to modify the intake velocities on all even numbered spillways (2, 4, 6, 8 and 10).  The Wells Project is considered a "run-of-the-river" project due to its relatively limited storage capacity.

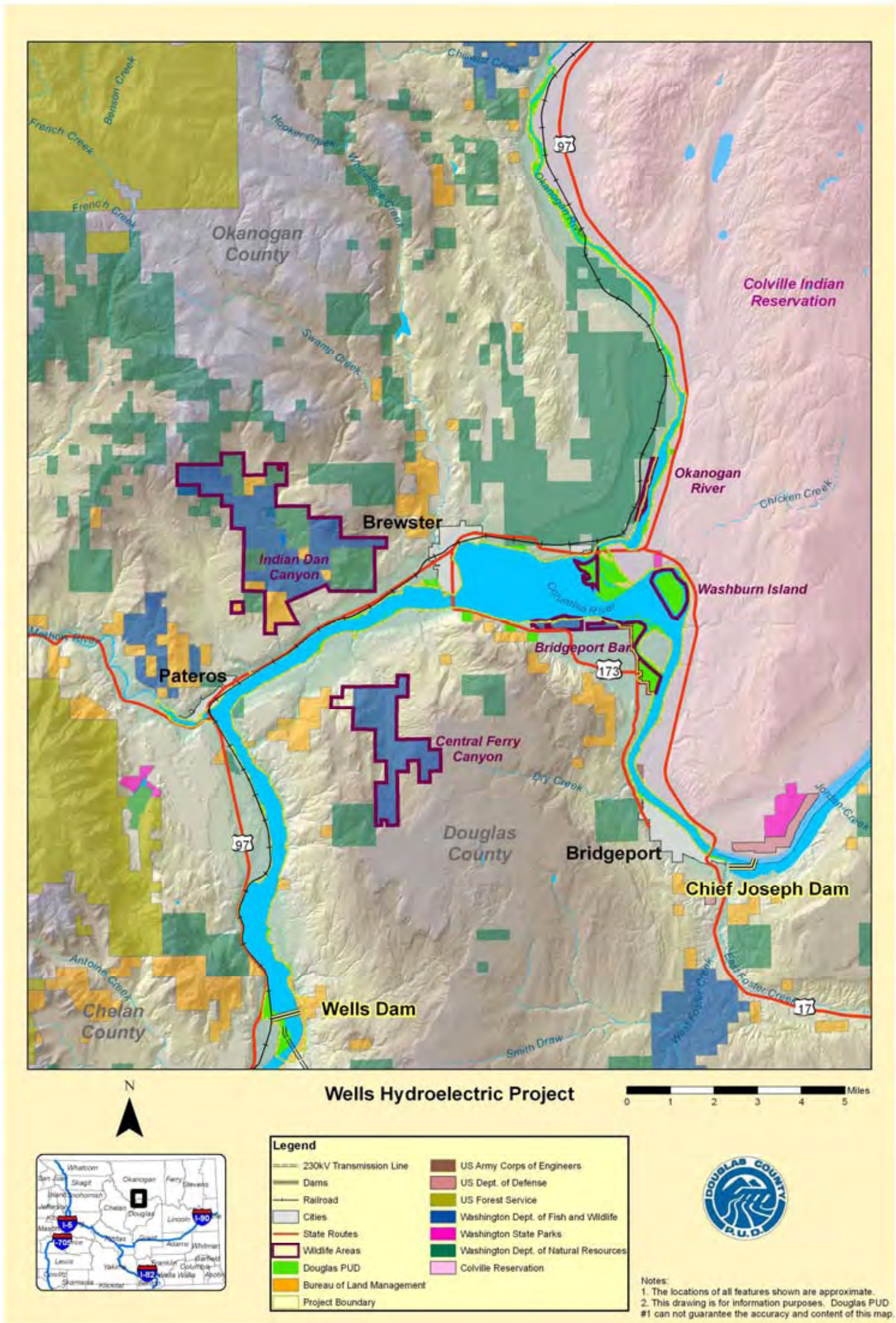



**Figure 1. Map of the Wells Hydroelectric Project in Central Washington.**

The Wells Reservoir is approximately 30 miles long.  The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir.  The Wells Project boundary extends approximately 1.5

miles up the Methow River and approximately 15.5 miles up the Okanogan River. The surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet and usable storage of 97,985 acre-feet at the normal maximum water surface elevation of 781 feet.

## 1.2 Regulatory Framework

The WQS of the Washington Administrative Code (WAC) define standards for the surface waters of Washington State.

Under the WQS, TDG shall not exceed 110 percent at any point of measurement in any state water body. However, the standards exempt dam operators from this TDG standard when the river flow exceeds the seven-day, 10-year-frequency flood (7Q10). The 7Q10 flow is the highest calculated flow of a running seven consecutive day average, using the daily average flows that may be seen in a 10-year period. The 7Q10 total river flow for the Wells Project was computed using the hydrologic record from 1974 through 1998, coupled with a statistical analysis to develop the number from 1930 through 1998. These methods follow the United States Geological Survey (USGS) Bulletin 17B, “Guidelines for Determining Flood Flow Frequency” and determined that the 7Q10 flow at Wells Dam is 246,000 cfs (Pickett et. al. 2004).

In addition to allowances for natural flood flows, the TDG criteria may be adjusted to aid fish passage over hydroelectric dams when consistent with an Ecology-approved gas abatement plan. This plan must be accompanied by fisheries management and physical and biological monitoring plans. Ecology may approve, on a per application basis, an interim adjustment to the TDG standard (110 percent) to allow spill for juvenile fish passage past dams on the Columbia and Snake rivers (WAC 173-201A-200(1)(f)(ii)). This adjustment comprises three separate standards to be met by dam operators. TDG shall not exceed 125 percent in any one-hour period in the tailrace of a dam. Further, TDG shall not exceed 120 percent in the tailrace of a dam and shall not exceed 115 percent in the forebay of the next dam downstream as measured as an average of the 12 highest consecutive hourly readings in any 24-hour period (12C High). The increased levels of spill resulting in elevated TDG levels are authorized by Ecology to allow salmonid smolts a non-turbine downstream passage route that is less harmful to fish populations than caused by turbine fish passage. This TDG exemption provided by Ecology is based on a risk analysis study conducted by the National Marine Fisheries Service (NMFS) (NMFS 2000).

A significant portion of the Wells Reservoir occupies lands within the boundaries of the Colville Indian Reservation. Wells Project operations do not affect TDG levels in tribal waters, where Tribes’ TDG standard is a maximum of 110%, year-round, at all locations. This TDG standard is also EPA’s standard for all tribal waters on the Columbia River, from the Canadian border to the Snake River confluence. TDG levels on the Colville Reservation portion of the mainstem Columbia River within Wells Reservoir result from the operations of the upstream Chief Joseph Dam.

### 1.2.1 7Q10

The 7Q10 flood flow at the Wells Project is 246 kcfs. The Project is not be required to comply with state WQS for TDG when incoming flows exceed this value.

### 1.2.2 Fish Spill Season

For purposes of compliance with the WQS for TDG, the "fish spill" season is April 1 through August 31; and "non-fish spill" season occurs from September 1 to March 31. During non-fish spill, Douglas PUD will make every effort to remain in compliance with the 110 percent standard. During fish spill, Douglas PUD will make every effort not to exceed an average of 120 percent as measured in the tailrace of the dam. TDG at the Wells Project also must not exceed an average of 115 percent as measured in the forebay of the next downstream dam (Rocky Reach). These averages are calculated using the twelve (12) highest consecutive hourly readings in any 24-hour period. In addition, there is a maximum one-hour average of 125 percent, relative to atmospheric pressure, during fish spill season. Nothing in these special conditions allows an impact to existing and characteristic uses.

### 1.2.3 Incoming TDG Levels

Compliance with the TDG standards is not required when water reaching the Project forebay exceeds the TDG standard. During the fish spill season, TDG concentrations in the Wells Project forebay are primarily determined by the USACE's upstream water management activities at Chief Joseph Dam.

Since the completion of spill deflectors at Chief Joseph Dam in 2008, there has been a significant increase in the amount of spill at the Chief Joseph Project resulting from FCRPS-wide operations. This recent increase in the amount of spill at Chief Joseph Dam has resulted in a dramatic increase in the volume of water that is supersaturated with TDG. This mass influx of supersaturated water has resulted in significantly higher TDG concentrations observed in the forebay of Wells Dam.

Despite the total lack of fish passage at Chief Joseph Dam, the US Army Corps of Engineers has operated under the assumption that the fish passage TDG adjustment approved by Ecology applies to all FCRPS dams, rather than the eight dams with fish passage in the lower Snake and Columbia rivers. Douglas PUD does not believe that the fish passage adjustment is authorized for Chief Joseph Dam by Ecology, and that the USACE is out of compliance with Washington state WQS, as well as the EPA TDG standard and the Colville Tribe's TDG standard, whenever TDG in the Chief Joseph Dam tailrace exceeds 110%.

#### 1.2.3.1 TMDL

In June 2004, a total maximum daily load (TMDL) was jointly established for the Mid-Columbia River and Lake Roosevelt by Ecology, the Spokane Tribe of Indians, and the U.S. Environmental Protection Agency (EPA)(Ecology et al. 2004). EPA's issuance covers all waters above Grand Coulee Dam, and all tribal waters; EPA's TMDL covers all tribal waters of the Colville Confederated Tribes, including the right bank of the Columbia River from Chief Joseph Dam downstream to the Okanogan River confluence. Ecology's issuance covers all state waters downstream from Grand Coulee Dam to the Snake River confluence.

A summary implementation strategy prepared by Ecology and the Spokane Tribe of Indians describes proposed measures that could be used to reduce TDG levels in the Columbia River. Short-term actions primarily focus on meeting Endangered Species Act (ESA) requirements, while long-term goals address both ESA and TMDL requirements (Pickett et. al., 2004). Many of the recommended TMDL actions are currently being addressed by Douglas PUD through the implementation of Habitat Conservation Plan (HCP) activities for anadromous salmon, the Bull Trout Monitoring and Management Plan resulting from consultation with the U.S. Fish and Wildlife Service, and requirements described in current and past GAPs.

The Wells Project occupies waters both upstream and downstream of the Okanogan River. In waters upstream of the Okanogan River, the TMDL does not provide an exemption for fish passage spills (except as a temporary waiver or special condition as part of the short-term compliance period, as described in the Implementation Plan, Appendix A of the TMDL). Downstream of the Okanogan River, allocations are provided based on both the 110% criteria and the criteria established for fish passage in the Washington State water quality standards. Any allocations or exemptions for fish passage downstream of the Okanogan River may be used only after approval of a gas abatement plan (Ecology et al. 2004).

## *1.3 History of Operations and Compliance*

### 1.3.1 Flows

Flow from the Columbia River originates in the headwaters of the Canadian Rockies and picks up snow melt from tributary streams as it travels over 1,243 miles before emptying into the Pacific Ocean. There are 85,300 square miles of drainage area above Wells Dam. The natural hydrograph had low flows in November through January with high flows in May through July. Storage dams on the Columbia River and its tributaries upstream of the Wells Project in the U.S. and Canada capture spring and summer high flows to hold for release in the fall and winter months. Table 1 presents information on Columbia River flow, as measured at Wells Dam from 2001 to2010, and shows that the current hydrograph of the Columbia River is controlled by upstream storage and release regimes. Juvenile anadromous salmonid migration occurs within a regime of reduced high flows during the spring migration period.

In general, the hydropower system and reservoir operations in the Columbia River are coordinated through a set of complex agreements and policies that are designed to optimize the benefits and minimize the adverse effects of project operations. The Wells Project operates within the constraints of the Pacific Northwest Coordination Agreement, Canadian Treaty, Canadian Entitlement Agreement, Hourly Coordination Agreement, the Hanford Reach Fall Chinook Protection Program and the Federal Energy Regulatory Commission (FERC) regulatory and license requirements.

Table 1. Average monthly flows (kcfs) at Wells Dam, by month (2001-2010).

| | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 2001 | 96.5 | 88.2 | 73.8 | 62.9 | 55.2 | 84.5 | 53.4 | 70.3 | 62.5 | 56.1 | 70.9 | 79.1 |
| 2002 | 91.0 | 91.9 | 66.1 | 116.9 | 135.0 | 205.6 | 176.5 | 115.1 | 73.9 | 79.4 | 96.7 | 93.3 |
| 2003 | 75.7 | 69.9 | 82.2 | 106.7 | 130.7 | 137.6 | 106.2 | 96.4 | 64.0 | 74.6 | 87.7 | 105.5 |
| 2004 | 96.2 | 80.5 | 70.0 | 87.3 | 114.2 | 132.3 | 101.5 | 95.7 | 75.7 | 79.3 | 90.9 | 112.0 |
| 2005 | 102.0 | 104.4 | 94.9 | 85.4 | 122.1 | 130.8 | 136.8 | 107.9 | 67.6 | 78.5 | 90.9 | 91.8 |
| 2006 | 101.2 | 104.5 | 87.3 | 148.4 | 165.3 | 195.1 | 127.9 | 103.9 | 66.3 | 66.3 | 77.1 | 90.8 |
| 2007 | 114.5 | 85.3 | 120.3 | 154.7 | 159.2 | 152.0 | 133.0 | 113.1 | 60.0 | 64.4 | 80.2 | 86.8 |
| 2008 | 104.0 | 88.6 | 82.4 | 90.3 | 158.7 | 206.8 | 135.3 | 86.5 | 60.7 | 63.0 | 75.2 | 94.2 |
| 2009 | 107.8 | 80.2 | 71.5 | 111.0 | 122.7 | 146.6 | 103.1 | 74.5 | 53.5 | 58.1 | 80.1 | 101.8 |
| 2010 | 71.1 | 72.1 | 65.2 | 70.7 | 112.2 | 173.0 | 119.9 | 83.6 | 53.8 | 67.7 | 85.8 | 86.2 |
| All | 96.0 | 86.3 | 81.4 | 103.4 | 127.6 | 156.4 | 119.4 | 94.7 | 63.8 | 68.7 | 83.5 | 93.7 |

## 1.3.2 Spill Operations

### 1.3.2.1 General Operation

The Hourly Coordination Agreement is intended to integrate power operations for the seven dams from Grand Coulee to Priest Rapids. "Coordinated generation" is assigned to meet daily load requirements via Central Control in Ephrata, WA. Automatic control logic is used to maintain pre-set reservoir levels to meet load requirements and minimize involuntary spill. These pre-set reservoir levels are maintained at each project via management of a positive or negative "bias". Positive or negative bias assigns a project more or less generation based on its reservoir elevation at a given time and thus, maximizes system benefits and minimizes involuntary spill.

### 1.3.2.2 Spill for Fish

Wells Dam is a hydrocombine design where the spillway is situated directly above the generating units. Research at Wells Dam in the mid-1980s showed that a modest amount of spill effectively guided a high percentage of the downstream migrating juvenile salmonids through the Juvenile Bypass System (JBS). The operation of the Wells JBS utilizes the five even-numbered spillways. These spillways have been modified with constricting barriers to improve the attraction flow while using modest levels of water. These spillways are used to provide a non-turbine passage route for downstream migrating juvenile salmonids from April through August. Normal operation of the JBS uses 10 kcfs. During periods of extreme high flow, one or more of the JBS barriers may be removed to provide adequate spill capacity to respond to a plant load rejection.

Typically, the JBS will use approximately 6 to 8 percent of the total river flow for fish guidance. Between the years 1997 and 2004, the volume of water dedicated to JBS operations has ranged from 1.5 to 3.2 million acre-feet annually. The operation of the JBS adds a small amount of TDG (0 – 2 percent) while meeting a very high level of fish guidance and protection. This high level of fish protection at Wells Dam has met the approval of the fisheries agencies and tribes and is vital to meeting the survival performance standards contained within the FERC-approved HCP with NMFS. The Wells Project JBS is the most efficient system on the mainstem Columbia River. The bypass system on average collects and safely passes 92.0 percent of the spring migrating salmonids (yearling Chinook, steelhead and sockeye) and 96.2 percent of the summer migrating subyearling Chinook (Skalski et al. 1996) (Table 2).

**Table 2. Wells Hydroelectric Project Juvenile Bypass Efficiency.**

| Species | % JBS Passage |
|---|---|
| Yearling (spring) Chinook | 92.0 |
| Steelhead | 92.0 |
| Sockeye | 92.0 |
| Subyearling (summer/fall) Chinook | 96.2 |

The JBS is used to protect downstream migrating juvenile salmonids. Fish bypass operations at Wells Dam falls into two seasons, Spring Bypass and Summer Bypass. For 21 years, the status of the fish migration for both spring and summer periods was monitored by an array of hydroacoustic sensors placed in the forebay of Wells Dam. Since 2003, the operation period for the juvenile bypass has been from April 12 through August 26, and is based on these 21 years of hydroacoustic and fyke net data. These dates bracket the run timing of greater than 95% of both the spring and summer migrants. Annually, as many as ten million juvenile salmonids have migrated past Wells Dam.

#### 1.3.2.3 Flows in Excess of Hydraulic Capacity

The Wells Project is a "run-of-the river" project with a relatively small storage capacity. River flows in excess of the ten-turbine hydraulic capacity must be passed over the spillways.

The forebay elevation at Wells Dam is maintained between 781.0 and 771.0 msl. The Wells Project has a hydraulic generating capacity of approximately 220 kcfs (ASL, 2007) and a spillway capacity of 1,180 kcfs. Data for Columbia River flows for eighty-five years at Priest Rapids yielded a peak daily average discharge of 690 kcfs on June 12, 1948 (USGS web page for historical flows at Priest Rapids on the Columbia River, http://waterdata.usgs.gov/wa/nwis/dv/?site_no=12472800). The hydraulic capacity of Wells Dam is well within the range of recorded flow data.

#### 1.3.2.4 Flow in Excess of Power Demand

Spill may occur at flows less than the Wells Project hydraulic capacity when the volume of water is greater than the amount required to meet electric power system loads. This may occur during temperate weather conditions and when power demand is low or when non-power constraints on river control results in water being moved through the Mid-Columbia at a different time of day than the power is required (i.e. off-peak periods). Hourly coordination (Section 3.2) between hydroelectric projects on the river was established to minimize this situation for spill. Spill is in excess of power demand provides benefit to migration juvenile salmonids. Fish that pass through the spillway survival at a higher rate relative to passage through a turbine and the turbulence in the tailrace generated by spill in excess of power demand increases tailrace velocity and reduces tailrace egress times. The reductions in tailrace egress time and increases in water turbulence and velocity reduce predation in the Wells tailrace.

#### 1.3.2.5 Gas Abatement Spill

Gas Abatement Spill is used to manage TDG levels throughout the Columbia River Basin. The Technical Management Team (including NMFS, USACE, and Bonneville Power Administration [BPA]) implements and manages this spill. Gas Abatement Spill is requested from dam operators from a section of the river where gas levels are high. A trade of power generation for spill is made between operators, providing power generation in the river with high TDG and trading an equivalent amount of spill from a project where TDG was low. Historically, the Wells Project has accommodated requests to provide Gas Abatement Spill. In an effort to limit TDG generated at the Wells Project, Douglas PUD has adopted a policy of not accepting Gas Abatement Spill at Wells Dam.

#### 1.3.2.6 Other Spill

Other spill includes spill as a result of maintenance or plant load rejection. A load rejection occurs when the generating plant is forced off-line by an electrical fault, which trips breakers and shuts off the generation. At a run-of-the-river hydroelectric dam, if water cannot flow through operating turbines, then the river flow that was producing power has to be spilled until turbine operation can be restored. These events are extremely rare, and would account for approximately 10 minutes in every ten years.

Maintenance spill is utilized for any activity that requires spill to assess the routine operation of individual spillways and turbine units. These activities include checking gate operation, and all other maintenance that would require spill. The FERC requires that all spillway gates be operated once per year. To control TDG levels associated with maintenance spill, Douglas PUD limits, to the extent practical, maintenance spill during the spill season.

### 1.3.3 Compliance Activities in Previous Year

#### 1.3.3.1 Operational

Since the Wells Project is a “run-of-the river” project with a relatively small storage capacity, river flows in excess of the ten-turbine hydraulic capacity must be passed over the spillways. Outside of system coordination and gas abatement spill (Douglas PUD has adopted a policy of not accepting the latter), minimization of involuntary spill has primarily focused on minimizing TDG production dynamics of water spilled based upon a reconfiguration of spillway operations. The Wells Project 2009 GAP (Le and Murauskas, 2009) introduced the latest numerical model developed by the University of Iowa’s IIHR-Hydroscience and Engineering Hydraulic Research Laboratories. The two-phase flow computational fluid dynamics tool was used to predict hydrodynamics of TDG distribution within the Wells Dam tailrace and further identify operational configurations that would minimize TDG production at the project. In an April 2009 report, the model demonstrated that Wells Dam can be operated to meet the TDG adjustment criteria during the passage season with flows up to 7Q-10 levels (246,000 cfs; Pickett et. al. 2004). Compliance was achieved through the use of a concentrated spill pattern through Spillbay No. 7

and surplus flow volume through other spillbays in a defined pattern and volume. These preferred operating conditions create surface-oriented flows by engaging submerged spillway lips below the ogee, thus increasing degasification at the tailrace surface, decreasing supersaturation at depth, and preventing high-TDG waters from bank attachment. These principles were the basis of the 2009 Wells Project Spill Playbook and were fully implemented for the first time during the 2009 fish passage (spill) season with success. Overall, no exceedances were observed in either the Wells Dam tailrace or the Rocky Reach forebay in 2009.

In 2010, the concepts from the 2009 Spill Playbook were integrated into the 2010 Wells Project Spill Playbook given their effectiveness in maintaining levels below TDG criteria during the previous year. High Columbia River flows in June, which exceeded the preceding 15-year average flow, resulted in several exceedances of the hourly (125% maximum) and 12C-High (120%) TDG limits in the Wells Dam tailrace, and Rocky Reach forebay (115% max). In response, Douglas PUD implemented an in-season analysis of the 2010 Spill Playbook and determined that full implementation of the recommendations from IIHR Engineering Laboratory would require the removal of the juvenile fish bypass system flow barriers in one spillbay. Following the in-season analysis and consultation with the HCP Coordinating Committee, changes were made to the 2010 Spill Playbook that allowed for the removal of the juvenile fish bypass system barriers in spillbay 6. Specifically, the Spill Playbook was modified to state that when spill levels approach the 53 kcfs threshold, the JBS barriers in spillbay 6 would be removed in order to remain in compliance with the TDG criteria in the Wells Dam tailrace and Rocky Reach Dam forebay. When spill exceeded 53 kcfs, excess spill would be directed through spillbays 6 and 7 rather than through spillbays 5 and 7. This operational configuration resulted in a more compact spill pattern that reduced the air-water interface surface area between spillway flows and the subsequent potential for lateral mixing and air entrainment.

River flows in 2010 were below average compared to the trailing 10-year average at the Wells Project (Table 3), with the exception of higher than average June flows. Flow in 2010 was most similar to 2003-2005, and 2008-2009 (Table 4). These low flow years typically begin with average flows around 100 kcfs in April, gradually increasing to 130-150 kcfs in May and June, and tapering off to below 70 kcfs in September.

Two significant observations were noted regarding compliance in 2010: (1) Unexpected June flows coupled with reduced operational flexibility created significant challenges for the Federal Columbia River Power System (FCRPS); and, (2) spill operations at Chief Joseph Dam in support of the FCRPS has contributed to the 2010 TDG exceedances at Wells Dam..

In expectation of a drought year, BPA had reduced discharge from Grand Coulee in May and early June and filled Grand Coulee storage reservoir one month earlier than normal. The subsequent heavy rain events in June resulted in unanticipated high flow volumes and, in addition, required some drafting of Grand Coulee Reservoir. These unexpected elevated flows created significant challenges for the operations of the FCRPS (BPA 2010) and the mid-Columbia PUDs.

In addition to accommodating high flows while meeting load requirements and Clean Water Act and Endangered Species Act requirements, Federal operators and BPA are also tasked with integrating approximately 3,000 megawatts of wind power resulting from renewable portfolio standards in Washington, Oregon, and California. This rapid increase in wind power requires balancing reserves to wind generators, which now consumes a significant portion of the operational flexibility of the FCRPS. In June, during the heavy rain events, wind power fluctuated between zero and almost full output as storms blew through the region. Loads remained fairly flat and low due to cool weather. Variable generation from wind, relatively low demands for electricity, and reduced operational flexibility of the system combined to create higher levels of involuntary spill. As part of the FCRPS GAP, involuntary spill is spread incrementally across all federally owned projects to prevent excessively high total dissolved gas levels. While not part of the criteria adjustment requested for the eight mainstem fish passage projects, the GAP includes spill at Grand Coulee and Chief Joseph dams as operational measures to manage TDG levels in the Columbia River that result from involuntary spill. During this time period, flow deflectors at Chief Joseph Dam increased allowable spill from 20 kcfs to 100 kcfs (BPA 2010).

At Wells Dam, river flows in June were approximately 4% higher than the 16-year average. June was the only month in 2010 where monthly flows were greater than the 16-year average. During the latter half of June, incoming flows to Wells Dam were often above 200 kcfs and on nine occasions, hourly flows exceeded the 7Q-10 value of 246 kcfs. Incoming TDG levels during this time period consistently ranged between 110-114% as Chief Joseph Dam spilled higher volumes of water. The outage of Unit 7 for generator rebuild at Wells Dam resulted in less generating capacity and may have contributed to the need to spill additional water. Outage of Unit 7 likely also contributed to higher TDG by not supporting the surface jet for spill discharged from spillbay 7. These factors high flow volumes and relatively high incoming TDG resulted in the several observed exceedances of the 125% hourly criterion (3 exceedances) and 12C-High 120% criterion (4 exceedances) in the Wells Dam tailrace, and the 12C-High 115% criterion in the Rocky Reach Forebay (8 exceedances) despite implementation of the initial 2010 Spill Playbook. However, it is important to note that after the in-season analysis and modification to the Spill Playbook, only 1 exceedance (in the Rocky Reach forebay) was observed for the remainder of the fish passage season.

Despite the lack of fish passage facilities at Chief Joseph Dam, the USACE has operated under TDG adjustments for fish passage during Phase 1 of the TDG TMDL implementation (Ecology et al. 2004). In 2011, Chief Joseph Dam should begin to operate under Phase 2 of the TDG TMDL, as operational and structural changes to meet compliance with a $\Delta P$ load allocation of 73 mm Hg have been completed. Compliance with the Chief Joseph Dam TDG load allocation will greatly facilitate compliance at Wells Dam and at other fish-passing downstream projects, as well as reducing exposure to elevated TDG of ESA-listed salmonids and other aquatic life.

**Table 3. 2010 river flows compared to 10-yr average flows (in kcfs). Spring is defined as April 12 – June 30. Summer is defined as July 1 – August 26.**

| Season | 10 Year (2001-2010)Average Flows (kcfs) | 2010 Average Flows | % of 10 Year Average |
|---|---|---|---|
| Spring | 129.1 | 118.6 | 91.9 |
| Summer | 107.0 | 85.8 | 80.2 |

**Table 4. Average hourly flow (kcfs) and TDG (percent saturation) during the fish spill season at the Wells Project (including tailrace and forebay) 2001-2010, by month. Years of similar river flow volume to 2010 are shaded for comparison.**

| | April | | May | | June | | July | | August | | All | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YR | Flow | TDG | Flow | TDG | Flow | TDG | Flow | TDG | Flow | TDG | Flow | TDG |
| 2001 | 63 | 107 | 55 | 109 | 85 | 107 | 53 | 110 | 70 | 107 | 65 | 107 |
| 2002 | 117 | 108 | 135 | 110 | 206 | 119 | 177 | 119 | 115 | 112 | 137 | 112 |
| 2003 | 107 | 106 | 131 | 109 | 138 | 112 | 106 | 112 | 96 | 108 | 107 | 109 |
| 2004 | 87 | 108 | 114 | 109 | 132 | 109 | 101 | 111 | 96 | 109 | 101 | 109 |
| 2005 | 85 | 107 | 122 | 109 | 131 | 111 | 137 | 111 | 108 | 108 | 109 | 108 |
| 2006 | 148 | 108 | 165 | 115 | 195 | 120 | 128 | 115 | 104 | 109 | 134 | 113 |
| 2007 | 155 | 109 | 159 | 112 | 152 | 112 | 133 | 112 | 113 | 108 | 129 | 110 |
| 2008 | 90 | 106 | 159 | 111 | 207 | 119 | 135 | 113 | 86 | 111 | 123 | 111 |
| 2009 | 111 | 107 | 123 | 110 | 147 | 113 | 103 | 114 | 75 | 110 | 102 | 110 |
| 2010 | 80 | 106 | 112 | 106 | 173 | 113 | 120 | 113 | 86 | 111 | 118 | 110 |
| All | 104 | 107 | 128 | 110 | 157 | 113 | 119 | 113 | 95 | 109 | 113 | 110 |

#### 1.3.3.2 Structural

No structural modifications are scheduled for the 2011 monitoring season, other than the removal of the JBS barriers in spillway 6 whenever spill is projected to exceed 53 kcfs for more than 8 hour.

#### 1.3.3.3 Biological Monitoring

The 2010 Wells Project GAP included the National Marine Fisheries Service (NMFS) recommendation to sample for Gas Bubble Trauma (GBT) in juvenile salmon when TDG levels exceed 125% saturation (NMFS 2000). In 2010, no hourly TDG readings at Wells Dam forebay or in the forebay of Rocky Reach Dam exceeded 125% saturation. In the Wells Dam tailrace, there were five instances where hourly TDG exceeded 125% saturation during the 2010 TDG monitoring season. Two observations occurred on June 17$^{th}$ (127.0%, 129.9%), one on June 22$^{nd}$ (125.3%), and two on June 29$^{th}$ (126.1%, 126.3%). There was no GBT monitoring following the June 17$^{th}$ event. On June 24$^{th}$ at 0800, Douglas PUD staff conducted GBT monitoring at Rocky Reach Dam in response to the June 22$^{nd}$ exceedance. Relatively few juvenile salmonid outmigrants were moving through the mid-Columbia River at this time. In total, four Chinook and 13 sockeye juveniles were sampled from the Rocky Reach bypass 0800-0900. No signs of GBT were observed. On the morning of June 30$^{th}$, Chelan PUD staff conducted GBT sampling on behalf of Douglas

PUD, in response to the June 29th exceedances. Three sockeye and 18 Chinook were examined with no sign of GBT observed.

### 1.3.4 Compliance Success in Previous Year (2010)

#### 1.3.4.1 TDG

River flows in 2010 were indicative of a low water year with the notable exception of late June, when several heavy rain events and warm spring time temperatures created high flows and elevated TDG values in the Snake and lower Columbia River. During the 2010 monitoring season, TDG in the forebay of Wells Dam did not exceed 115%. The TDG TMDL load allocation for Chief Joseph Dam during Phase 1 (2004-2010) may have allowed Chief Joseph Dam operators to use the fish passage adjustment criteria (Ecology et al. 2004), in which case they would have been in compliance with the TDG criterion for the Wells Dam forebay. On ten occasions, between June 11th and July 27th, 12C-High values reached 113-114% at various flow conditions; however, on none of these occasions did the 12-C High value exceed the 115% criterion.

In the Wells Dam tailrace, the TDG criterion of 120% was exceeded in the spring on 4 occasions; June 22nd, June 24th, June 26th, and June 29th (Table 5). Wells Dam tailrace 12C-High TDG values, which ranged from 120.5% to 123.2%, occurred during flow conditions ranging from 188.5 kcfs to 268.6 kcfs, the latter being above the 7Q-10 value for Wells Dam of 246.0 kcfs. In the forebay of Rocky Reach Dam, the 115% 12C-HighTDG criterion was exceeded on eight occasions (seven in the spring and once in the summer) (Table 5); June 22nd-June 25th, June 27th-June 30th, and July 2nd. 12C-High values ranged from 115.6% to 120.9%. There were five exceedances of the 125% hourly TDG criterion in the Wells tailrace, three of which occurred when flows were less than the 7Q10 flow of 246 kcfs. Exceedances occurred during flow conditions ranging from 169.6 kcfs to 257.9 kcfs.

As discussed in section 1.3.3.1, weather events generating unexpected high flows in June; FCRPS -wide spill operations implemented at Chief Joseph Dam; and BPA's integration of large amounts of wind power in the region were major contributing factors to higher than normal observed TDG values at the Wells Project in 2010. Despite such conditions, adaptive management of spill operations at Wells Dam via implementation of the modified Spill Playbook resulted in improved TDG performance and significant reductions in observed exceedances of the TDG criteria (1 observed exceedance after implementation of the modified Spill Playbook).

**Table 5. Summary of Spill and TDG Compliance in 2010. Spring is defined as April 12 – June 30. Summer is defined as July 1 – August 26.**

| Season | Average Daily % Spill | Average Daily Spill Volume (kcfs) | Wells Tailrace TDG Compliance (%) | Rocky Reach Forebay TDG Compliance (%) |
|---|---|---|---|---|
| Spring | 9.4 | 13.55 | 95 | 91 |
| Summer | 7.8 | 8.30 | 100 | 98 |

#### 1.3.4.2 Gas bubble trauma monitoring

Seven Chinook and 31 sockeye juveniles were examined at the Rocky Reach bypass sampling period following exceedances of the 125% hourly TDG standard in the Wells Dam tailrace. Each juvenile salmon was examined under magnification following sedation for evidence of bubbles in the eyes and non-paired fins, and along the lateral line. No evidence of gas bubble trauma was observed in any of the 38 fish examined. Sample sizes were small as sampling following exceedances occurred during periods of low abundance of smolts migrating downstream (L. Keller, Chelan PUD, personal communication). WDFW personnel operating the adult trapping facilities at Wells Dam were requested to monitor adults for GBT; however, no trapping occurred during this time period.

# 2.0 Proposed Operations and Activities

## *2.1 Operational Spill*

### 2.1.1 Minimizing Involuntary Spill

Based on the success of 2009 and 2010 operations associated with implementation of the Wells Project Spill Playbook, those operations will be followed again this year with minor modification.

As discussed in Section 1.3.3.1 above, high Columbia River flows in June 2010 resulted in several exceedances at the Wells Project resulting in an in-season analysis of the 2010 Spill Playbook. Following the analysis and in consultation with the HCP Coordinating Committee, the Spill Playbook was modified to state that when spill levels approach the 53 kcfs threshold, the JBS barriers in spillbay 6 would be removed to remain in compliance with the TDG criteria in the Wells Dam tailrace and Rocky Reach Dam forebay. When spill exceeds 30 kcfs through spillway 5, excess spill will be directed through adjacent spillbay 6, resulting in a more compact spill pattern that minimizes the air-water interface surface area between spillway flows and the subsequent potential for lateral mixing and air entrainment. In February 2011, Douglas PUD, in preparation for the upcoming fish passage season, conducted an additional technical analysis of the 2010 Spill Playbook (after in-season changes) and confirmed that continued implementation, with minor modifications, would be appropriate for 2011. The 2011 Spill Playbook is attached as Appendix 2.

## *2.2 Implementation*

### 2.2.1 Fisheries Management Plans

Juvenile salmon and steelhead survival studies conducted at the Wells Project in accordance with the HCP have shown that the operation of the Wells Project, of which the JBS is an integral part, provides an effective means for outmigrating salmon and steelhead to pass through the Wells Project with a high rate of survival (Bickford et al. 2001, Bickford et al. 2010 draft)(Table 6). The Wells Anadromous Fish Agreement and HCP (Douglas PUD 2002) is the Wells Project's fisheries management plan for anadromous salmonids, and directs operations of the Wells JBS to achieve the No Net Impact (NNI) standard for HCP Plan Species. The Wells JBS is the most efficient juvenile fish bypass system on the mainstem Columbia River (Skalski et al. 1996).

**Table 6. 1998 -2000, 2010 Wells Hydroelectric Project Juvenile Survival Study Results.**

| Species | % Project Survival |
|---|---|
| Yearling Chinook (2010) | 96.4 |
| Yearling Chinook and Steelhead (1998, 1999, 2000) | 96.2 |

In spring 2010, Douglas PUD conducted a survival verification study with yearling Chinook salmon, a required 10-year follow-up study to confirm whether the Wells Project continues to achieve survival standards of the Wells Anadromous Fish Agreement and HCP. Approximately 80,000 PIT-tagged yearling summer Chinook were released over a 30 day period in 15 replicates. The study determined that juvenile Chinook survival from the mouth of the Okanogan and Methow rivers averaged 96.4% over the 15 replicate releases of study fish (Table 6). This result confirms conclusions from the three previous years of study and documents that juvenile fish survival through the Wells Project continues to exceed the 93% Juvenile Project Survival Standard required by the HCP (Bickford et al., 2010 draft). A final report will be available in early 2011.

The current phase designations (status of salmon and steelhead species reaching final survival determination) for the HCP Plan species are summarized in Table 7. Specific details regarding survival study design, implementation, analysis, and reporting are available in annual summary reports prepared and approved by the Wells HCP Coordinating Committee.

**Table 7. Wells Hydroelectric Project Habitat Conservation Plan Species Phase Designations.**

| Species | Phase Designation |
|---|---|
| Yearling (spring) Chinook | Phase III[1] – Standards Achieved (22-Feb-05) |
| Steelhead | Phase III – Standards Achieved (22-Feb-05) |
| Sockeye | Phase III – Additional Juvenile Studies (22-Feb-05) |
| Subyearling (summer/fall) Chinook | Phase III – Additional Juvenile Studies (22-Feb-05) |
| Coho | Phase III – Additional Juvenile Studies (27-Dec-06) |

In 2011, Douglas PUD shall continue to operate Wells Dam adult fishways and the JBS in accordance with HCP operations criteria to protect aquatic life designated uses. Furthermore, all fish collection (hatchery broodstock and/or evaluation activities) or assessment activities that occur at Wells Dam will

[1] Phase III = Dam survival >95% or project survival >93% or combined juvenile and adult survival >91% (Standard Achieved).

require approval by Douglas PUD and the HCP Coordinating Committee to ensure that such activities protect aquatic life designated uses.

Douglas PUD shall continue to operate the Wells Project in a coordinated manner toward reducing forebay fluctuations and maintaining relatively stable reservoir conditions that are beneficial to multiple designated uses (aquatic life, recreation, and aesthetics). Coordinated operations reduce spill, thus reducing the potential for exceedances of the TDG numeric criteria and impacts to aquatic life associated with TDG.

### 2.2.2 Biological Monitoring

Douglas PUD will work with the Washington Department of Fish and Wildlife hatchery programs to monitor the occurrence of Gas Bubble Trauma (GBT) on adult broodstock collected for hatchery needs. Upon collection of brood, hatchery staff will inoculate each fish, place a marking identification tag on them and look for any fin markings or unusual injuries. NMFS has shown that GBT is low if the level of TDG can be managed to below 120 percent (NMFS 2000). They recommend that "the biological monitoring components will include smolt monitoring at selected smolt monitoring locations and daily data collection and reporting only when TDG exceeds 125 percent for an extended period of time." Thus, biological sampling at Wells Dam of adult broodstock will only occur when hourly TDG levels in the mid-Columbia exceed 125 percent. The JBS at Wells Dam does not have facilities to allow for juvenile fish sampling and observation. As in past years, if hourly TDG levels exceed 125 percent in the tailrace of Wells Dam, Douglas PUD will request biological sampling of migrating juveniles for symptoms of GBT at the Rocky Reach juvenile bypass sampling facility.

### 2.2.3 Water Quality Forums

Douglas PUD is currently involved in the Water Quality Team meetings held in Portland, Oregon. The purpose of the Water Quality Team is to address regional water quality issues. This forum allows regional coordination for monitoring, measuring, and evaluating water quality in the Columbia River Basin. Douglas PUD will continue its involvement in the Water Quality Team meetings for further coordination with other regional members.

Douglas PUD is also currently involved in the Transboundary Gas Group that meets annually to coordinate and discuss cross border dissolved gas issues in Canada and the U.S. Douglas PUD will continue its involvement with the Transboundary Gas Group.

In 2010, Douglas PUD actively participated in regional water quality forums with Ecology, Washington Department of Fish and Wildlife, Tribal Agencies, the U.S. Fish and Wildlife Service, the USACE, and other Mid-Columbia PUDs (i.e., Grant and Chelan counties). These meetings, ranging from the Trans-boundary Gas Group to meetings with the USACE, allow for regional coordination for monitoring, measuring, and evaluating water quality in the Columbia River Basin. Douglas PUD will continue its involvement in such forums to further improve coordination with other regional water quality managers.

# 3.0 Structural Activities

No structural modifications related to spill are scheduled to occur at the Wells Project in 2011. As in 2010, high flow volume and spill may require JBS barrier removal.

# 4.0 Compliance and Physical Monitoring

## *4.1 Monitoring Locations*

### 4.1.1 TDG

TDG monitoring has been implemented in the Wells Dam forebay since 1984. Douglas PUD began monitoring TDG levels in the Wells Dam tailrace in 1997 by collecting data from a boat and drifting through the tailrace at four points across the width of the river. During the transect monitoring, no TDG "hot spots" were detected; the river appeared completely mixed horizontally. A fixed TDG monitoring station was established in 1998. The placement of the fixed monitoring station was determined based upon the 1997 work and was further verified as collecting data representative of river conditions during a 2006 TDG assessment at Wells Dam (EES et. al. 2007). Results of the 2008-2009 TDG numerical modeling activities conducted by University of Iowa/IIHR have also confirmed that the tailrace monitoring station is located at a site representative of the mixed river flow, particularly during higher flows. Furthermore, locations of both forebay and tailrace sensors had to be protected to avoid sensor/data loss and damage and for safe accessibility during extreme high flows. The current locations of both the forebay and tailrace monitors took these criteria into consideration.

TDG monitoring at the Wells Project typically commences on April 1 and continues until September 15 annually. This monitoring period will encompass the operation of the Wells JBS as well as when river flows are at their highest and when a majority of forced spill occurs. Throughout this period, data from both forebay and tailrace sensors are transmitted by slave radio transmitters to a master radio at Wells Dam. This system is checked at the beginning of the season for communication between the probes and transmitters by technicians at Wells Dam. TDG data are sent and logged at the Douglas PUD Headquarters' building in 15-minute intervals. Information on barometric pressure, water temperature and river gas pressure is sent to the USACE on the hour over the Internet. The four data points (15 minute) within an hour are used in compiling hourly TDG values, the 24 hour TDG average and the average of the twelve highest consecutive hourly readings in a day (24-hour period).

### 4.1.2 Water Temperature

Douglas PUD has been monitoring water temperatures around the Wells Reservoir and in the Wells Dam tailrace year round since 2005. Temperature monitoring locations are provided in Table 8. Temperature monitoring through the reservoir and the inundated portions of tributary streams is performed with Onset Tidbit thermographs.

**Table 8. List of Wells Reservoir and tributary temperature monitoring stations.**

| River | Side/Mile | Location |
|---|---|---|
| Columbia | Left / 515.6 | Wells Forebay* |
| Columbia | Left / 544.5 | Chief Joseph Tailrace |
| Columbia | Left/515.5 | Wells Dam Tailrace |
| Columbia | Right/515.5 | Wells Dam Tailrace |
| Methow | Right / 2.8 | Near Pateros |
| Okanogan | Center / 10.5 | Near Monse |

## *4.2 Quality Assurance*

### 4.2.1 TDG

As part of the Douglas PUD's Quality Assurance/Quality Control (QA/QC) program, Douglas PUD's water quality consultant will visit both TDG sensor sites monthly for maintenance and calibration of TDG instruments. Calibration follows criteria established by the USACE, with the exception of monthly rather than bi-weekly calibration of sensors. A spare probe will be available and field-ready in the event that a probe needs to be removed from the field for repairs.

The consultant will inspect instruments during the monthly site visits and TDG data will be monitored weekly by Douglas PUD personnel. If, upon inspection of instruments or data, it is deemed that repairs are needed, they will be promptly made. Occasionally during the monthly sensor calibration, an error may develop with the data communication. These problems are handled immediately. Generally, the radio transmitters at each fixed station will run the entire season without any problems.

Douglas PUD intends to collect quality, usable data for each day over the 168-day (April 1 – September 15) monitoring season. As part of the quality assurance process, data anomalies will be removed. This would include data within a 2-hour window of probe calibration and any recording errors that result from communication problems. Data errors will prompt a technician or water quality specialist site visit, to inspect the instrument and repair or replace if necessary.

### 4.2.2 Water Temperature

QA/QC measures will be accomplished through calibration of thermographs at the beginning and end of a period of sensor deployment. As part of the QA/QC process, data anomalies will be identified and removed from the data set. Sensors will be deemed unreliable if calibration against a National Institute of Standards and Technology standard reference thermometer shows a variance of ± 0.2°C. Thermographs will be replaced quarterly (every three months) using recently tested sensors to avoid data loss.

### *4.3 Reporting*

Upon approval of the Wells GAP and issuance of a Wells Project TDG adjustment, Douglas PUD shall submit an annual report describing the results of all monitoring activities described within this GAP. The report will be submitted to Ecology no later than December 31 of each year that the TDG adjustment is approved. A draft GAP report will be submitted to Ecology for review no later than December 31 of each year that the TDG adjustment is approved. The annual report will summarize all GAP activities conducted for the year in which it is submitted as required by Ecology.

# 5.0 Conclusions

Pending approval by Ecology, implementation of the measures identified within the 2011 GAP are intended to serve as a long-term strategy to maintain compliance with the Washington State WQS for TDG in the Columbia River at the Wells Project while continuing to provide safe passage for downstream migrating juvenile salmonids.

# 6.0 Literature Cited

ASL Environmental Sciences (ASL). 2007. Turbine Discharge Measurements by Acoustic Scintillation Flow Meter at Units 1 and 2, Wells Hydroelectric Project, Pateros, Washington, August 2006. Prepared by ASL Environmental Sciences Inc. Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, WA.

Bickford, S. A., J. R. Skalski, R. Townsend, S. McCutcheon, R. Richmond, R. Frith and R. Fechhelm. 2001. Project survival estimates for yearling summer steelhead migrating through the Wells Hydroelectric Facility, 2000.

Bickford, S.A., T. Kahler, R. Townsend, J.R. Skalski, R. Richmond, S. McCutcheon and R. Fechhelm. Project survival estimates for yearling Chinook migrating through the Wells Hydroelectric Project, 2010 draft. (2010 spring migrant survival verification study).

Bonneville Power Administration (BPA). 2010. Columbia River high-water operations [June 1-14, 2010]. September 2010. 12 pages. DOE/BP-4203.

EES Consulting, Carroll, J., ENSR, and Parametrix. 2007. Total Dissolved Gas Production Dynamics Study. Wells Hydroelectric Project. FERC No. 2149. Prepared by EES Consulting, Joe Carroll, ENSR, and Parametrix. Prepared for Public Utility District No. 1 of Douglas County, East Wenatchee, WA.

Le, B and J. Murauskas. 2009. Total Dissolved Gas Abatement Plan. Wells Hydroelectric Project. April 2009. Prepared for Washington Department of Ecology, Yakima, Washington, 98902-3452.

National Marine Fisheries Service (NMFS). 2000. Endangered Species Act – Section 7 Consultation: Biological Opinion. Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. F/NWR/2004/00727. November 30, 2005. Pages 5-6, 5-7, 5-53, 10-9, and Appendix E: Risk Analysis.

Pickett, P., H. Rueda, M. Herold. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt. Submittal Report. Washington Department of Ecology, Olympia, WA. U.S. Environmental Protection Agency, Portland, OR. June 2004. Publication No. 04-03-002.

Skalski, J. R, G. E. Johnson, C. M. Sullivan, E. Kudera and M. W. Erho. 1996. Statistical Evaluation of Turbine Bypass Efficiency at Wells Dam on the Columbia River, Washington. Canadian Journal of Fisheries and Aquatic Science. Volume 53, No. 10, 1996. Pages 2188-2198.

Washington Department of Ecology, Spokane Tribe of Indians and U.S. Environmental Protection Agency. 2004. Total Maximum Daily Load for Total Dissolved Gas in the Mid-Columbia River and Lake Roosevelt: Submittal Report. Accessed online December 7, 2010 at: http://www.ecy.wa.gov/biblio/0403002.html

# 7.0 Appendices

**Appendix 1. Letter from Pat Irle on Gas Abatement Plan for 2010.**

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
*15 W Yakima Ave, Ste 200 • Yakima, WA 98902-3452 • (509) 575-2490*

April 9, 2010

Beau Patterson
Douglas County PUD No. 1
1151 Valley Mall Boulevard
East Wenatchee, WA 98802

RE: Wells Hydropower Project No. 2149
2010 Total Dissolved Gas Abatement Plan

Dear Beau -

**The 2010 Total Dissolved Gas Abatement Plan for Wells Dam is hereby approved for the 2010 fish spill season,** in accordance with WAC 173-201A- 200(1)(f)(ii).

Two minor comments:

1) The draft Gas Abatement Plan report for this year should be submitted to Washington State Department of Ecology (Ecology) by October 31, 2010.

2) The next annual draft Gas Abatement Plan (for 2011) should be submitted to Ecology by February 28th, 2011, at the latest, so that we can prepare comments and Douglas County Public Utility District can address those comments by April 1st, 2011, the date that fish spill is expected to begin.

Thanks for your high quality work.

Sincerely,

Pat Irle
Hydropower Projects Manager
Water Quality Program

**Appendix 2. Wells Hydroelectric Project Spill Playbook, 2011.**

# Memorandum

**To:** Ken Pflueger, Mike Bruno, Arlen Simon, Hank Lubean, Tom Kahler, Brian Hicks
**From:** Beau Patterson, Shane Bickford
**Date:** xxx, 2011
**Subject:** 2011 Wells Dam Spill Playbook

The 2009 Wells Dam Spill Playbook was based on the TDG production dynamics modeling conducted by the University of Iowa's IIHR-Hydroscience and Engineering Hydraulic Research Laboratories. The two-phase flow computational fluid dynamics (CFD) model was used to predict hydrodynamics of TDG distribution within the tailrace of Wells Dam and further identify operational configurations that would minimize TDG production at the project. There were no TDG exceedances during the 2009 spill season, and the 2009 playbook was again implemented in 2010.

From June 17 to July 2, 2010 we had a few exceedances of hourly (125% max) and 12C-High (120% max) TDG concentrations in the Wells tailrace, and more prolonged exceedances in the Rocky Reach forebay (115% max). These were due to a complex interaction of record cool temperatures, very high seasonal precipitation, unusual spill operations of the upstream dams, and dentated spill patterns at Wells when spill exceeded 53 kcfs. As a result, we changed the 2010 spill playbook mid-season to improve compliance with state and federal water quality standards for TDG. While we had improved compliance with the TDG water quality standard after the revision was implemented, and some indication of improved TDG performance, the lack of exceedances is also attributable to declining flow volumes.

Recommendations for 2011 operations, from a TDG management perspective, include:

1. Minimize spill.

2. Forced Spill (≤ 53.0 kcfs). Switch the priority for forced spill less than 53 kcfs from spillbay 7 to spillbay 5. Units 4 and 5 should be operated to support spill from spillbay 5.

3. If spill exceeds 53 kcfs, or is predicted to exceed 40 kcfs for more than 8 hours, remove the Juvenile Bypass System (JBS) barriers in spillbay 6.

4. When spill exceeds 30 kcfs in spillbay 5 and JBS barriers have been removed in spillbay 6, shift at least 15.0 kcfs from spillbay 5 to spillbay 6 (i.e., 27.2 kcfs and 15.0 kcfs through spillbays 5 and 6, respectively). Support spill through spillbays 5 and 6 by operating units 4, 5 and 6.

5. Reinstall the JBS barriers if total spill is predicted to remain below 40 kcfs for more than four days.

Operate the powerhouse to maximize utilization and total release through the center units (3-6, 8, and 7 if operational) when forced spill is occurring.

## I. No Forced Spill

The Wells Dam JBS (even numbered spillbays, 10.0 kcfs total) should be operated continuously throughout the juvenile salmon outmigration (normally April 12 to August 26). The Wells JBS is normally operated with 1.7 kcfs passed through *S2* and *S10*, and 2.2 kcfs through *S4*, *S6*, and *S8* (Figure 1).

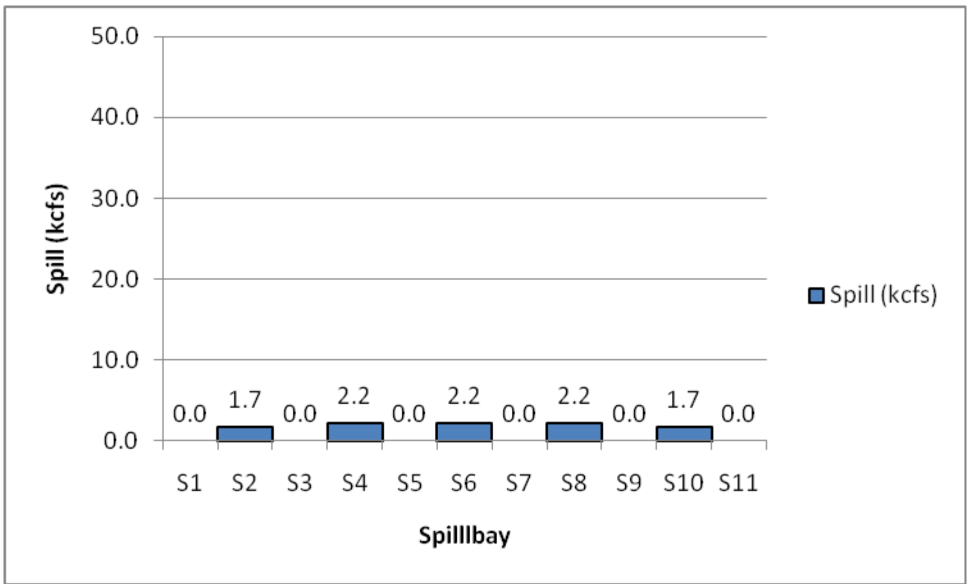



**Figure 2.** Operational configuration under no forced spill (JBS only).

## II. Total Spill ≤ 53.0 kcfs, JBS barriers in place

As forced spill increases, Project Operators should allocate all spill through *S5* until the maximum capacity is reached through that spillbay (~43.0 kcfs). Note that *S5* spill requires support of generation flows from units 4 and 5 to minimize TDG production. This, along with the already established JBS spill (10.0 kcfs) would equal 53.0 kcfs (Figure 2). Over 90% of the spill events over the past decade could have been handled under this configuration.

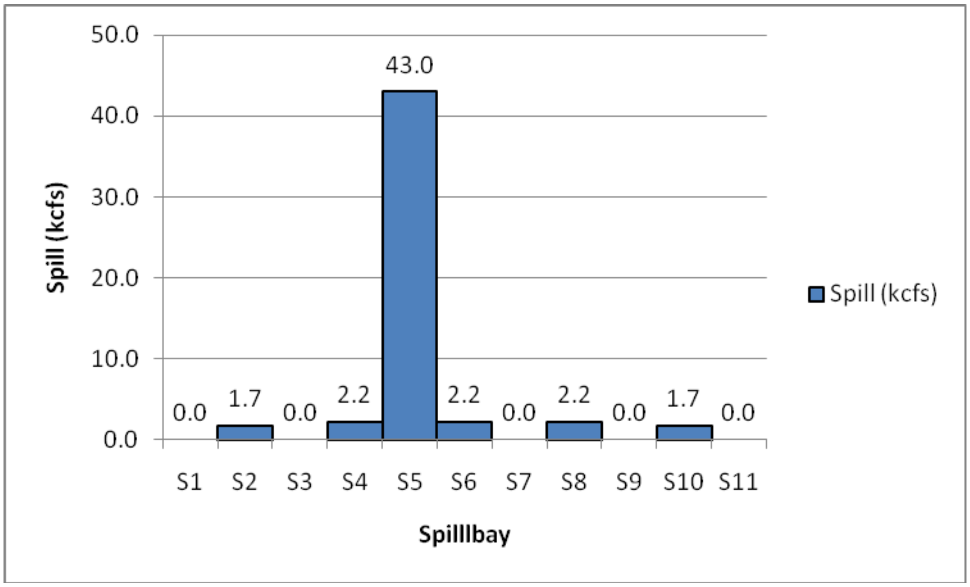



**Figure 3.** Operational configuration under spill ≤ 53.0 kcfs (including JBS).

## III. JBS Barrier Removal Criteria

When either of the following occurs, remove the JBS barrier in *S6*:

Spill in *S5* reaches 30 kcfs and total spill is expected to exceed 40kcfs for more than 8 hours, *or* total spill is expected to exceed 53 kcfs. After the JBS barrier is removed from *S6* and when flow through S5 is at least 30kcfs, shift 15 kcfs to *S6* (Figure 3). It is best to have generating units 4, 5, and 6 operating to support this spill configuration. Once at least 15 kcfs is being spilled through *S6*, spill can be allocated to *S5* until 43.0 kcfs is reached.

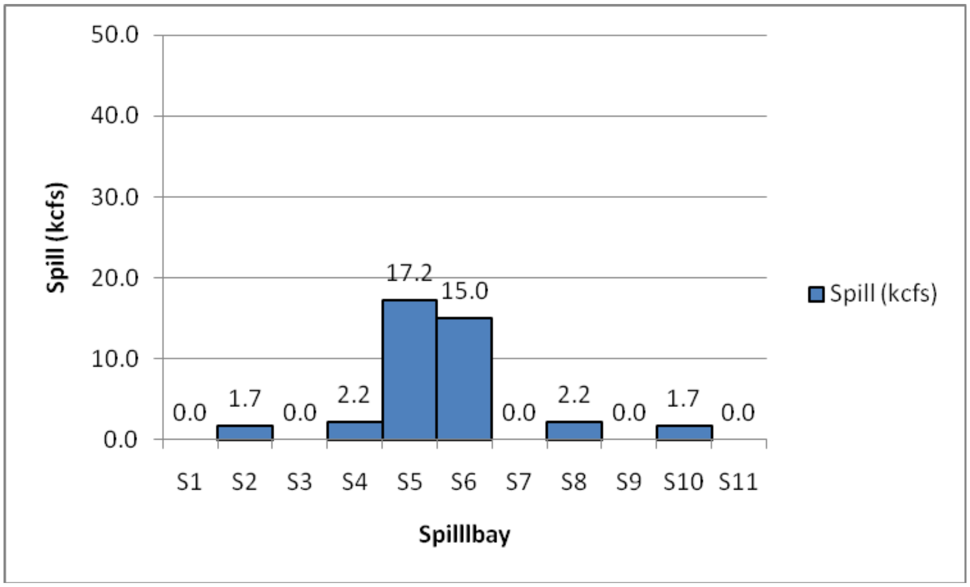



**Figure 3.** Operational configuration once spill reaches 30 kcfs in S5 and is expected to be above 40 kcfs for more than 8 hours (JBS removed). Shift sufficient spill from S5 to maintain a minimum of 15 kcfs spill at S6. Note that the 15.0 kcfs includes the existing 2.2 kcfs JBS flow.

## IV. Short duration decreases in Forced Spill (<53.0 kcfs) and JBS Barriers in *S6* Removed

If after removal of JBS barrier in *S6*, total spill drops below 53 kcfs (between 10-53 kcfs), and is expected to stay in this range for only a short period (4 days or less), direct spill through *S6* up to 15 kcfs (total spill < 22.9 kcfs). When total spill exceeds 22.8 kcfs, direct the remainder of spill through *S5*.

## V. Forced Spill (> 53.0 kcfs) and JBS Barriers in *S6* Removed

After *S5* reaches 43.0 kcfs, additional spill should be allocated to *S6* (*S6* is already spilling at least 15.0 kcfs need to fully engage the submerged spillway lip below the ogee). As flow increases, spill should continually increase through *S6* until paired with *S5* (e.g., 43.0 kcfs through *S5* and 26.0 kcfs through *S6*) (Figure 4). Eventually, *S6* will reach 43.0 kcfs (93.8 kcfs, Figure 5).

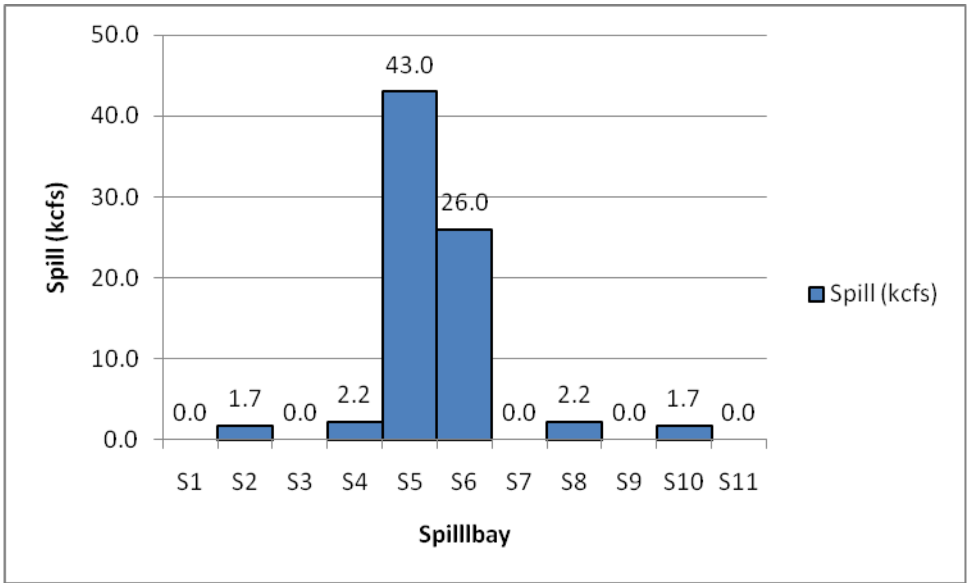



**Figure 4.** Operational configuration under forced spill > 53.0 kcfs (including JBS flow, with removal of JBS barriers in *S6*). In this instance spill has reached the 43.0 kcfs maximum in S5 and additional spill is being allocated to S6 (26.0 kcfs).

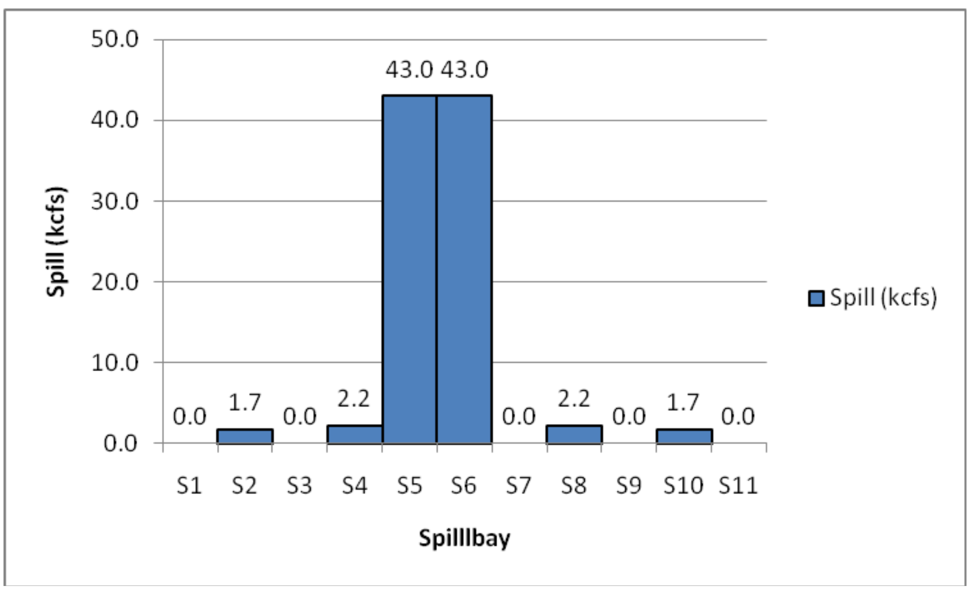



**Figure 5.** Operational configuration under forced spill > 53.0 kcfs (including JBS). In this instance (93.8 kcfs of spill), S6 has been fully allocated and 43.0 kcfs is now allocated through both *S5* and *S6*.

## VI. Forced Spill (> 93.8 kcfs) and JBS Barriers in *S6* Removed

After both *S5* and *S6* reach 43.0 kcfs, spill can also be allocated to *S7*. Since a minimum of 15.0 kcfs is needed to fully engage the submerged spillway lip below the ogee, spill through *S6* should be relocated to *S7* (Figure 6). As flow increases, spill can be continually increased through *S7* until paired with *S6* (30.0 kcfs through S6 and S7, while S5 continues at 43.0 kcfs). After this point, both *S6* and *S7* can be increased until all three spillbays have reached 43.0 kcfs (136.8 kcfs of spill, Figure 7).

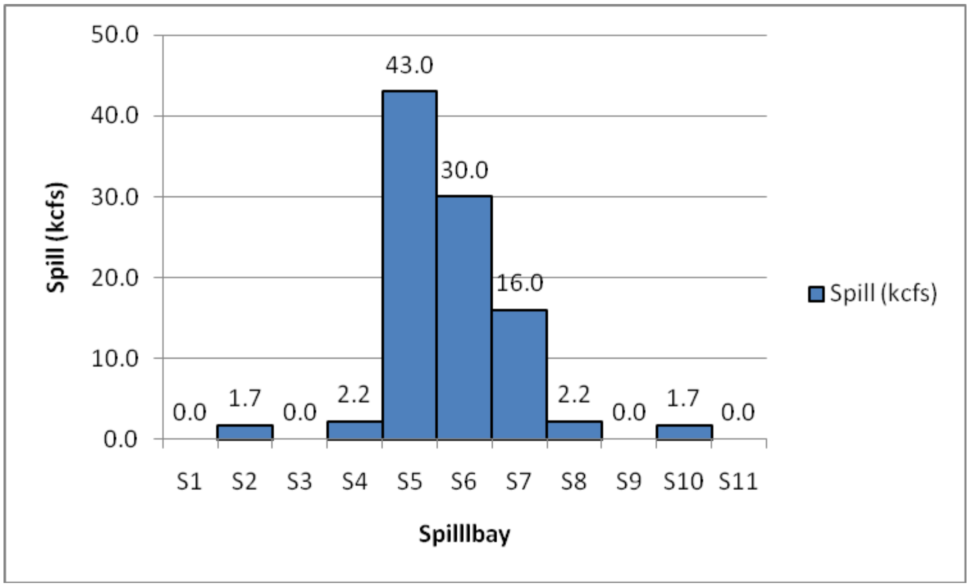



**Figure 6.** Operational configuration under forced spill > 96.0 kcfs. In this instance (96.8 kcfs of total spill), spill from *S6* is relocated to *S7* to maintain concentrated flow with *S5*. A spill of 16.0 kcfs is maintained in *S7* as to engage the submerged spillway lip.

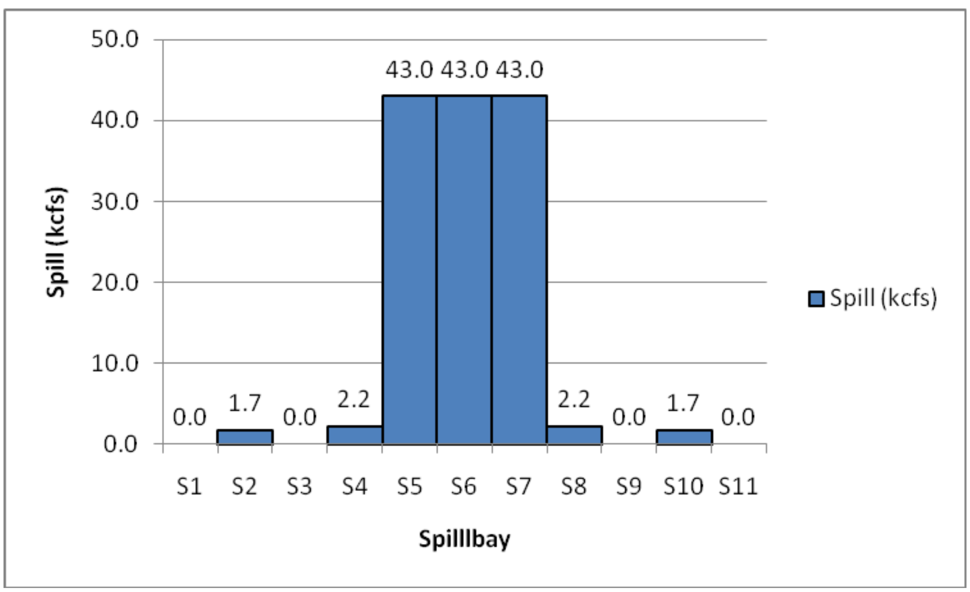



**Figure 7.** Operational configuration under forced spill > 96.0 kcfs (with removal of JBS barriers in *S6*). In this instance (136.8 kcfs of total spill), 43.0 kcfs is allocated through *S5*, *S6*, and *S7*.

### Forced Spill (> 136.8 kcfs)

Forced spill exceeding 136.8 kcfs rarely occurs (less than 0.5%). If these conditions arise and total river flow exceeds 246.0 kcfs, then 7Q-10 conditions are occurring and Wells Dam is exempt from the TDG standards. Under this situation, Project Operators may perform any combination of operations to ensure that flood waters are safely passed. Also, at this point, JBS barriers will likely be removed allowing additional flexibility to spill up to 43 kcfs each through *S2*, *S4*, *S6*, and *S8*. Project Operators may pass spill through *S3* in a similar fashion to operations mentioned above (starting at a minimum of 15.0 kcfs to ensure that spillway lips are engaged).

## VII. JBS Re-Installment Criteria

Once spills of less than 40.0 kcfs are predicted for at least four days, JBS barriers should be re-installed in *S6*.

## I. Spill Lookup Table

| Operation | Total Spill | S1 - | S2 JBS | S3 | S4 JBS | S5 | S6 JBS | S7 | S8 JBS | S9 | S10 JBS | S11 - |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Spillbay Number | | | | | | | | | | |
| I. No Forced Spill | 10.0 | 0.0 | 1.7 | 0.0 | 2.2 | 0.0 | 2.2 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| II. Spill (≤ 53.0 kcfs), min. | 11.0 | 0.0 | 1.7 | 0.0 | 2.2 | 1.0 | 2.2 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| II. Spill (≤ 53.0 kcfs), max. | 53.0 | 0.0 | 1.7 | 0.0 | 2.2 | 43.0 | 2.2 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| III. Spill (> 53.0 kcfs, *S6* JBS out), min. | 54.0 | 0.0 | 1.7 | 0.0 | 2.2 | 31.2 | 15.0 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| III. Spill (> 53.0 kcfs, *S6* JBS out), max. | 93.8 | 0.0 | 1.7 | 0.0 | 2.2 | 43.0 | 43.0 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| IV. Spill (> 93.8 kcfs, *S6* JBS out), min. | 96.8 | 0.0 | 1.7 | 0.0 | 2.2 | 43.0 | 38.8 | 15.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| IV. Spill (> 93.8 kcfs, *S6* JBS out), max. | 136.8 | 0.0 | 1.7 | 0.0 | 2.2 | 43.0 | 43.0 | 43.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| V. Spill (>137.0 kcfs), min. | 137.0 | 0.0 | 1.7 | 15.0 | 2.2 | 43.0 | 43.0 | 28.2 | 2.2 | 0.0 | 1.7 | 0.0 |
| V. Spill (>137.0 kcfs), max. | - | *Operators may adjust as needed. TDG exemption in place when total river flows exceed 246.0 kcfs.* | | | | | | | | | | |

Notes: (1) No spill through *S1* and *S11* as to minimize interference with fish ladders. (2) Even-numbered spillbays are designated as the Juvenile Bypass System (JBS). (3) Primary spillbays for forced spill are *S5*, *S6*, *S7*, *S3*, and *S9* (in that order).

**Appendix 2. Letter of 2011 GAP approval from Washington Department of Ecology**

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
*15 W Yakima Ave, Ste 200 ◦ Yakima, WA 98902-3452 ◦ (509) 575-2490*

March 31, 2011

Beau Patterson
Douglas County PUD No. 1
1151 Valley Mall Boulevard
East Wenatchee, WA 98802

RE: Wells Hydropower Project No. 2149
2011 Total Dissolved Gas Abatement Plan

Dear Beau:

**The 2011 Total Dissolved Gas Abatement Plan for Wells Dam is hereby approved for the 2011 fish spill season,** in accordance with WAC 173-201A- 200(1)(f)(ii).

Two minor comments:

1) The next annual draft Gas Abatement Plan (for 2012) should be submitted to Ecology by February 28th, 2012, at the latest, so that we can prepare comments and Douglas County Public Utility District can address those comments by April 1st , 2012, the date that fish spill is expected to begin.

2) We need to discuss procedures for monitoring and reporting compliance with the 110% standard during non-fish spill season.

Thanks for your continuing high quality work.

Sincerely,

Pat Irle
Hydropower Projects Manager

**Appendix 3. Example Hach® HYDROLAB MiniSonde calibration report from the 2011 monitoring season**

Columbia Basin Environmental

# Calibration Report

**Client:** Public Utility District No. 1 of Douglas County

**Date:** 26-Jul-10
**Arrival Time:** 10:10
**Departure Time:** 10:45

**Site: WEL**

**Calibration Type:** Field

**Date:** 26-Jul-10 **Time:** 10:20

| **BP Station:** 735.7 mmHg | **Std** | **Initial** | **Final** |
|---|---|---|---|
| **Temperature** | 17.85 | 17.8 | N / C |
| **TDG 100%** | 735.7 | 737 | N / C |
| **TDG 113%** | 835.7 | 836 | N / C |
| **TDG 126%** | 935.7 | 936 | N / C |
| **TDG 139%** | 1035.7 | 1037 | N / C |
| **TDG membrane ID** | DPUD-10-01 | | |
| **Integrity Check** | Pass | | |

**Comments:**

*Report created* August 05, 2010

Columbia Basin Environmental

# Calibration Report

**Client:** Public Utility District No. 1 of Douglas County

**Date:** 26-Jul-10 **Site: WELW**
**Arrival Time:** 11:15
**Departure Time:** 11:55

**Calibration Type:** Field

**Date:** 26-Jul-10 **Time:** 11:35

| BP Station: 736 mmHg | Std | Initial | Final |
|---|---|---|---|
| **Temperature** | 19.3 | 19.2 | N / C |
| **TDG 100%** | 736 | 737 | N / C |
| **TDG 113%** | 836 | 837 | N / C |
| **TDG 126%** | 936 | 937 | N / C |
| **TDG 139%** | 1036 | 1037 | N / C |
| **TDG membrane ID** | DPUD-10-02 | | |
| **Integrity Check** | Pass | | |

**Comments:**

*Report created* August 05, 2010

**Appendix 4.  Wells Project 2011 Spill Playbook**

# Memorandum

**To:** Ken Pflueger, Mike Bruno, Arlen Simon, Hank Lubean, Tom Kahler, Brian Hicks
**From:** Beau Patterson, Shane Bickford
**Date:** xxx, 2011
**Subject:** 2011 Wells Dam Spill Playbook

The 2009 Wells Dam Spill Playbook was based on the TDG production dynamics modeling conducted by the University of Iowa's IIHR-Hydroscience and Engineering Hydraulic Research Laboratories. The two-phase flow computational fluid dynamics (CFD) model was used to predict hydrodynamics of TDG distribution within the tailrace of Wells Dam and further identify operational configurations that would minimize TDG production at the project. There were no TDG exceedances during the 2009 spill season, and the 2009 playbook was again implemented in 2010.

From June 17 to July 2, 2010 we had a few exceedances of hourly (125% max) and 12C-High (120% max) TDG concentrations in the Wells tailrace, and more prolonged exceedances in the Rocky Reach forebay (115% max). These were due to a complex interaction of record cool temperatures, very high seasonal precipitation, unusual spill operations of the upstream dams, and dentated spill patterns at Wells when spill exceeded 53 kcfs. As a result, we changed the 2010 spill playbook mid-season to improve compliance with state and federal water quality standards for TDG. While we had improved compliance with the TDG water quality standard after the revision was implemented, and some indication of improved TDG performance, the lack of exceedances is also attributable to declining flow volumes.

Recommendations for 2011 operations, from a TDG management perspective, include:

1. Minimize spill.

2. Forced Spill (≤ 53.0 kcfs). Switch the priority for forced spill less than 53 kcfs from spillbay 7 to spillbay 5. Units 4 and 5 should be operated to support spill from spillbay 5.

3. If spill exceeds 53 kcfs, or is predicted to exceed 40 kcfs for more than 8 hours, remove the Juvenile Bypass System (JBS) barriers in spillbay 6.

4. When spill exceeds 30 kcfs in spillbay 5 and JBS barriers have been removed in spillbay 6, shift at least 15.0 kcfs from spillbay 5 to spillbay 6 (i.e., 27.2 kcfs and 15.0 kcfs through spillbays 5 and 6, respectively). Support spill through spillbays 5 and 6 by operating units 4, 5 and 6.

5. Reinstall the JBS barriers if total spill is predicted to remain below 40 kcfs for more than four days.

Operate the powerhouse to maximize utilization and total release through the center units (3-6, 8, and 7 if operational) when forced spill is occurring.

## I. No Forced Spill

The Wells Dam JBS (even numbered spillbays, 10.0 kcfs total) should be operated continuously throughout the juvenile salmon outmigration (normally April 12 to August 26). The Wells JBS is normally operated with 1.7 kcfs passed through *S2* and *S10*, and 2.2 kcfs through *S4*, *S6*, and *S8* (Figure 1).

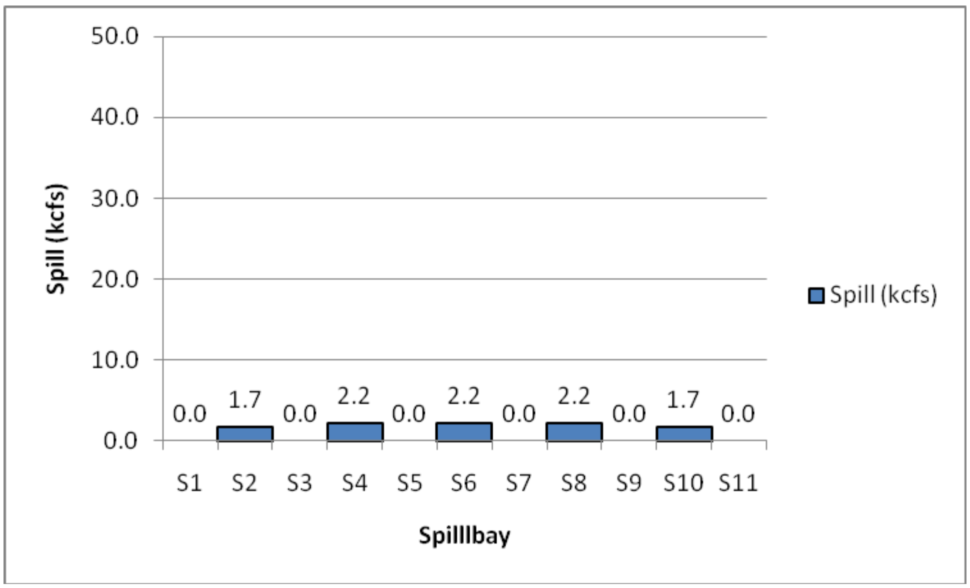



**Figure 2.** Operational configuration under no forced spill (JBS only).

## II. Total Spill ≤ 53.0 kcfs, JBS barriers in place

As forced spill increases, Project Operators should allocate all spill through *S5* until the maximum capacity is reached through that spillbay (~43.0 kcfs). Note that *S5* spill requires support of generation flows from units 4 and 5 to minimize TDG production. This, along with the already established JBS spill (10.0 kcfs) would equal 53.0 kcfs (Figure 2). Over 90% of the spill events over the past decade could have been handled under this configuration.

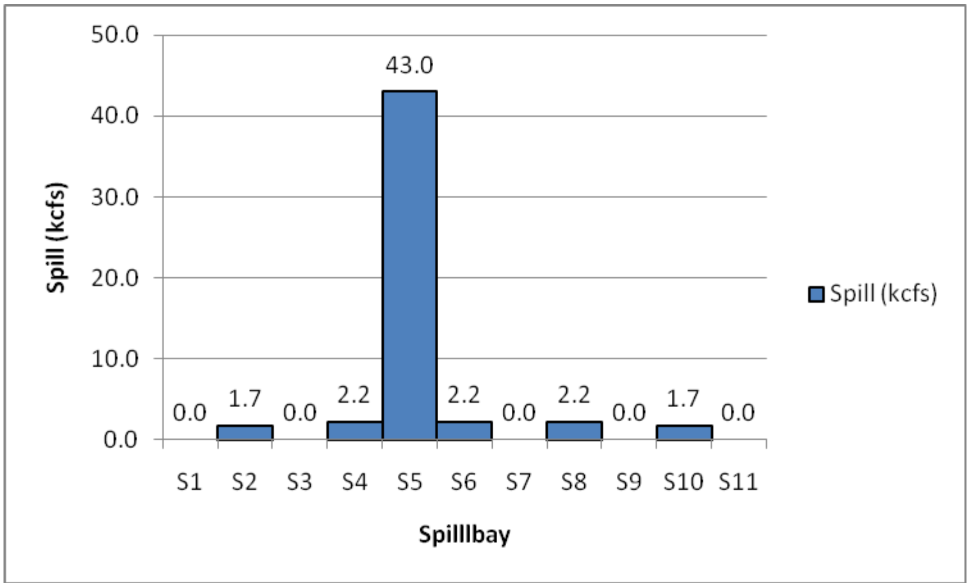



**Figure 3.** Operational configuration under spill ≤ 53.0 kcfs (including JBS).

## III. JBS Barrier Removal Criteria

When either of the following occurs, remove the JBS barrier in *S6*:

Spill in *S5* reaches 30 kcfs and total spill is expected to exceed 40kcfs for more than 8 hours, *or* total spill is expected to exceed 53 kcfs. After the JBS barrier is removed from *S6* and when flow through S5 is at least 30kcfs, shift 15 kcfs to *S6* (Figure 3). It is best to have generating units 4, 5, and 6 operating to support this spill configuration. Once at least 15 kcfs is being spilled through *S6*, spill can be allocated to *S5* until 43.0 kcfs is reached.

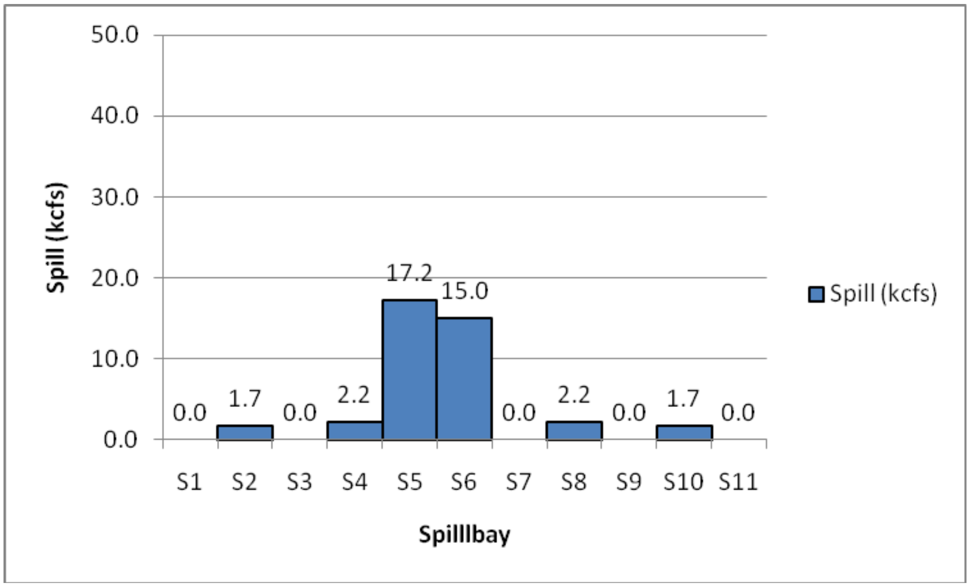



**Figure 3.** Operational configuration once spill reaches 30 kcfs in S5 and is expected to be above 40 kcfs for more than 8 hours (JBS removed). Shift sufficient spill from S5 to maintain a minimum of 15 kcfs spill at S6. Note that the 15.0 kcfs includes the existing 2.2 kcfs JBS flow.

## IV. Short duration decreases in Forced Spill (<53.0 kcfs) and JBS Barriers in *S6* Removed

If after removal of JBS barrier in *S6*, total spill drops below 53 kcfs (between 10-53 kcfs), and is expected to stay in this range for only a short period (4 days or less), direct spill through *S6* up to 15 kcfs (total spill < 22.9 kcfs). When total spill exceeds 22.8 kcfs, direct the remainder of spill through *S5*.

## V. Forced Spill (> 53.0 kcfs) and JBS Barriers in *S6* Removed

After *S5* reaches 43.0 kcfs, additional spill should be allocated to *S6* (*S6* is already spilling at least 15.0 kcfs need to fully engage the submerged spillway lip below the ogee). As flow increases, spill should continually increase through *S6* until paired with *S5* (e.g., 43.0 kcfs through *S5* and 26.0 kcfs through *S6*) (Figure 4). Eventually, *S6* will reach 43.0 kcfs (93.8 kcfs, Figure 5).

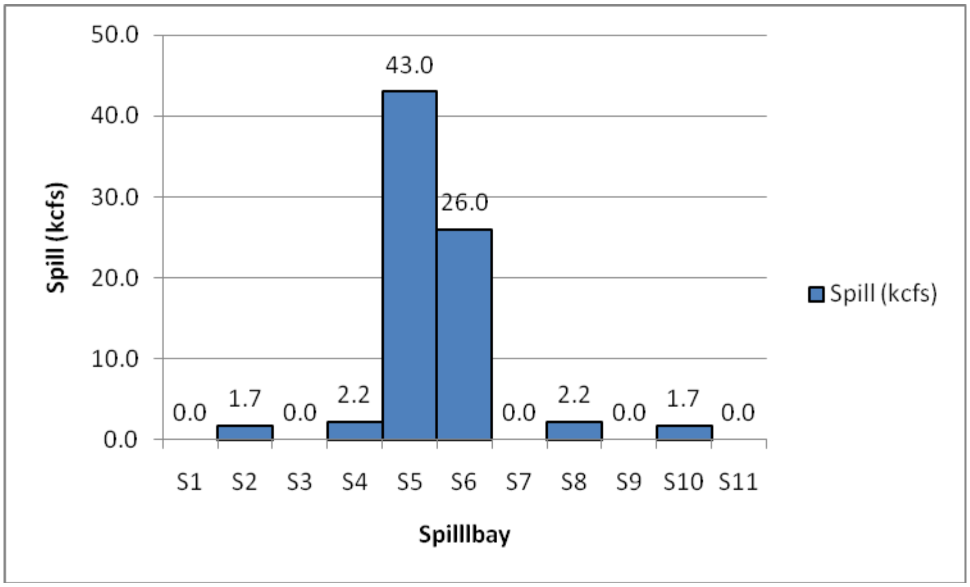



**Figure 4.** Operational configuration under forced spill > 53.0 kcfs (including JBS flow, with removal of JBS barriers in *S6*). In this instance spill has reached the 43.0 kcfs maximum in S5 and additional spill is being allocated to S6 (26.0 kcfs).

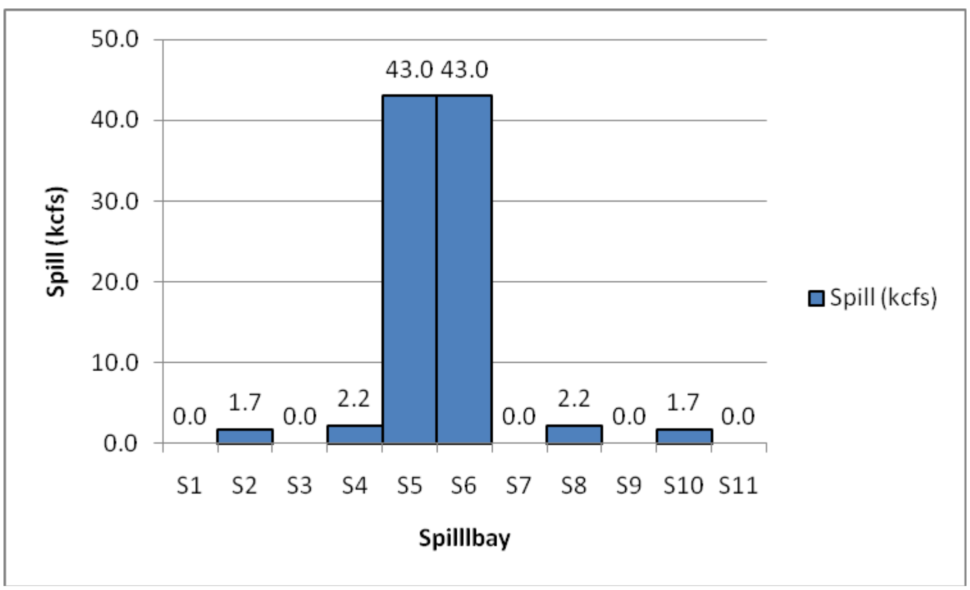



**Figure 5.** Operational configuration under forced spill > 53.0 kcfs (including JBS). In this instance (93.8 kcfs of spill), S6 has been fully allocated and 43.0 kcfs is now allocated through both *S5* and *S6*.

## VI. Forced Spill (> 93.8 kcfs) and JBS Barriers in *S6* Removed

After both *S5* and *S6* reach 43.0 kcfs, spill can also be allocated to *S7*. Since a minimum of 15.0 kcfs is needed to fully engage the submerged spillway lip below the ogee, spill through *S6* should be relocated to *S7* (Figure 6). As flow increases, spill can be continually increased through *S7* until paired with *S6* (30.0 kcfs through S6 and S7, while S5 continues at 43.0 kcfs). After this point, both *S6* and *S7* can be increased until all three spillbays have reached 43.0 kcfs (136.8 kcfs of spill, Figure 7).

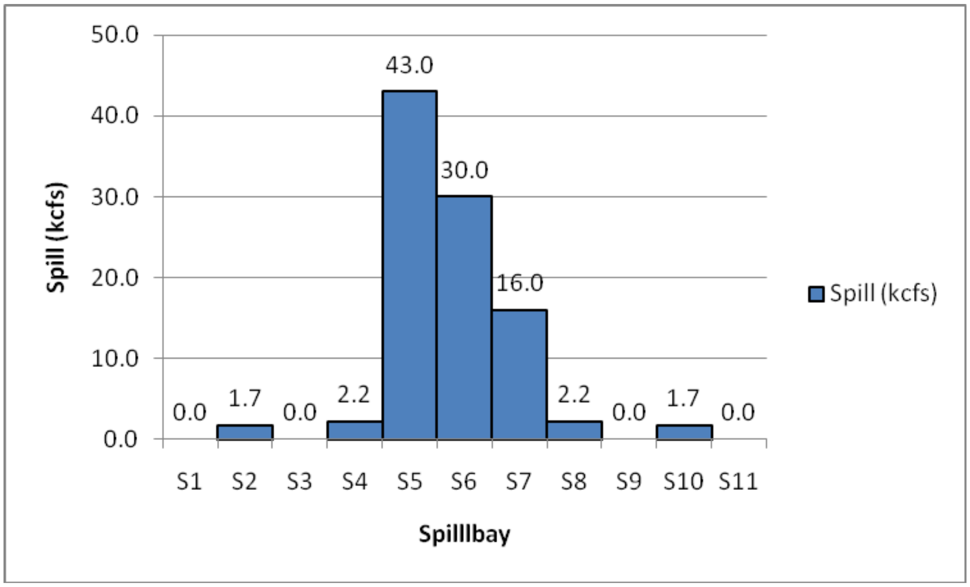



**Figure 6.** Operational configuration under forced spill > 96.0 kcfs. In this instance (96.8 kcfs of total spill), spill from *S6* is relocated to *S7* to maintain concentrated flow with *S5*. A spill of 16.0 kcfs is maintained in *S7* as to engage the submerged spillway lip.

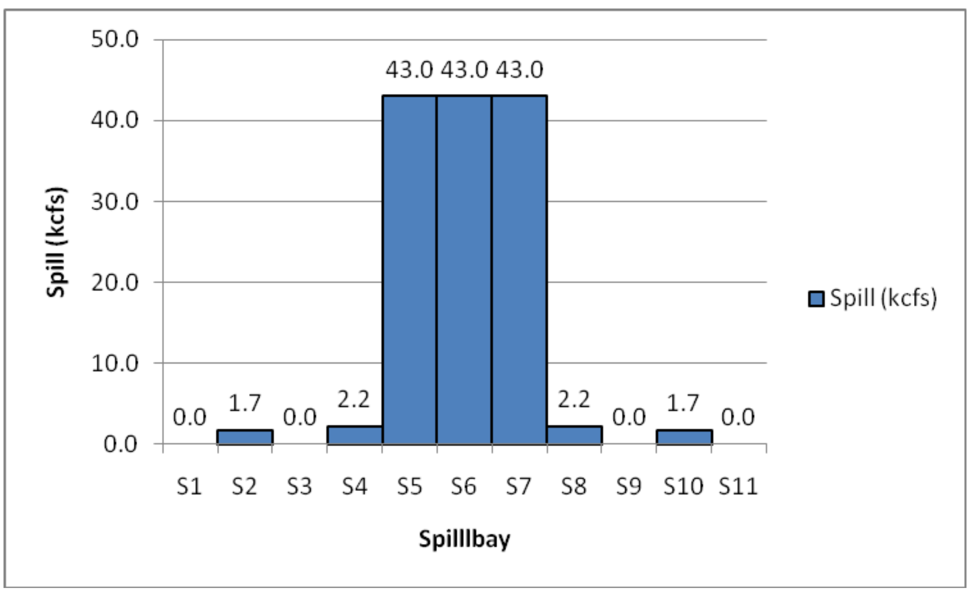



**Figure 7.** Operational configuration under forced spill > 96.0 kcfs (with removal of JBS barriers in *S6*). In this instance (136.8 kcfs of total spill), 43.0 kcfs is allocated through *S5*, *S6*, and *S7*.

### Forced Spill (> 136.8 kcfs)

Forced spill exceeding 136.8 kcfs rarely occurs (less than 0.5%). If these conditions arise and total river flow exceeds 246.0 kcfs, then 7Q-10 conditions are occurring and Wells Dam is exempt from the TDG standards. Under this situation, Project Operators may perform any combination of operations to ensure that flood waters are safely passed. Also, at this point, JBS barriers will likely be removed allowing additional flexibility to spill up to 43 kcfs each through *S2*, *S4*, *S6*, and *S8*. Project Operators may pass spill through *S3* in a similar fashion to operations mentioned above (starting at a minimum of 15.0 kcfs to ensure that spillway lips are engaged).

## VII. JBS Re-Installment Criteria

Once spills of less than 40.0 kcfs are predicted for at least four days, JBS barriers should be re-installed in *S6*.

## I. Spill Lookup Table

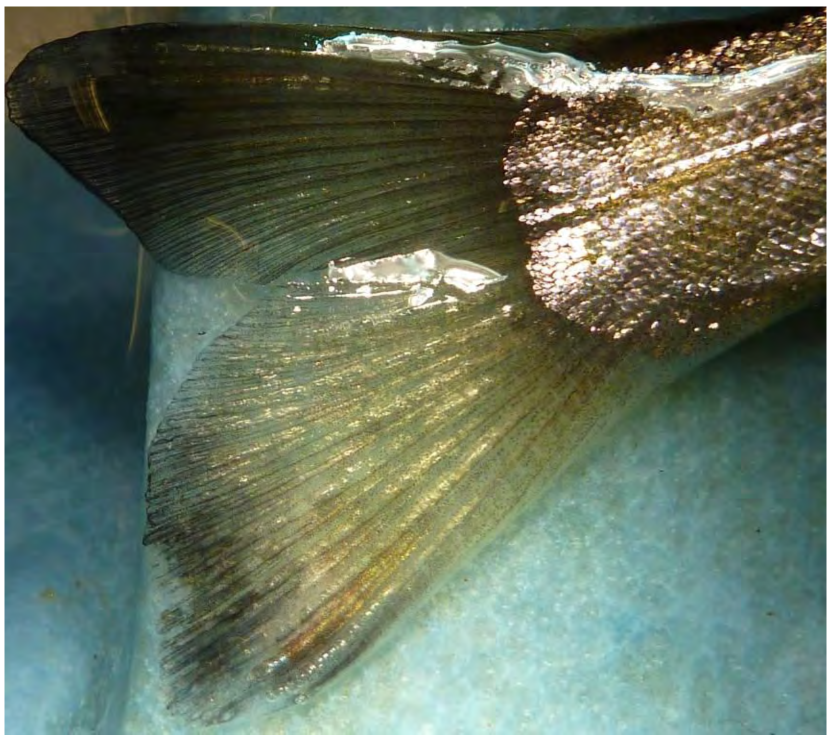
| Operation | Total Spill | Spillbay Number *S1* - | *S2* JBS | **S3** | *S4* JBS | **S5** | *S6* JBS | **S7** | *S8* JBS | **S9** | *S10* JBS | *S11* - |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I. No Forced Spill | 10.0 | 0.0 | 1.7 | 0.0 | 2.2 | 0.0 | 2.2 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| II. Spill (≤ 53.0 kcfs), min. | 11.0 | 0.0 | 1.7 | 0.0 | 2.2 | 1.0 | 2.2 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| II. Spill (≤ 53.0 kcfs), max. | 53.0 | 0.0 | 1.7 | 0.0 | 2.2 | 43.0 | 2.2 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| III. Spill (> 53.0 kcfs, *S6* JBS out), min. | 54.0 | 0.0 | 1.7 | 0.0 | 2.2 | 31.2 | 15.0 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| III. Spill (> 53.0 kcfs, *S6* JBS out), max. | 93.8 | 0.0 | 1.7 | 0.0 | 2.2 | 43.0 | 43.0 | 0.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| IV. Spill (> 93.8 kcfs, *S6* JBS out), min. | 96.8 | 0.0 | 1.7 | 0.0 | 2.2 | 43.0 | 38.8 | 15.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| IV. Spill (> 93.8 kcfs, *S6* JBS out), max. | 136.8 | 0.0 | 1.7 | 0.0 | 2.2 | 43.0 | 43.0 | 43.0 | 2.2 | 0.0 | 1.7 | 0.0 |
| V. Spill (>137.0 kcfs), min. | 137.0 | 0.0 | 1.7 | 15.0 | 2.2 | 43.0 | 43.0 | 28.2 | 2.2 | 0.0 | 1.7 | 0.0 |
| V. Spill (>137.0 kcfs), max. | - | *Operators may adjust as needed. TDG exemption in place when total river flows exceed 246.0 kcfs.* | | | | | | | | | | |

Notes: (1) No spill through *S1* and *S11* as to minimize interference with fish ladders. (2) Even-numbered spillbays are designated as the Juvenile Bypass System (JBS). (3) Primary spillbays for forced spill are *S5*, *S6*, *S7*, *S3*, and *S9* (in that order).

**Appendix 5. Wells Hydroelectric Project Gas Bubble Trauma Biological Monitoring 2011 - Draft.**

# DOUGLAS PUD GAS BUBBLE TRAUMA BIOLOGICAL MONITORING 2011
# WELLS HYDROELECTRIC PROJECT

## FERC NO. 2149



December 30, 2011

Prepared by:
Andrew Gingerich & Beau Patterson
Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

For copies contact:

Public Utility District No. 1 of Douglas County
Attn: Natural Resources
1151 Valley Mall Parkway
East Wenatchee, WA 98802-4497
Phone: (509) 881-2323

# 1.0 SUMMARY

As part of Douglas County Public Utility District's (Douglas PUD) Gas Abatement Plan (GAP; approved by the Washington Department of Ecology; 2011), Douglas PUD is committed to examining migrating smolts if total dissolved gas (TDG) in the Wells tailrace exceeds an hourly average of 125%. Primary physical monitoring evaluates TDG concentrations below and above Wells Dam, and occurs during the fish spill season. In 2011 spill season occurred between April 12th and August 26th. The biological monitoring commitment serves as a secondary monitoring tool when TDG approaches levels that have been documented to cause acute harmful effects to aquatic life.

When hourly TDG exceedance occurred in the Wells tailrace, juveniles and adult salmonids were examined for gas bubble trauma/disease (GBT) on the day following the exceedance. Juveniles were sampled at Rocky Reach juvenile bypass facility. Adult fish examinations took place concomitantly with the Washington Department of Fish and Wildlife's monitoring and evaluation activities at Wells Dam. Many of the methods used during Douglas PUD's biological monitoring followed those used by The Fish Passage Center's Smolt Monitoring Program and are, therefore, similar to those used at other hydroelectric projects on the lower Columbia and Snake Rivers.

During the 2011 season, biological monitoring was initiated on May 21st and continued daily as TDG levels above and below Wells Dam remained above thresholds, which require monitoring. Daily observations continued until Monday May 30th, 2011 when the Washington Department of Ecology (Pat Irle Pers. Comm.) approved a three day/week sampling schedule when TDG levels are sustained above 125%. Douglas PUD continued to monitor TDG conditions and biological responses into late July.

Overall, GBT expression in juvenile salmonids examined at Rocky Reach was variable, and appeared to track TDG concentrations reasonably well. GBT expression was confounded by species specific sensitivities to levels of TDG coupled with changes to the species run composition during the spill season. Juvenile salmonids expressed varied amount of GBT by species. Coho expressed the highest incidence of GBT with steelhead and yearling Chinook expressing intermediate GBT and sockeye and subyearling Chinook appearing to be the most resilient to high TDG concentrations. Throughout the season, adult fish sampled at wells dam appeared to have little symptoms of GBT, even when TDG was above 130% in the Wells tailrace.

# 2.0 METHODS

## 2.1 Juvenile sampling methods

Juvenile sampling took place downstream of Wells dam at the Rocky Reach Juvenile Bypass Collection facility on the day after an exceedance. Index samples are taken at Rock Reach on the top of the hour, 24 hours a day early in the season, and from 0800-1100 during the latter spill season. Samples last 30 minutes or until the raceway carrying capacity is reached (NMFS sets this capacity; Lace Keller Personal Communication). After fish were examined by Rocky Reach smolt monitors, Douglas PUD staff examined a subsample of index fish for GBT.

The unpaired fins (dorsal, caudal and anal), and eyes were examined for signs of GBT in juvenile fish. The proportion of area covered with bubbles was quantified for each fin or eye following methods prescribed in the Fish Passage Center's GBT monitoring protocol. For juveniles, all examinations were conducted using a variable magnification dissecting scope (6X to 40X). A tray, allowing fish to be continually anesthetized with 30mg/l MS-222 during the GBT examination, was placed under the microscope to facilitate examinations (Figure 1). Buckets placed above the fish fed anesthetic water to the fish via gravity for the duration of the examination (Figure 1). Fish were already knocked down by Rocky Reach smolt monitoring staff using a 50mg/l MS-222 dose prior to the GBT examination. After the examination, fish were returned to the JBS following instruction from Rocky Reach Smolt Monitors.


Figure 1. GBT examination station used at Rocky Reach juvenile bypass facility to examine juvenile salmonids exposed to high TDG concentrations.

### 2.1.1 Sample Size and composition

No more than 40 juveniles were sampled from each hourly index sample from the Rocky Reach juvenile fish bypass. Often, more than one index sample was used to collect GBT information. The total numbers of fish examined each sample day was based on the availability of fish at Rocky Reach Dam on the day after the exceedance. Species composition of the sample was random and shifted through the year and is associated with seasonal species run timing.

### 2.1.2 GBT Ranks

GBT data was recorded based on the percent area of the fin or eye that was covered with bubbles. The eye with the highest level of bubble occlusion was used for ranking. Figure 2 shows the spectrum of GBT that can be exhibited in the caudal fin of juvenile salmonids. Ranks were evaluated as follows:

- **0= no signs of bubbles/emphysema/emboli in the tissue/fin**
- **1=1-5% of bubbles/emphysema/emboli in the tissue/fin**
- **2= 6-25% of bubbles/emphysema/emboli in the tissue/fin**
- **3= 26-50% signs of bubbles/emphysema/emboli in the tissue/fin**
- **4= >50% bubbles/emphysema/emboli in the tissue/fin**.

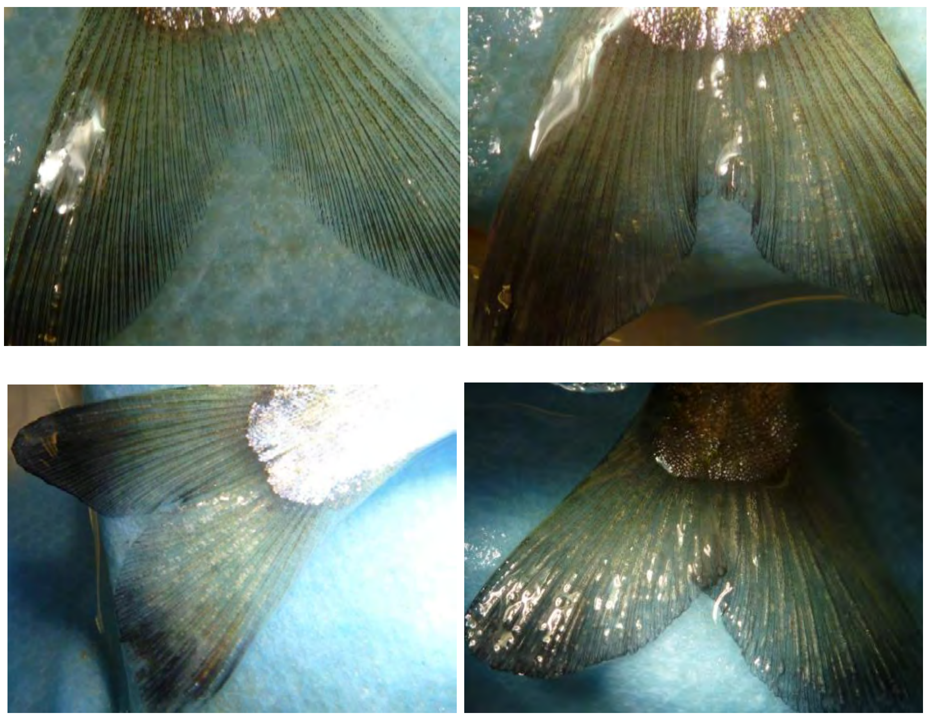


Figure 2. Examples of GBT severity ranges from four individuals sample in 2011 at the Rocky Reach Juvenile bypass facility.

## 2.2 Adult Fish Protocol

Adult examinations were conducted concomitantly with the Washington Department of Fish and Wildlife (State) staff. The State seasonally traps adults for hatchery brood collection. Only adults that are already being handled were sampled for GBT. Since adult fish are much larger than juvenile they were not examined under a microscope. Instead, adults were examined both with the "naked-eye" and a handheld lens. Adults were examined in the following locations, the eyes, lateral line and fins. For adults, the presence or absence of bubbles/emboli was recorded.

## 2.3 Statistical Analyses

We plotted the date and corresponding TDG level observed in the Rocky Reach forebay during the sample day, against the percent of fish showing signs of GBT (irrespective of species or severity) to illustrate GBT expression in juvenile fish throughout the season. Subsequently, we plotted total dissolved gas concentrations continuously (irrespective of date), against GBT expression (percent presence) and used a linear regression (or polynomial where appropriate) analysis to see if there was a positive correlation between TDG concentration and GBT response in smolts.

Upon finding that TDG was a significant positive correlate to GBT expression, we used similar linear regressions to discern how TDG predicted species specific GBT expression. However, species separation reduced our sample size for these analyses dramatically. Further, species specific analyses only included days where more than five fish of a given species were evaluated for GBT in the Rock Reach bypass sample. Given these reductions in sample size, species specific regression analyses could only be conducted on Coho, subyearling Chinook and sockeye. Steelhead and yearling Chinook were left out of these species specific analyses given the low sample numbers for these species (much of these runs were completed during the later spill season sampling days).

Finally, we showed graphical interpretations of severity over the course of the spill season and plotted severity proportions against TDG concentration in the Rocky Reach forebay. To describe trends in severity by species we calculated each fish's "total severity score". This score was calculated on a scale of 0-16, where the severity score at each tissue location was summed. For example, if I fish had a severity score of 0 on the anal fin, 0 in the eye, 1 in the dorsal, and 4 in the caudal fin, this fish was given a total severity score of 5 (the sum of these scores). Once each fish of a given species was assigned a total severity score the average score was calculated for each species, regardless of TDG concentration. The total severity score means between species were compared using a one-way ANOVA. A Tukey-Kramer HSD post hoc analysis was performed to determine where the differences existed once the total severity means were confirmed to be different among the species. Means are expressed as plus or minus one standard deviation. All significance was assessed to an alpha of 0.05 and all analyses were performed in JMP 7.0.2 (SAS).

# 3.0 RESULTS AND DISCUSSION

Over the course of the biological monitoring period five juvenile anadromous fish species were examined, including spring and summer Chinook, steelhead, sockeye and Coho. District biologists sampled juveniles on 28 days over a two month span (May 21 to July 21). An average of 44 ±25.7 (standard deviation) juveniles were sampled on each of these sampling days, across a TDG range of 120-134% (daily mean; Rocky Reach forebay). Together, District staff examined 1234 juvenile fish across this TDG spectrum. In addition, District staff and the Washington Department of Fish and Wildlife examined 474 adult Chinook salmon captured at Wells Dam fish ladders during broodstock collection activities with only one confirmed case of GBT despite sampling fish when TDG was between 125-137%.

## 3.1 Juveniles

GBT expression in juveniles tracked TDG concentrations relatively well. The largest proportion of GBT was observed during the peak of TDG production in late May 2011. The high production of TDG was related to drafting in the Lake Roosevelt reservoir, and resulting high spill volume at Grand Coulee. As a result TDG in the Rocky Reach forebay was between 130-

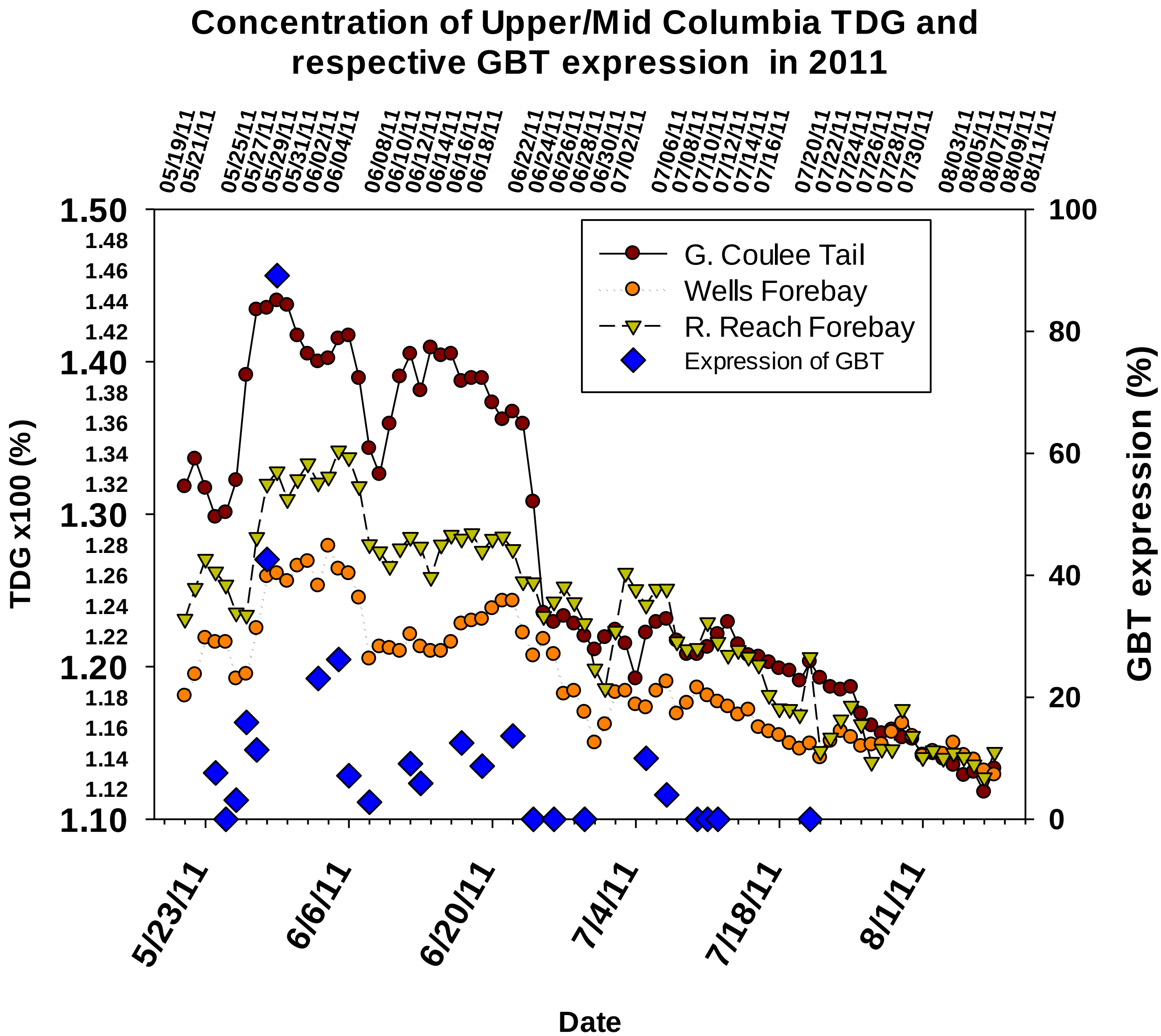



Figure 3. Concentrations of TDG through the mid and upper Columbia River during the 2011 spill season and GBT expression in juvenile salmonids observed at Rocky Reach dam during the same time periods.

A polynomial regression revealed a significant relationship between TDG observed in the Rocky Reach forebay and the proportion of GBT expression observed in sampled (Figure 4). GBT expression was regularly less than 15%, and often 0 % when TDG was less than 125%. Juveniles began to show more GBT symptoms once TDG was above 125%. A noticeable increase occurred after 130%, with no more than 20% of the population showing sign of GBT

b
1

·90% of the population above

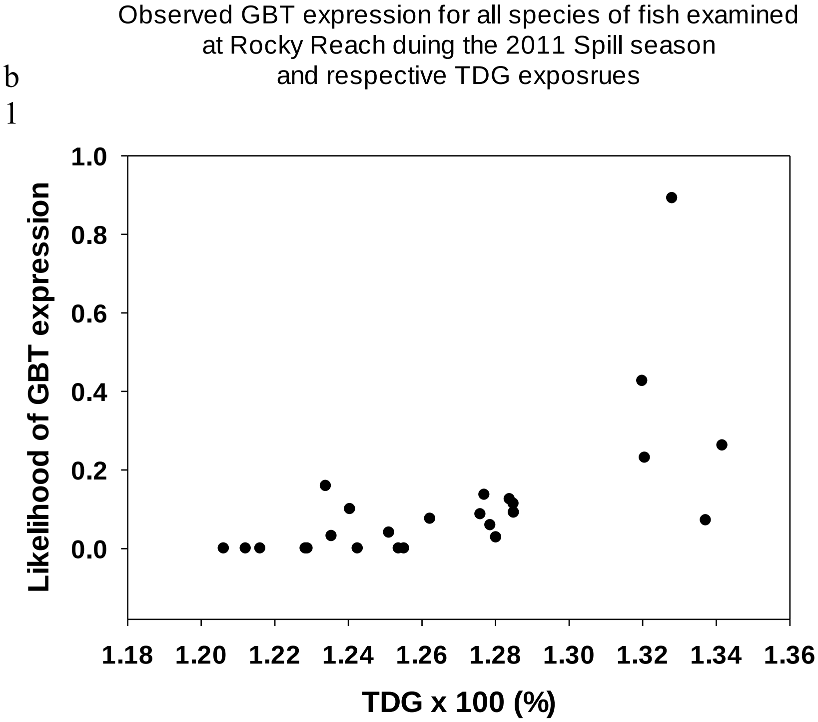



Figure 4. Observed GBT expression for all species of juvenile salmonids (yearling and subyearling Chinook, sockeye, and steelhead) at given TDG concentration in the Rocky Reach forebay. The included polynomial regression represents a significant relationship between the two variables ($p = 0.0025$, $R2= 0.42$, $df = 24$).

Species specific differences were difficult to evaluate since the run composition changes through the spring and summer. In the early weeks of the spring spill season, the juvenile sample was dominated by yearling Chinook, and Steelhead. These species were also exposed to the highest TDG concentrations in late May and early June. By mid June the sample at Rocky reach was dominated by subyearling Chinook, and TDG had decreased dramatically (Figure 3). Due to sample size we were able to analyze the relationship of TDG concentration and GBT expression in Coho, subyearling Chinook and sockeye only. In each case, TDG was a significant correlate for GBT expression (Figure 5). Results indicate dramatic differences between species existed, with Coho being the most susceptible to GBT at any give TDG concentration. Sockeye and subyearling Chinook appeared to have more comparable resilience to TDG. For example, at a TDG concentration of 126% species specific curves would predict GBT presence in less than 5% of the sockeye and subyearling Chinook sampled, but as much as 50% of the Coho population (Figure 5). Possible explanations for this difference in susceptibility to TDG include behavioral differences between species (migrating swimming depth), stock-specific differences associated with local adaptations to TDG resilience, and physiological differences between species that cause differences in GBT expression at the same TDG concentrations. Although, we cannot explain the mechanism for this difference, the differences between species susceptibility to TDG were obvious.

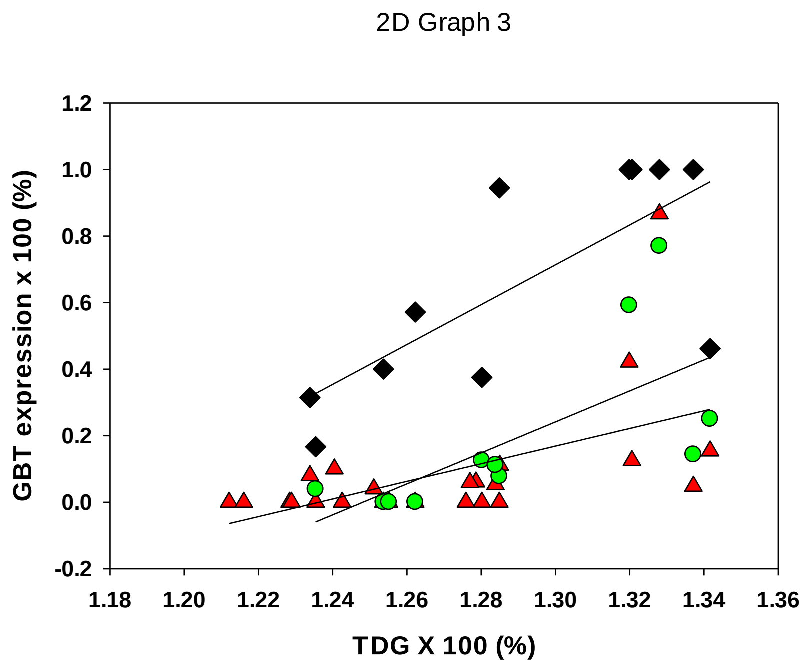



Figure 5. GBT expression in Coho (black diamonds), subyearling Chinook (red triangles) and sockeye (green circles), at various TDG concentration. Yearling Chinook and steelhead were left out of the species specific analysis since low numbers were sampled throughout the biological monitoring period, since the bulk of these runs had already passed. Linear regressions are included and were found to be significant for each species in the figure, where Coho; ($p$ = 0.01, $R2$= 0.54, df = 10); Subyearling Chinook ($p$ = 0.02, $R2$= 0.29, df = 23); and sockeye ($p$ = 0.024, $R2$= 0.45, df = 10)

Severity of GBT expression also appeared to correlate positively with TDG concentrations, if not qualitatively (Figure 6). As TDG increased the relative frequency of higher severity scores (2-4) increased. Throughout the season severity scores of 1 were the most frequent. In most cases fish would show subtle symptoms of GBT in one location being evaluated (eyes and unpaired fins). Severity scores of 3 and 4 occurred very infrequently in the population of juveniles examined throughout the season. Scores of 4 were only seen in those fish sampled before the middle of June and were rare in Chinook, steelhead and sockeye. Therefore, as TDG decreased the severity of GBT expression also decreased.

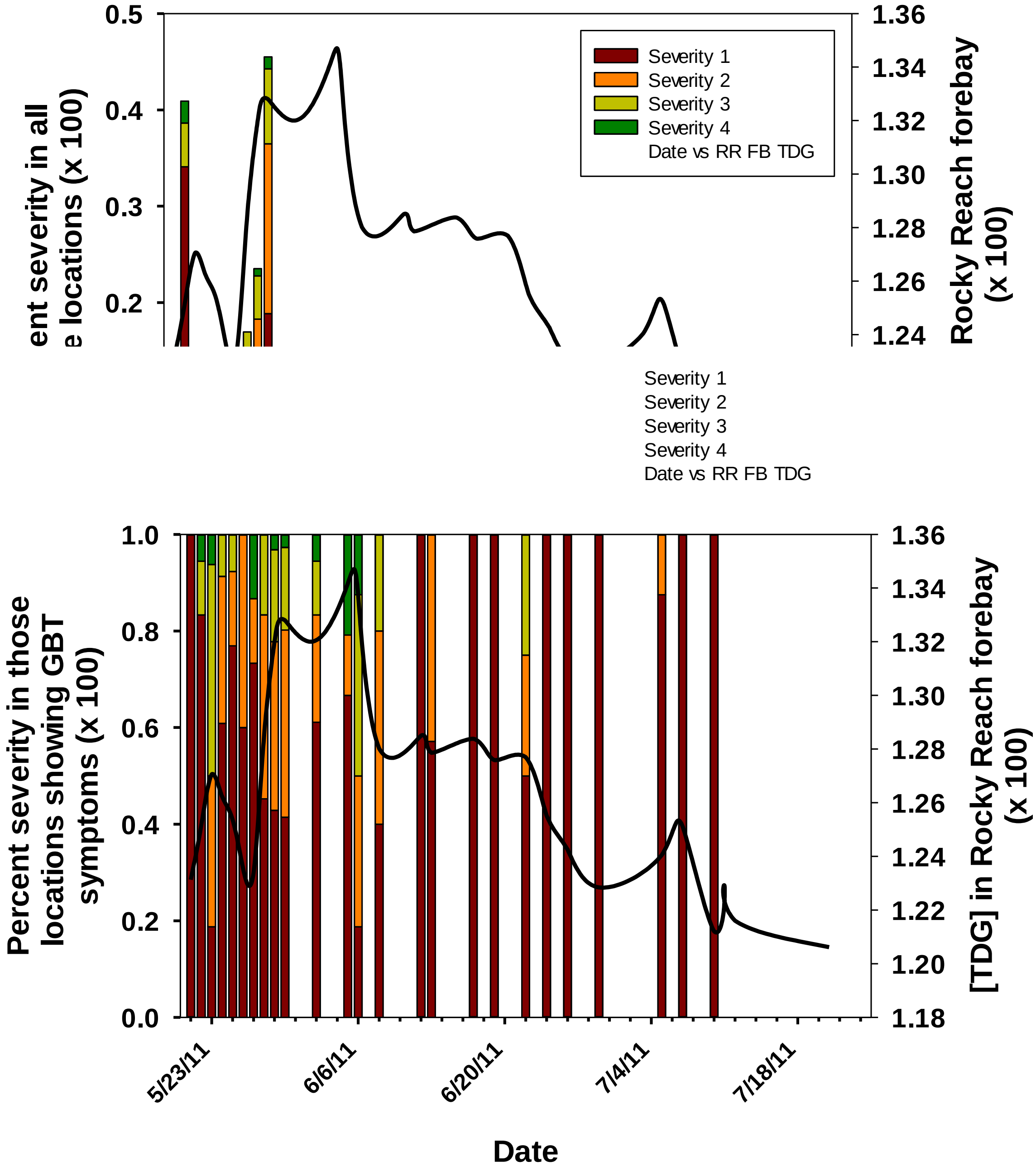



Figure 6. Severity of GBT symptoms observed in juveniles collected at Rocky Reach JBS, expressed as the percentage of severity in all tissues examined (top panel) and the percentage of severity in only those fish showing some signs of GBT on a given day (bottom panel)

Five hundred and eleven subyearling Chinook, 140 yearling Chinook, 166 coho, 60 steelhead, and 161 sockeye were identified to species during GBT examinations. Out of a possible total severity score of 16 only Coho had an average severity score above 1 (2.32), which was significantly higher than all other species (Tukey-Kramer HSD), and highlights Coho's increased susceptibility to GBT (Table 1). However, species composition was not consistent throughout the season. For example, subyearling Chinook were dominant in the sample towards the end of the season, which was also the time when lower TDG levels were present above Rocky Reach dam, and thus their severity scores may be depressed as a result of lower TDG exposure. Notably, the highest single fish total severity score was a 10 (out of a possible 16) and was observed in a Coho examined during the June 5th sample. No other species had any fish with a total severity score of more than 8. None of the subyearling Chinook had a total severity score of more than 4 (Table 1). Table 1 also shows the percent of fish showing some amount of GBT throughout the season. The overall percent of fish showing symptoms of GBT was 21% throughout the season, when TDG in the Wells tailrace was exceeding 125%.

Table 1. Species specific expression of GBT and severity scores over the season.

| | Species | | | | |
|---|---|---|---|---|---|
| | **CH0** | **CH1** | **SH** | **SK** | **CO** |
| No. Examined | 511 | 140 | 60 | 161 | 166 |
| No. Exhibiting GBT | 40 | 31 | 20 | 34 | 98 |
| Percent Exhibiting GBT | 8% | 22% | 33% | 21% | 59% |
| | | | | | |
| Maximum total severity score* of any fish throughout the season | 4 | 8 | 8 | 5 | 10 |
| Average total severity score (0-16)* | 0.12 (±0.48) | 0.51 (±1.26) | 0.78 (±1.55) | 0.42 (±0.99) | 2.32 (±2.58) |
| Tukey-Kramer HSD (p<0.001) # | A | B | B | AB | C |

* Severity score mean from 0-16 was calculated by summing the scores at each tissue location examined (eyes and unpaired fins; 4 locations times a possible score of 4 at each location = 16) for each fish, adding these scores for each fish within a species, and dividing by the number of fish in a given species examined.

# Dissimilar letters represent significant differences from other species average total severity scores.

## 3.2 Adults

Adults captured at Wells dam have shown little to no expression of GBT over the high TDG period. During the weeks of May 23rd and May 30th a total of 199 and 68 adult fish at Wells dam were collected from the west and east fish ladders respectively. Measureable amounts of GBT were suspected in 2 fish of these fish. During the week of June 6th, 167 fish from the west ladder, and 40 from the east ladder were also collected and examined for signs of GBT. During this week 11 possible signs and one confirmed sign of GBT were observed. Together. 474 adult salmon were examined at Wells dam, with 1 (0.2%) confirmed case of GBT (Figure 7), and 13 (2.5%) unconfirmed cases. Over the course of this adult sampling period TDG was 125-137%. Adult GBT sampling was concluded following the week of June 6th, since State brood collection was completed for spring Chinook salmon and TDG had subsided during periods of additional broodstock collection activities. Figure 8 shows examples of fish examined for GBT during the adult sampling.

Figure 7. Adult spring Chinook sampled on 05-24-11 at Wells Dam east fish ladder. Anal fin hemorrhaging may or may not be related to GBT since emphysema and embolisms were not present.

Figure 8. Four spring Chinook sampled from 06-01-11 sampling at Wells Dam east fish ladder. Fish were immediately sampled once they entered the ladder trap.

## 4.0 SUMMARY OF SAMPLING

Together, juvenile results indicate that the 125% TDG value, as a threshold that requires biological monitoring, is consistent with the level where GBT begins to be expressed in juveniles at Rocky Reach. GBT expression occurred in 0-20% of the juvenile population when TDG levels were between 125-130%. When TDG concentrations were found to exceed 130%, GBT expression could be found in 0-90% of the juvenile population. Data suggests that positive, linear (or polynomial) relationships exist between the percent TDG found in the Rocky Reach forebay and the percent of GBT expression exhibited by sampled juveniles. Further, important species specific differences were observed at a given TDG concentration. Adults appear most resilient to high TDG concentrations with Spring Chinook adult that were concurrently sampled as part of a brood collection effort showed little signs of GBT expression, even when tailrace concentrations were above 130%.

**Appendix 6. Ecology-Approved 12C-High Calculation Method.**

April 2, 2008

TO: Columbia and Snake River Dam Spill Operators

FROM: Chris Maynard, Hydropower Coordinator, Washington State Department of Ecology

RE: Method for averaging 12 consecutive daily average high TDG readings in any one day

I have been asked to clarify how Ecology expects operators to measure TDG during fish passage spill on the Columbia and Snake Rivers.

Washington's previous 1997 total dissolved gas (TDG) Water Quality Standards (WQS) for fish spill on the Snake and Columbia Rivers required TDG measurements to be taken at least hourly and the 12 highest measurements averaged over the course of a day. A day was assumed to be a 24 hours period although the start and end time were never clearly defined. The operators averaged measurements and reported based on a calendar day, starting at 12:a.m. and ending at 12 am. The term 'day' did not need to be defined because averaging any high TDG from midnight to midnight captured all high TDG readings. Often the high readings for tailraces would occur during the early hours after midnight and in the evening hours with a period of lower readings in between during the day. This is because fish spill often occurs more at night.

The revised 2006 Washington WQS require measuring the average of the 12 highest *consecutive* hours in any one day. This is because at 120% TDG or less, studies have shown that aquatic organisms experience the most TDG harm from consecutive exposure, not intermittent exposure throughout a 24 hour period. High TDG and corresponding spills tend to occur during consecutive blocks of time. Measuring midnight to midnight breaks up the consecutive period of nightly high TDG.

<u>Beginning during the 2008 spill season, the operators should use the following method to average and report the 12 consecutive hourly high TDG reading in a day:</u>

*Method*: Use a rolling average to measure 12 consecutive hours. The highest 12 hour average in 24 hours is reported on the calendar day (ending at midnight) of the final measurement.

- The first averaging period of each calendar day begins with the first hourly measurement at 1:00 a.m. This hour is averaged with the previous day's last 11 hourly measurements.
- Each subsequent hourly measure is averaged with the previous 11 hours until there are 24 averages for the day.
- From the 24 hour averages, the highest average is reported for the calendar day.
- Round 12 hour average to nearest whole number.

*Rationale for the rolling average:* The standards say "in any one day", but a day need not be a calendar day. Defining a day as starting at a set hour (like midnight) and ending 24 hours later leaves only twelve 12-hour blocks to average within 24 hours. If a period ends at midnight, night spill TDG measurements would be cut off during the middle of the night and the consecutive readings of the highest spill period would not be averaged since the period from 12 midnight on would not be counted with the previous day. So a rolling 12-hour average makes the most sense. This method best captures consecutive hours of high TDG not only below dams that spill at night, but also for dams that vary their hours of spill from nighttime. It also captures consecutive forebay reading which measure TDG from the upstream dam hours later.

The accompanying table shows an example of how the TDG should be tracked and averaged as a rolling average. It shows what hours will be reported for a day: the highlighted green and blue hours are those that are averaged each hour to report as May 19th. The first period evaluated for May 19th reporting begins with the first hour's measurements of the day. Since the previous 12 hour measurements are needed for a consecutive average, eleven of those hours (in the first highlighted column) will necessarily occur on May 18th. The next hour's measurement is then evaluated with the eleven hours previous, and so on through the day until the last measurement at midnight. There are now twenty-four averaging periods, and the highest average (ending at 2: a.m. May 19th) is chosen to report for May 19th.

Cc: Agnes Lut, ODEQ
Margaret Filardo, FPC
WQT
Pat Irle, Ecology
Marcie Mangold, Ecology

**Appendix 7. Wells Hydroelectric Project 2011 Fish Spill Season 12-C High Daily Flow and TDG Values.**

| Date | WEL (Wells Forebay) | WELW (Wells Tailwater) | RRH (Rocky Reach Forebay) | Flow (cfs) |
|---|---|---|---|---|
| 4/12/2011 | 107.4 | 109.2 | 108.0 | 157.46, |
| 4/13/2011 | 107.4 | 109.2 | 108.9 | 155.51, |
| 4/14/2011 | 103.7 | 106.5 | 109.0 | 145.18, |
| 4/15/2011 | 102.4 | 105.4 | 107.0 | 147.63, |
| 4/16/2011 | 104.3 | 107.0 | 106.5 | 128.13, |
| 4/17/2011 | 104.4 | 107.0 | 106.2 | 130.75, |
| 4/18/2011 | 104.1 | 106.3 | 105.9 | 133.52, |
| 4/19/2011 | 103.1 | 106.1 | 105.6 | 145.44, |
| 4/20/2011 | 104.8 | 107.3 | 106.6 | 144.04, |
| 4/21/2011 | 104.3 | 106.4 | 106.3 | 140.95, |
| 4/22/2011 | 104.1 | 105.9 | 105.8 | 148.82, |
| 4/23/2011 | 105.6 | 108.1 | 107.0 | 144.55, |
| 4/24/2011 | 106.4 | 108.7 | 108.1 | 134.74, |
| 4/25/2011 | 106.5 | 108.7 | 108.0 | 136.47, |
| 4/26/2011 | 105.5 | 107.9 | 107.1 | 142.99, |
| 4/27/2011 | 104.9 | 107.3 | 107.1 | 133.74, |
| 4/28/2011 | 105.7 | 108.1 | 107.2 | 138.98, |
| 4/29/2011 | 105.0 | 107.3 | 106.4 | 138.42, |
| 4/30/2011 | 105.6 | 107.6 | 106.3 | 133.63, |
| 5/1/2011 | 106.5 | 108.7 | 107.3 | 149.03, |
| 5/2/2011 | 107.1 | 109.2 | 108.5 | 145.23, |
| 5/3/2011 | 107.1 | 108.9 | 107.7 | 132.91, |
| 5/4/2011 | 107.1 | 109.1 | 108.1 | 136.23, |
| 5/5/2011 | 108.3 | 110.2 | 110.0 | 126.00, |
| 5/6/2011 | 108.6 | 110.8 | 110.1 | 147.57, |
| 5/7/2011 | 108.7 | 110.9 | 110.3 | 143.36, |
| 5/8/2011 | 108.4 | 110.3 | 110.1 | 140.75, |
| 5/9/2011 | 108.1 | 110.0 | 109.5 | 126.10, |
| 5/10/2011 | 108.1 | 111.2 | 110.0 | 163.37, |
| 5/11/2011 | 108.8 | 112.1 | 110.6 | 183.80, |
| 5/12/2011 | 107.1 | 111.3 | 109.4 | 189.66, |
| 5/13/2011 | 110.3 | 113.8 | 111.6 | 195.87, |
| 5/14/2011 | 112.2 | 114.6 | 113.2 | 194.03, |
| 5/15/2011 | 115.3 | 118.7 | 114.9 | 199.52, |
| 5/16/2011 | 114.8 | 117.1 | 115.5 | 182.12, |
| 5/17/2011 | 114.6 | 117.6 | 116.6 | 178.88, |
| 5/18/2011 | 114.9 | 119.3 | 116.0 | 213.76, |
| 5/19/2011 | 115.2 | 121.0 | 117.8 | 231.36, |
| 5/20/2011 | 120.0 | 126.0 | 120.0 | 244.27, |

| | | | | |
|---|---|---|---|---|
| 5/21/2011 | 118.3 | 127.0 | 125.1 | 266.06, |
| 5/22/2011 | 120.6 | 117.5 | 125.6 | 272.25, |
| 5/23/2011 | 122.1 | 127.7 | 127.8 | 258.42, |
| 5/24/2011 | 122.0 | 128.5 | 126.6 | 244.19, |
| 5/25/2011 | 122.2 | 127.4 | 125.8 | 237.40, |
| 5/26/2011 | 119.3 | 126.8 | 124.6 | 247.26, |
| 5/27/2011 | 119.7 | 131.2 | 125.0 | 274.47, |
| 5/28/2011 | 125.0 | 134.1 | 129.8 | 289.65, |
| 5/29/2011 | 126.9 | 135.1 | 132.7 | 292.35, |
| 5/30/2011 | 126.6 | 137.3 | 133.7 | 288.57, |
| 5/31/2011 | 126.3 | 133.9 | 131.3 | 293.02, |
| 6/1/2011 | 126.9 | 135.3 | 133.2 | 284.23, |
| 6/2/2011 | 127.3 | 137.7 | 133.4 | 283.23, |
| 6/3/2011 | 126.3 | 135.5 | 132.6 | 286.26, |
| 6/4/2011 | 129.1 | 137.3 | 133.3 | 287.88, |
| 6/5/2011 | 126.9 | 137.0 | 134.5 | 295.06, |
| 6/6/2011 | 126.3 | 136.5 | 133.9 | 285.19, |
| 6/7/2011 | 124.8 | 135.2 | 131.9 | 270.15, |
| 6/8/2011 | 121.5 | 130.9 | 128.4 | 261.30, |
| 6/9/2011 | 121.8 | 129.6 | 128.5 | 232.84, |
| 6/10/2011 | 121.4 | 128.6 | 127.3 | 251.34, |
| 6/11/2011 | 121.6 | 148.4 | 129.2 | 272.03, |
| 6/12/2011 | 122.8 | No Value | 128.9 | 265.57, |
| 6/13/2011 | 122.3 | No Value | 128.4 | 250.71, |
| 6/14/2011 | 121.1 | 131.0 | 127.3 | 276.41, |
| 6/15/2011 | 121.5 | 131.5 | 128.4 | 270.25, |
| 6/16/2011 | 121.9 | 132.1 | 129.6 | 266.86, |
| 6/17/2011 | 123.8 | 131.0 | 128.4 | 258.63, |
| 6/18/2011 | 123.6 | 130.7 | 129.0 | 263.33, |
| 6/19/2011 | 123.4 | 129.8 | 128.0 | 258.51, |
| 6/20/2011 | 123.9 | 131.4 | 129.8 | 252.75, |
| 6/21/2011 | 125.2 | 129.4 | 128.6 | 242.17, |
| 6/22/2011 | 124.5 | 129.1 | 128.1 | 250.21, |
| 6/23/2011 | 123.0 | 129.3 | 126.8 | 254.43, |
| 6/24/2011 | 121.1 | 126.4 | 126.3 | 233.02, |
| 6/25/2011 | 122.0 | 125.6 | 124.2 | 232.08, |
| 6/26/2011 | 121.5 | 127.2 | 125.4 | 232.79, |
| 6/27/2011 | 118.6 | 125.3 | 126.7 | 242.7 |
| 6/28/2011 | 118.8 | 127.1 | 125.6 | 237.16, |
| 6/29/2011 | 117.4 | 127.6 | 123.9 | 234.25, |
| 6/30/2011 | 115.2 | 121.9 | 122.3 | 237.23, |
| 7/1/2011 | 116.8 | 123.1 | 120.4 | 245, |
| 7/2/2011 | 119.2 | 129.1 | 124.1 | 245.30, |

| | | | | |
|---|---|---|---|---|
| 7/3/2011 | 118.7 | 129.2 | 126.7 | 230.20, |
| 7/4/2011 | 118.3 | 125.8 | 125.5 | 220.70, |
| 7/5/2011 | 117.7 | 126.4 | 124.6 | 237.10, |
| 7/6/2011 | 119.2 | 129.1 | 125.8 | 253.90, |
| 7/7/2011 | 119.5 | 126.8 | 126.8 | 258.30, |
| 7/8/2011 | 117.3 | 124.6 | 121.7 | 253, |
| 7/9/2011 | 118.0 | 123.6 | 121.4 | 244.90, |
| 7/10/2011 | 119.2 | 126.9 | 121.3 | 249, |
| 7/11/2011 | 118.3 | 125.2 | 123.9 | 233, |
| 7/12/2011 | 118.0 | 123.1 | 122.4 | 226.30, |
| 7/13/2011 | 117.8 | 125.0 | 120.9 | 233.70, |
| 7/14/2011 | 116.9 | 124.2 | 121.1 | 223.80, |
| 7/15/2011 | 117.7 | 124.2 | 121.1 | 211.40, |
| 7/16/2011 | 116.4 | 120.0 | 121.5 | 196.70, |
| 7/17/2011 | 116.4 | 119.5 | 118.3 | 186.50, |
| 7/18/2011 | 115.7 | 121.0 | 117.3 | 192, |
| 7/19/2011 | 115.2 | 120.5 | 118.4 | 198.20, |
| 7/20/2011 | 114.8 | 127.6 | 118.0 | 184.10, |
| 7/21/2011 | 115.2 | 122.1 | 123.0 | 187.10, |
| 7/22/2011 | 114.2 | 121.8 | 114.7 | 181.20, |
| 7/23/2011 | 115.5 | 121.9 | 116.2 | 181.40, |
| 7/24/2011 | 116.6 | 122.4 | 116.9 | 188.60, |
| 7/25/2011 | 116.2 | 121.7 | 118.1 | 170.90, |
| 7/26/2011 | 115.2 | 116.0 | 116.6 | 162.50, |
| 7/27/2011 | 115.0 | 115.7 | 114.0 | 172.20, |
| 7/28/2011 | 115.2 | 114.6 | 115.2 | 162.30, |
| 7/29/2011 | 116.0 | 119.2 | 115.1 | 169, |
| 7/30/2011 | 116.8 | 118.1 | 118.6 | 159.20, |
| 7/31/2011 | 116.1 | 116.2 | 115.7 | 148.30, |
| 8/1/2011 | 114.4 | 114.2 | 114.3 | 149.00, |
| 8/2/2011 | 115.0 | 113.1 | 115.2 | 158.78, |
| 8/3/2011 | 114.8 | 115.0 | 114.6 | 153.55, |
| 8/4/2011 | 115.5 | 115.8 | 115.2 | 143.88, |
| 8/5/2011 | 114.7 | 115.9 | 114.4 | 138.46, |
| 8/6/2011 | 114.5 | 117.4 | 113.7 | 151.16, |
| 8/7/2011 | 114.1 | 115.4 | 114.6 | 144.38, |
| 8/8/2011 | 114.1 | 115.4 | 113.5 | 141.80, |
| 8/9/2011 | 114.1 | 115.4 | 112.8 | 143.41, |
| 8/10/2011 | 114.0 | 115.3 | 112.8 | 147.20, |
| 8/11/2011 | 112.2 | 113.8 | 112.4 | 153.34, |
| 8/12/2011 | 112.0 | 113.4 | 112.2 | 155.69, |
| 8/13/2011 | 112.3 | 114.0 | 112.7 | 133.40, |
| 8/14/2011 | 111.3 | 112.9 | 111.4 | 128.93, |

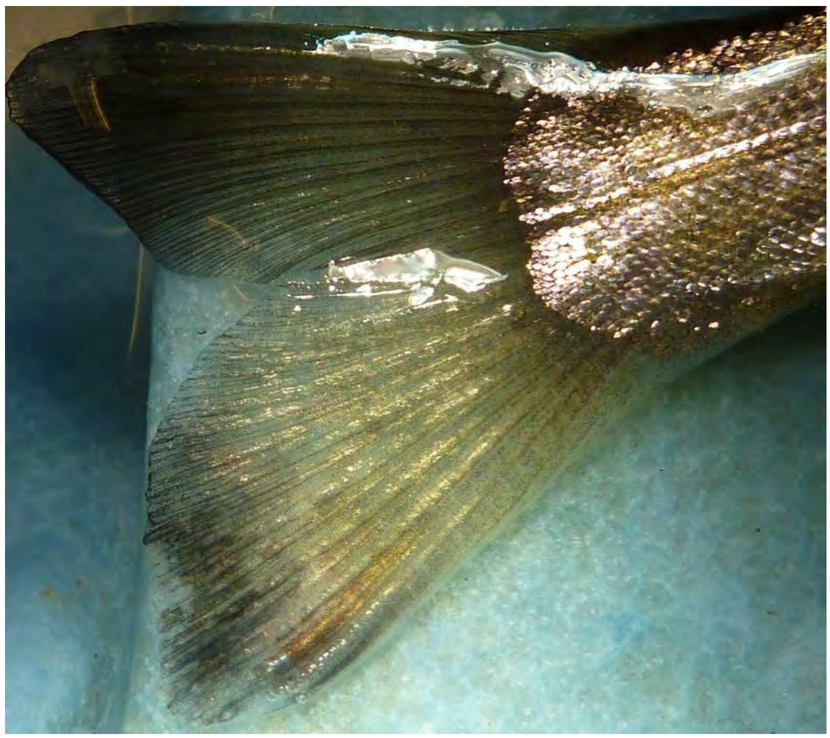
| | | | | |
|---|---|---|---|---|
| 8/15/2011 | 111.0 | 112.5 | 110.3 | 145.1 |
| 8/16/2011 | 110.6 | 112.7 | 110.4 | 154.9 |
| 8/17/2011 | 110.7 | 113.1 | 111.1 | 149.4 |
| 8/18/2011 | 110.7 | 113.1 | 110.6 | 153.6 |
| 8/19/2011 | 110.4 | 112.8 | 111.5 | 143.7 |
| 8/20/2011 | 111.1 | 112.9 | 112.2 | 132.3 |
| 8/21/2011 | 111.8 | 113.5 | 111.4 | 137.2 |
| 8/22/2011 | 110.9 | 112.6 | 111.1 | 141.6 |
| 8/23/2011 | 109.0 | 113.1 | 110.3 | 145.5 |
| 8/24/2011 | 109.8 | 112.1 | 111.1 | 143.3 |
| 8/25/2011 | 110.1 | 111.7 | 110.3 | 128.0 |
| 8/26/2011 | 110.0 | 111.7 | 110.2 | 141.5 |

# 2011 WELLS PROJECT GAS BUBBLE TRAUMA BIOLOGICAL MONITORING REPORT (REVISED FEBRUARY 2012)

# 2011 GAS BUBBLE TRAUMA BIOLOGICAL MONITORING

# WELLS HYDROELECTRIC PROJECT

# FERC NO. 2149



February, 2012

Prepared by:
Andrew Gingerich & Beau Patterson
Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

For copies contact:

Public Utility District No. 1 of Douglas County
Attn: Natural Resources
1151 Valley Mall Parkway
East Wenatchee, WA 98802-4497
Phone: (509) 884-7191

**Table of Contents**

## List of Tables

## List of Figures

# 1.0 SUMMARY

As part of Public Utility District No. 1 of Douglas County's (Douglas PUD) Gas Abatement Plan (GAP), Douglas PUD is required to examine migrating salmonids if total dissolved gas (TDG) in the Wells tailrace exceeds 125%. Primary physical monitoring evaluates TDG concentrations below and above Wells Dam, and occurs during the fish spill season. In 2011 spill season occurred between April 12th and August 26th. The biological monitoring commitment serves as a secondary monitoring tool when TDG approaches levels that have been documented to cause acute harmful effects to aquatic life.

When 125% TDG exceedance occurred in the Wells tailrace, juveniles and adult salmonids were examined for gas bubble trauma/disease (GBT) on the day following the exceedance. Juveniles were sampled at Rocky Reach juvenile bypass facility. Adult fish examinations took place concomitantly with the Washington Department of Fish and Wildlife's (WDFW) monitoring and evaluation activities at Wells Dam. Many of the methods used during Douglas PUD's biological monitoring followed those used by The Fish Passage Center's Smolt Monitoring Program and are, therefore, similar to those used at other hydroelectric projects on the lower Columbia and Snake rivers.

During the 2011 season, biological monitoring was initiated on May 21st and continued daily as TDG levels above and below Wells Dam remained above 125%. Daily observations continued until Monday May 30th, 2011 when the Washington Department of Ecology (Pat Irle Pers. Comm.) approved a three day/week sampling schedule when TDG levels are sustained above 125%. Douglas PUD continued to monitor TDG conditions and biological responses into late July.

Overall, GBT expression in juvenile salmonids examined at Rocky Reach was variable, and appeared to track TDG concentrations reasonably well. GBT expression was confounded by species specific sensitivities to levels of TDG coupled with changes in the run composition during the spill season. Juvenile salmonids expressed varied amount of GBT by species. Coho expressed the highest incidence of GBT with steelhead and yearling Chinook expressing intermediate GBT and sockeye and subyearling Chinook appearing to be the most resilient to high TDG concentrations. Throughout the season, adult fish sampled at Wells Dam showed few symptoms of GBT, even when TDG was above 130% in the Wells tailrace.

# 2.0 METHODS

## 2.1 Juvenile Sampling Methods

Juvenile sampling took place downstream of Wells Dam at the Rocky Reach Juvenile Bypass Collection (RRJBC) facility on the day after an exceedance. Index samples are taken at RRJBC on the top of the hour, 24 hours a day early in the season, and from 0800-1100 during the latter spill season. Samples last 30 minutes or until the raceway carrying capacity is reached (National Marine Fisheries Service sets this capacity; Lance Keller Personal Communication). After fish were examined by RRJBC personnel, Douglas PUD biologists examined a subsample of index fish for GBT.

The unpaired fins (dorsal, caudal and anal), and eyes were examined for signs of GBT in juvenile fish. The proportion of area covered with bubbles was quantified for each fin or eye following methods prescribed in the Fish Passage Center's GBT monitoring protocol. For juveniles, all examinations were conducted using a variable magnification dissecting scope (6X to 40X). A tray, allowing fish to be continually anesthetized with 30mg/l MS-222 during the GBT examination, was placed under the microscope to facilitate examinations (Figure 1). Buckets placed above the fish fed anesthetic water to the fish via gravity for the duration of the examination (Figure 1). Fish were already anaesthetized by RRJBC staff using a 50mg/l MS-222 dose prior to the GBT examination. After the examination, fish were returned to the Juvenile Bypass System (JBS) following protocols provided by RRJBC staff.

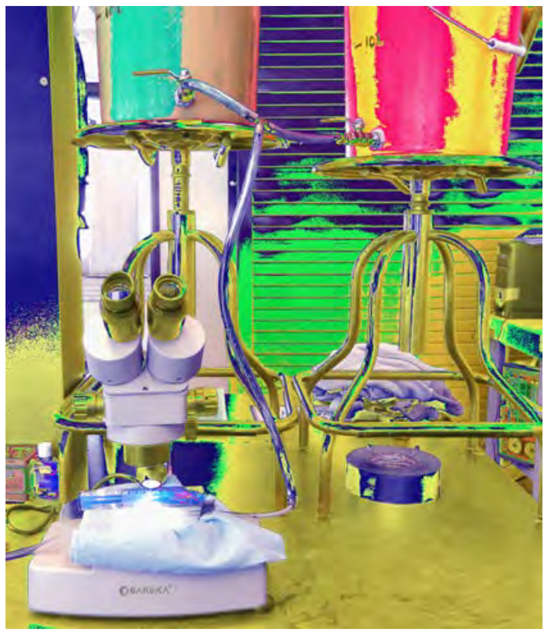


**Figure 1. GBT examination station used at Rocky Reach juvenile bypass facility to examine juvenile salmonids exposed to high TDG concentrations.**

### 2.1.1 Sample Size and Composition

No more than 40 juveniles were sampled from each hourly index sample from the Rocky Reach juvenile fish bypass. Often more than one index sample was used to collect GBT information. The total numbers of fish examined each sample day was based on the availability of fish at Rocky Reach Dam on the day after the exceedance. Species composition of the sample was random and shifted through the year and is associated with composition of the run at large.

### 2.1.2 GBT Ranks

GBT data was recorded based on the percent area of the fin or eye that was covered with bubbles. The eye with the highest level of bubble occlusion was used for ranking. Figure 2 shows the spectrum of GBT that can be exhibited in the caudal fin of juvenile salmonids. Ranks were evaluated as follows:

- **0= no signs of bubbles/emphysema/emboli in the tissue/fin**
- **1=1-5% of bubbles/emphysema/emboli in the tissue/fin**
- **2= 6-25% of bubbles/emphysema/emboli in the tissue/fin**
- **3= 26-50% signs of bubbles/emphysema/emboli in the tissue/fin**
- **4= >50% bubbles/emphysema/emboli in the tissue/fin**.

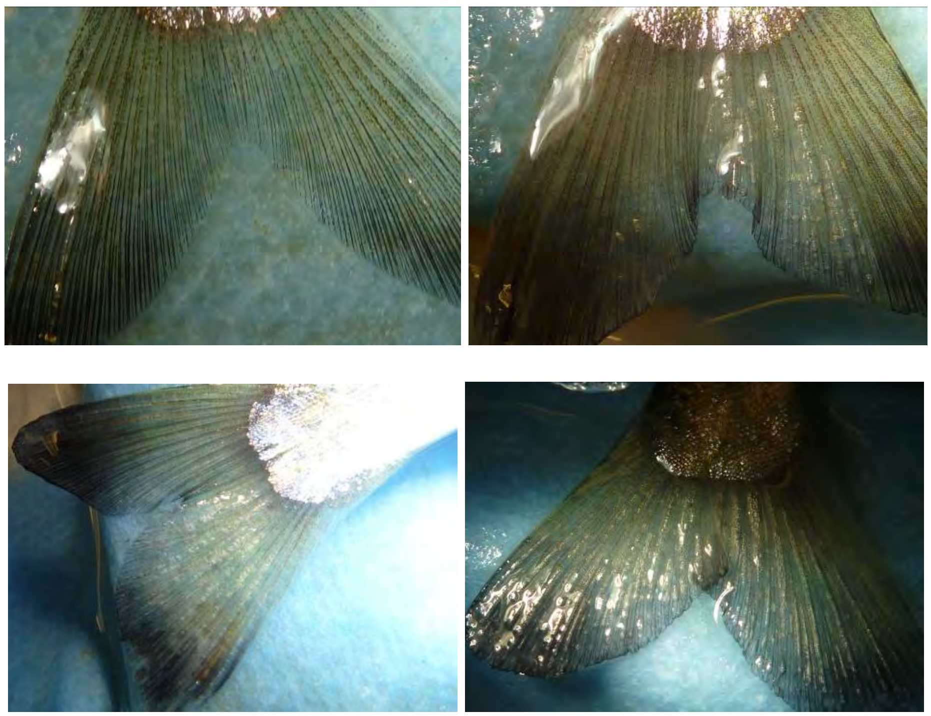


**Figure 2. Examples of GBT severity ranges from four individual samples in 2011 at the Rocky Reach juvenile bypass facility.**

## 2.2 Adult Fish Protocol

Adult examinations were conducted concomitantly with the WDFW staff. WDFW seasonally traps adults for hatchery brood collection. Only adults that are already being handled were sampled for GBT. Since adult fish are much larger than juvenile they were not examined under a microscope. Instead, adults were examined both with the "naked-eye" and a handheld lens. Adults were examined in the following locations: the eyes, lateral line and fins. For adults, the presence or absence of bubbles/emboli was recorded.

## 2.3 Statistical Analyses

Douglas PUD staff plotted the date and corresponding TDG level observed in the Rocky Reach forebay during the sample day, against the percent of fish showing signs of GBT (irrespective of species or severity) to illustrate GBT expression in juvenile fish throughout the season. Subsequently, staff plotted total dissolved gas concentrations continuously (irrespective of date), against GBT expression (percent presence) and used a linear regression (or polynomial where appropriate) analysis to see if there was a positive correlation between TDG concentration and GBT response in smolts.

Upon finding that TDG was a significant positive correlate to GBT expression, staff used similar linear regressions to discern how TDG predicted species-specific GBT expression. However, species separation reduced our sample size for these analyses dramatically. Further, species specific analyses only included days where more than five fish of a given species were evaluated for GBT in the Rocky Reach bypass sample. Given these reductions in sample size, species specific regression analyses could only be conducted on coho, subyearling Chinook and sockeye. Steelhead and yearling Chinook were not included in species-specific analyses given the low sample numbers for these species.

Finally, staff showed graphical interpretations of severity over the course of the spill season and plotted severity proportions against TDG concentration in the Rocky Reach forebay. To describe trends in severity by species we calculated each fish's "total severity score". This score was calculated on a scale of 0-16, where the severity score at each tissue location was summed. For example, if a fish had a severity score of 0 on the anal fin, 0 in the eye, 1 in the dorsal, and 4 in the caudal fin, this fish was given a total severity score of 5 (the sum of these scores). Once each fish of a given species was assigned a total severity score the average score was calculated for each species, regardless of TDG concentration. The total severity score means by species were compared using a one-way ANOVA. A Tukey-Kramer HSD post hoc analysis was performed to determine where the differences existed once the total severity means were confirmed to be different among the species. Means are expressed as plus or minus one standard deviation. All significance was assessed to an alpha of 0.05 and all analyses were performed in JMP 7.0.2 (SAS).

# 3.0 RESULTS AND DISCUSSION

Over the course of the biological monitoring period five juvenile anadromous fish species were examined, including spring and summer Chinook, steelhead, sockeye and coho. District biologists sampled juveniles on 28 days over a two month span (May 21 to July 21). An average of 44 ± 25.7 (standard deviation) juveniles were sampled on each of these sampling days, across a TDG range of 120-134% (daily mean; Rocky Reach forebay). Together, Douglas PUD staff examined 1,234 juvenile fish across this TDG spectrum. In addition, Douglas PUD staff and the WDFW examined 474 adult Chinook salmon captured at Wells Dam fish ladders during broodstock collection activities with only one confirmed case of GBT despite sampling fish when TDG was between 125-137%.

## 3.1 Juveniles

GBT expression in juveniles tracked TDG concentrations relatively well. The largest proportion of GBT was observed during the peak of TDG production in late May 2011. The high production of TDG was related to drafting in the Lake Roosevelt reservoir, and resulting high spill volume at Grand Coulee Dam. As a result TDG in the Rocky Reach forebay was between 130-135% during the late May early June period. Juvenile GBT expression generally decreased throughout the season and was observed in 0-20% of the sample after June 22, 2011 (Figure 3).

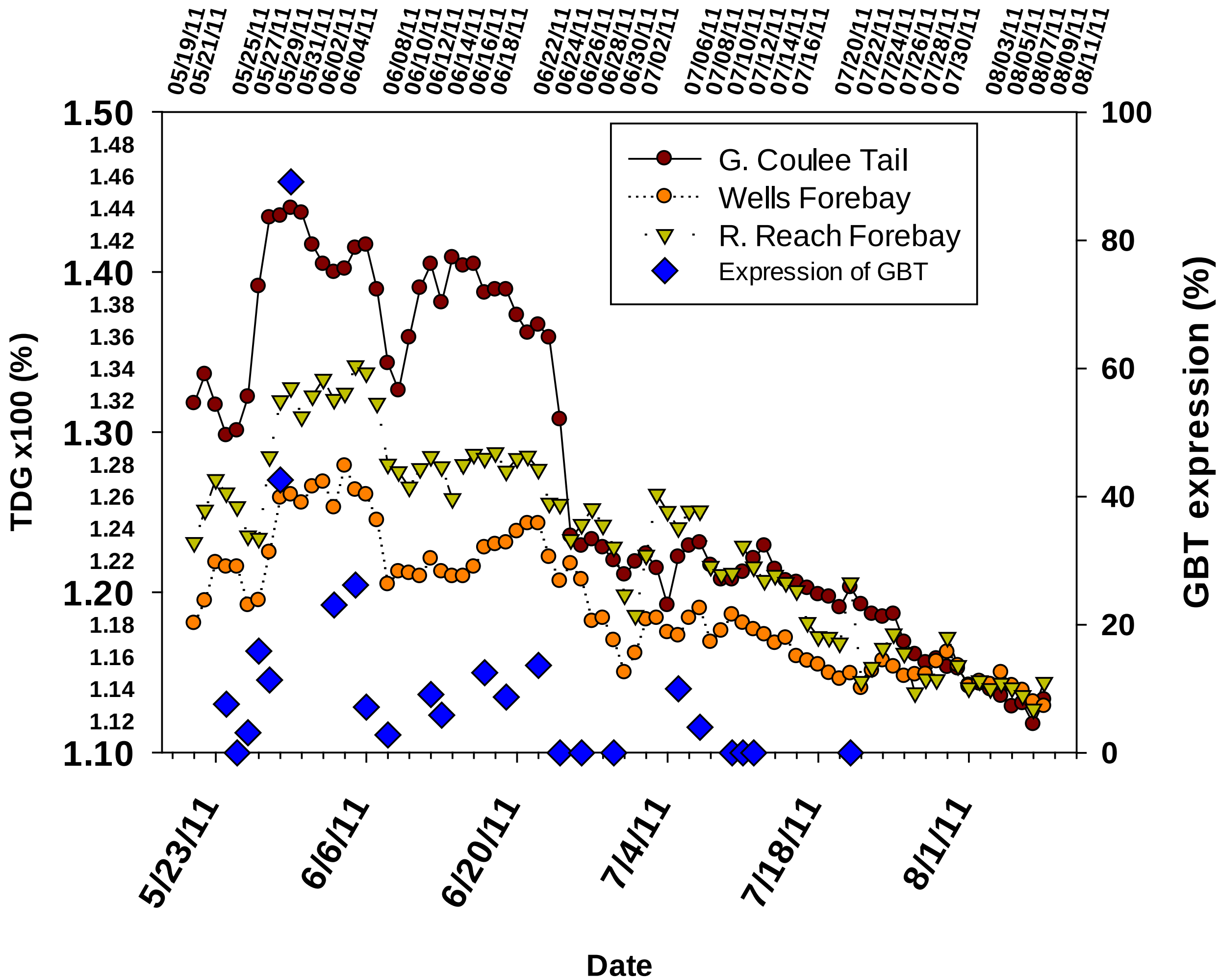



**Figure 3.** **Concentrations of TDG through the mid and upper Columbia River during the 2011 spill season and GBT expression in juvenile salmonids observed at Rocky Reach Dam during the same time periods.**

A polynomial regression revealed a significant relationship between TDG observed in the Rocky Reach forebay and the proportion of GBT expression observed in samples (Figure 4). GBT expression was regularly less than 15% and often 0% when TDG was less than 125%. Juveniles began to show more GBT symptoms once TDG was above 125%. A noticeable increase occurred after 130% with no more than 20% of the population showing signs of GBT below this mark. Expression was highly variable ranging between 0-90% of the population above 130% (Figure 4).

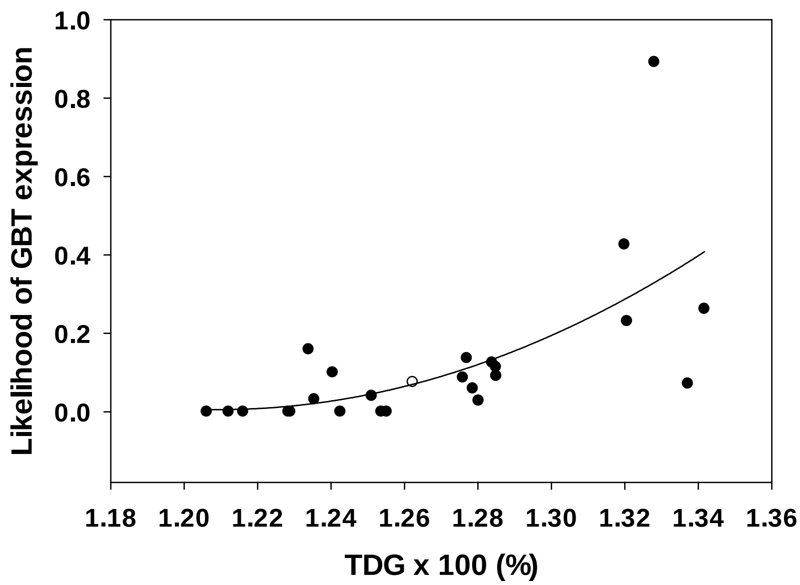



**Figure 4.** **Observed GBT expression for all species of juvenile salmonids (yearling and subyearling Chinook, sockeye, and steelhead) at given TDG concentration in the Rocky Reach forebay. The included polynomial regression represents a significant relationship between the two variables ($p = 0.0025$, R2= 0.42, df = 24).**

Species specific differences were difficult to evaluate since the run composition changes through the spring and summer. In the early weeks of the spring spill season, the juvenile sample was dominated by yearling Chinook and steelhead. These species were also exposed to the highest TDG concentrations in late May and early June. By mid June the sample at Rocky Reach was dominated by subyearling Chinook, and TDG had decreased dramatically (Figure 3). Due to sample size limitations, the relationship of TDG concentration and GBT expression was analyzed for coho, subyearling Chinook and sockeye only. In each case, TDG was a significant correlate for GBT expression (Figure 5). Results indicate dramatic differences between species existed, with coho being the most susceptible to GBT at any given TDG concentration. Sockeye and subyearling Chinook appeared to have more comparable resilience to TDG. For example, at a TDG concentration of 126% species specific curves would predict GBT presence in less than 5% of the sockeye and subyearling Chinook sampled, but as much as 50% of the coho population (Figure 5). Possible explanations for this difference in susceptibility to TDG include behavioral differences between species (migrating swimming depth), stock-specific differences associated with local adaptations to TDG resilience, and physiological differences between species that cause differences in GBT expression at the same TDG concentrations. We did not determine the mechanism for this difference.

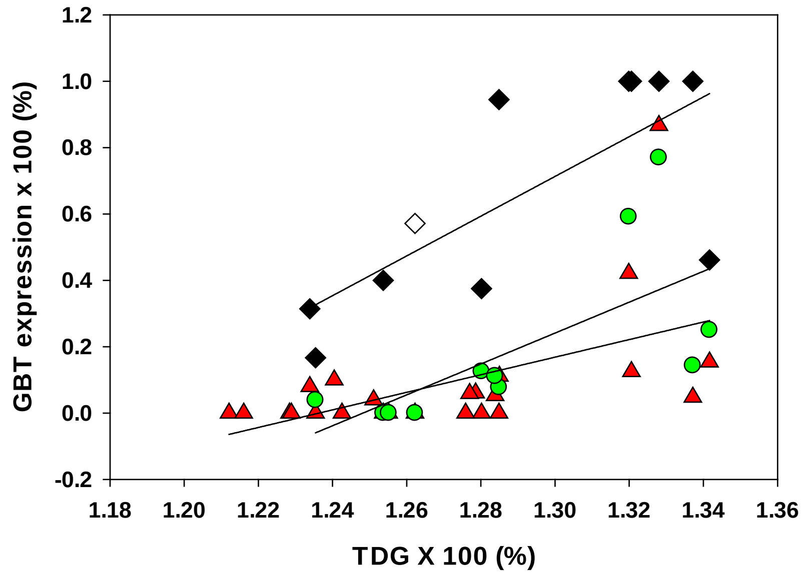



**Figure 5.** **GBT expression in coho (black diamonds), subyearling Chinook (red triangles) and sockeye (green circles), at various TDG concentration. Yearling Chinook and steelhead were left out of the species specific analysis since low numbers were sampled throughout the biological monitoring period, since the bulk of these runs had already passed. Linear regressions are included and were found to be significant for each species in the figure, where coho; ($p = 0.01$, R2= 0.54, df = 10); subyearling Chinook ($p = 0.02$, R2= 0.29, df = 23); and sockeye ($p = 0.024$, R2= 0.45, df = 10)**

Severity of GBT expression also appeared to correlate positively with TDG concentrations (Figure 6). As TDG increased the relative frequency of higher severity scores (2-4) increased. Throughout the season severity scores of 1 were the most frequent. In most cases fish would show subtle symptoms of GBT in one location being evaluated (eyes and unpaired fins). Severity scores of 3 and 4 occurred very infrequently in the population of juveniles examined throughout the season. Scores of 4 were only seen in those fish sampled before the middle of June and were rare in Chinook, steelhead and sockeye. Therefore, as TDG decreased the severity of GBT expression also decreased.

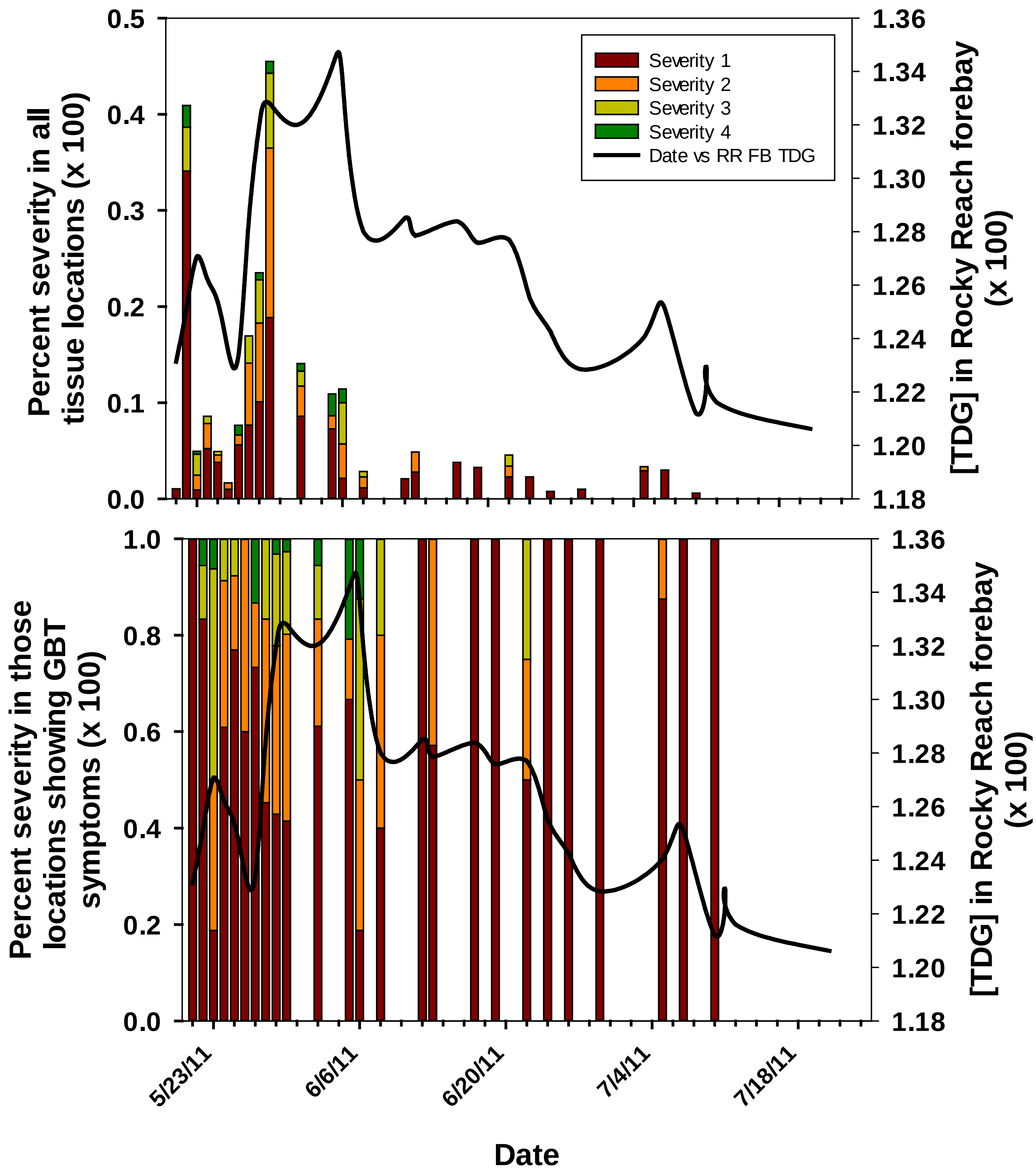



**Figure 6.** **Severity of GBT symptoms observed in juveniles collected at Rocky Reach JBS, expressed as the percentage of severity in all tissues examined (top panel) and the percentage of severity in only those fish showing some signs of GBT on a given day (bottom panel).**

Five hundred and eleven subyearling Chinook, 140 yearling Chinook, 166 coho, 60 steelhead, and 161 sockeye were identified to species during GBT examinations. Out of a possible total severity score of 16 only coho had an average severity score above 1 (2.32), which was significantly higher than all other species (Tukey-Kramer HSD), and highlights coho's increased susceptibility to GBT (Table 1). However, species composition was not consistent throughout the season. For example, subyearling Chinook were dominant in the sample towards the end of the season, which was also the time when lower TDG levels were present above Rocky Reach Dam, and thus their severity scores may be depressed as a result of lower TDG exposure. Notably, the highest single fish total severity score was a 10 (out of a possible 16) and was observed in a coho examined during the June 5th sample. No other species had any fish with a total severity score of more than 8. None of the subyearling Chinook had a total severity score of more than 4 (Table 1). Table 1 also shows the percent of fish expressing GBT throughout the season. The overall percent of fish showing symptoms of GBT was 21% throughout the season, when TDG in the Wells tailrace exceeded 125%.

**Table 1. Species specific expression of GBT and severity scores over the season.**

| | Species | | | | |
|---|---|---|---|---|---|
| | **CH0** | **CH1** | **SH** | **SK** | **CO** |
| No. Examined | 511 | 140 | 60 | 161 | 166 |
| No. Exhibiting GBT | 40 | 31 | 20 | 34 | 98 |
| Percent Exhibiting GBT | 8% | 22% | 33% | 21% | 59% |
| | | | | | |
| Maximum total severity score* of any fish throughout the season | 4 | 8 | 8 | 5 | 10 |
| Average total severity score (0-16)* | 0.12 (±0.48) | 0.51 (±1.26) | 0.78 (±1.55) | 0.42 (±0.99) | 2.32 (±2.58) |
| Tukey-Kramer HSD (p<0.001) # | A | B | B | AB | C |

* Severity score mean from 0-16 was calculated by summing the scores at each tissue location examined (eyes and unpaired fins; 4 locations times a possible score of 4 at each location = 16) for each fish, adding these scores for each fish within a species, and dividing by the number of fish in a given species examined.

# Dissimilar letters represent significant differences from other species average total severity scores.

## 3.2 Adults

Adults captured at Wells Dam demonstrated little to no expression of GBT over the high TDG period. During the weeks of May 23rd and May 30th a total of 199 and 68 adult fish at Wells Dam were collected from the west and east fish ladders respectively. Of these 267 fish, measureable amounts of GBT were suspected in only 2 fish. During the week of June 6th, 167 fish from the west ladder and 40 from the east ladder were also collected and examined for signs of GBT. During this week 11 possible signs and one confirmed sign of GBT were observed. Together, 474 adult salmon were examined at Wells Dam with 1 (0.2%) confirmed case of GBT (Figure 7) and 13 (2.5%) unconfirmed cases. Over the course of this adult sampling period TDG was 125-137%. Adult GBT sampling was concluded following the week of June 6th, since state brood collection was completed for spring Chinook salmon and TDG had subsided during periods of additional broodstock collection activities. Figure 8 shows examples of fish examined for GBT during the adult sampling.

**Figure 7. Adult spring Chinook sampled on 05-24-11 at Wells Dam east fish ladder. Anal fin hemorrhaging may or may not be related to GBT since emphysema and embolisms were not present.**

**Figure 8.** **Four spring Chinook sampled from 06-01-11 sampling at Wells Dam east fish ladder. Fish were immediately sampled once they entered the ladder trap.**

## 4.0 ROCKY REACH AND ROCK ISLAND COMPARISON

During the morning of June 2nd 2011 Douglas PUD and Chelan PUD toured the Rock Island smolt monitoring location. This effort was done to compare notes and examine fish collectively to see if differences in sampling occurred. Although sampling appeared to be very consistent between Rocky Reach and Rock Island a few important differences were discussed:

1. The sampling conducted by Douglas PUD at Rocky Reach included all salmonids, with coho showing more symptoms than other salmonids. Coho were not examined at Rock Island.
2. Steelhead samples have been low at Rocky Reach with 0-11 fish sampled over the previous ten days (out of 60 fish). This low sample size precludes quality comparisons between the two facilities.
3. Some steelhead at Rocky Reach have had high quantities of fungus making examinations in fins impossible (Fin examinations make up 3 of the 5 sample locations). Steelhead at Rock Island appeared to have less fungus than Rocky Reach fish.

4. Stocks are dissimilar since Wenatchee River origin fish spend little time in the mainstem Columbia before being sampled at Rock Island. This may explain dissimilar fungus condition between steelhead sampled at Rocky Reach and Rock Island.
5. Sampling of fish at Rock Island occurs over a 24 hour period, whereas sampling at Rocky Reach is closer to real time. At Rocky Reach fish are sampled over a 30 minute or less window. Fish at Rock Island may express GBT differently based on a different holding period prior to sampling.
6. The samplers may collect fish at different depths at these two projects. Depth of capture may be important since fish lower in the water column may be able to compensate for high TDG values found at the surface by sounding.

## 5.0 SUMMARY OF SAMPLING

Together, juvenile results indicate that the 125% TDG value, as a threshold that requires biological monitoring, is consistent with the level where GBT begins to be expressed in juveniles at Rocky Reach. GBT expression occurred in 0-20% of the juvenile population when TDG levels were between 125-130%. When TDG concentrations were above 130%, GBT expression was observed in 0-90% of the juvenile population. Data suggests that positive, linear or polynomial relationships exist between the percent of TDG found in the Rocky Reach forebay and the percent of GBT expression exhibited by sampled juveniles. Further, important species specific differences were observed at a given TDG concentration. Adults appear most resilient to high TDG concentrations with spring Chinook adult that were concurrently sampled as part of a brood collection effort showed little signs of GBT expression, even when tailrace concentrations were above 130%. Finally, caution should be used when comparing expression at Rocky Reach and Rock Island given the unique sampling and features at these facilities.

# 2010 BULL TROUT MONITORING AND MANAGEMENT PLAN ANNUAL REPORT

Commissioners:
T. JAMES DAVIS
LYNN M. HEMINGER
RONALD E. SKAGEN

General Manager:
WILLIAM C. DOBBINS

Public Utility District No. 1 of Douglas County

1151 Valley Mall Parkway • East Wenatchee, Washington 98802-4497 • 509/884-7191 • FAX 509/884-0553 • www.douglaspud.org

March 28, 2011

Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington DC 20426

**Subject: Wells Hydroelectric Project No. 2149**
**Wells Bull Trout Monitoring and Management Plan – Annual Report**

Dear Secretary:

In accordance with Article 62 of the Federal Energy Regulatory Commission (Commission) license for the Wells Hydroelectric Project (Wells Project), the Public Utility District No. 1 of Douglas County (Douglas PUD) hereby submits the 2010 Annual Report associated with the implementation of the Wells Bull Trout Monitoring and Management Plan (Bull Trout Plan).

On June 21, 2004, the Commission issued orders amending the license for the Wells Project in order to implement the terms of the Anadromous Fish Agreement and Habitat Conservation Plan (Wells HCP). The United States Fish and Wildlife Service (USFWS) issued a biological opinion (BO) pursuant to Section 7 of the Endangered Species Act (ESA) to assess the effects of the HCP on ESA listed bull trout and other listed species under the jurisdiction of the USFWS. The BO included reasonable and prudent measures (RPMs) and associated terms and conditions for implementing the RPMs for bull trout. The Commission order approving the Wells HCP added Article 61, 62 and 63 to the Wells Project license.

Article 61 of the license required Douglas PUD to file with the Commission a Bull Trout Plan for monitoring take associated with the operations of the Wells Project. Article 61 further required that Douglas PUD prepare the Bull Trout Plan in consultation with the USFWS, National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife (WDFW), and interested Indian Tribes (Colville Confederated Tribes and the Yakama Nation).

Following consultation with the USFWS, NMFS, WDFW, Colville Confederated Tribes, and the Yakama Nation, Douglas PUD filed the Bull Trout Plan with the Commission on February 28, 2005. The Bull Trout Plan was approved by the Commission on April 19, 2005.

Article 62 of the license requires Douglas PUD to prepare and file with the Commission an annual report describing the activities required by the Bull Trout Plan.

Article 63 of the license reserves the Commission's authority to require Douglas PUD to carry out specified measures for the purpose of participating in the development and implementation of a bull trout recovery plan.

Consistent with Article 62 of the license, please find enclosed Douglas PUD's Annual Bull Trout Report for activities that took place between January 01, 2010 and December 31, 2010. This report is simultaneously being provided to the USFWS and the parties to the Wells HCP.

The next reporting deadline associated with the Bull Trout Plan is March 31, 2012 (2011 Annual Report).

If you have any questions related to the 2010 Annual Bull Trout Report, please contact me at (509) 881-2208 or sbickford@dcpud.org.

Sincerely,

Shane Bickford

Shane Bickford
Supervisor of Natural Resources

Enclosure: (1) 2010 Bull Trout Annual Report. Wells Hydroelectric Project FERC Project No. 2149. March 2011.

Copy: Steve Lewis, USFWS
Patrick Regan, FERC, Portland, with 1 copy
James Hastreiter, FERC, Portland, with 1 copy
Erich Gaedeke, FERC, Portland with 1 copy
Mike Schiewe, Coordinator – HCP Coordinating Committee
Wells HCP Coordinating Committee – Members List
Wells Aquatic Settlement Work Group – Members List
Scott Kreiter, Douglas PUD

# BULL TROUT MONITORING AND MANAGEMENT PLAN
# 2010 ANNUAL REPORT

# WELLS HYDROELECTRIC PROJECT

# FERC PROJECT NO. 2149

March 28, 2011

Public Utility District No. 1 of Douglas County
East Wenatchee, Washington

For copies of this Annual Report, contact:

Public Utility District No. 1 of Douglas County
Attention: Natural Resources
1151 Valley Mall Parkway
East Wenatchee, WA 98802-4497
Phone: (509) 884-7191

## Table of Contents

**List of Tables**

## List of Figures

# EXECUTIVE SUMMARY

The goal of the Wells Hydroelectric Project (Wells Project) Bull Trout Monitoring and Management Plan (Bull Trout Plan) is to identify, develop, and implement measures to monitor and address potential project-related impacts on bull trout (*Salvelinus confluentus*) associated with the operations of the Wells Project and associated facilities (Douglas PUD 2004). The Bull Trout Plan was prepared and is implemented to meet monitoring requirements stipulated in a U.S. Fish and Wildlife Service (USFWS) Biological Opinion (USFWS 2004) regarding implementation of the Wells Project Anadromous Fish Agreement and Habitat Conservation Plan (Wells HCP). The USFWS Biological Opinion monitoring requirements were also incorporated by the Federal Energy Regulatory Commission (FERC) into the existing Wells Project license in 2004. The Bull Trout Plan was developed in collaboration with the USFWS, National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife (WDFW), the Colville Confederated Tribes, and the Yakama Nation, and was approved by the FERC. The Bull Trout Plan has four objectives, addressed by carrying out various field study components from 2004 to 2008 at the Wells Project.

In accordance with Article 62 of the FERC license for the Wells Project, Douglas PUD is required to prepare and file with the Commission an annual report describing the activities required by the Bull Trout Plan. In December 2008, Public Utility District No. 1 of Douglas County (Douglas PUD) filed with the FERC, a final comprehensive report summarizing the results of all activities conducted under the Bull Trout Plan between January 2005 and July 2008.

In a letter to the FERC on December 29, 2008, Douglas PUD requested that the 2008 annual report filing (due March 31, 2009) be eliminated and instead include all remaining 2008 activities (August to December 2008) within the 2009 annual report that was scheduled to be filed with the FERC on March 31, 2010. In a letter dated February 3, 2009 the FERC approved Douglas PUD's request. The 2009 annual report was submitted in March of 2010, and included both the results of those additional activities conducted in 2008 that were not included in the Bull Trout Plan 2005-2008 Final Report (LGL and Douglas PUD, 2008) and the ongoing Bull Trout Plan activities that were conducted in 2009.

The enclosed annual report is a comprehensive summary of the bull trout research, monitoring and evaluation efforts through 2010. This document is due to be filed with the FERC by March 31, 2011.

Observations of bull trout passing Wells Dam in the 2010 season remain similar to 2008 and 2009. Adult bull trout fishway counts at the Wells Project were 43, 43 and 44 respectively for the past three years. Off-season fishway monitoring continues to indicate that bull trout are not passing Wells Dam during the winter months. During the 2010 season 82% of all bull trout fishway observations were in the May-June period, with the last observation in late October 2010. This timing is consistent with past years, and indicates bull trout passage at the dam is a seasonal trend independent of Project operations.

Past, stranding and entrapment surveys have indicated that infrequent Project operations that result in lowering of the reservoir have not impacted adult or sub-adult bull trout in the Wells

Project.  These surveys were not conducted in 2010 because no low reservoir operating events took place during the 2010 monitoring period.

To date, no sub-adult bull trout have been observed in Wells Dam fishways.  Data collected from Methow River basin smolt collection operations confirm that sub-adult bull trout are present outside of the Wells Project.

In 2010, 10 DNA samples were collected from bull trout captured in the Twisp River.  These samples have yet to be delivered to USFWS.  Bob Jateff (WDFW, Fish Management Biologist) is the current custodian of these 2010 samples.  As reported in 2009, genetic samples were taken from 15 fish during the implementation of off-site smolt collection activities and provided to the USFWS for future genetic analysis.  These samples were provided to Judy De La Vergne (USFWS, Wenatchee, WA).  In addition to coordinating monitoring efforts and information exchanges of Project-specific bull trout data, Douglas PUD continues to participate in regional activities that support bull trout conservation and recovery.

Five adult bull trout were incidentally captured at Wells Dam during Chinook brood collection activities.  All five of these fish were PIT-tagged and then released back into the fishways to continue their migration.  Two of these fish were later detected in the Methow River Basin on instream PIT-tag detectors.

Ninety-one adult bull trout were incidentally captured at the Twisp River weir in 2010 (length range 44 - 79 cm), 87 of which were subsequently PIT-tagged and released back into the Twisp River upstream of the Twisp Weir.  The other four adult bull trout had been previously PIT-tagged.

Bull trout behavior in the Methow Basin during 2010 remained similar to previous years.  In the spring, adult bull trout were detected migrate upstream into the Twisp River.  After spawning and before winter there is a directed downstream migration exhibited by both adult and subadult fish seeking out overwintering habitat found within the lower Methow and Wells reservoir.

Hook and line sampling for residual steelhead in the Methow Basin captured 18 adult bull trout from December 2009 to January 2011, all of which were subsequently PIT-tagged and released unharmed (Charlie Snow, pers. comm.).  Tag codes for all PIT-tagged fish were uploaded to the PTAGIS database.  Queries of the PTAGIS database show that none of the bull trout PIT-tagged in the Methow Basin have been subsequently detected at Wells Dam or outside the Methow Basin.  The majority of bull trout detections in the Methow River Basin occurred between July and November in 2010 (95%) at the “Methow River at Twisp” and the “Lower Twisp River near MSRF Ponds” interrogation locations (nearly 82% of all detections were at these two locations).

# 1.0 INTRODUCTION

In August 1993, Douglas, Chelan, and Grant Public Utility Districts (collectively, "mid-Columbia PUDs") initiated discussions to develop a long-term, comprehensive program for managing fish and wildlife that inhabit the mid-Columbia River basin (the portion of the Columbia River from the tailrace of Chief Joseph Dam to the confluence of the Yakima and Columbia rivers). After an extensive review, the negotiating parties determined that the best basin-wide approach would be to develop an agreement for anadromous salmonids, specifically: spring and summer/fall Chinook salmon (*Oncorhynchus tshawytscha*); sockeye salmon (*O. nerka*); coho salmon (*O. kisutch*); and steelhead (*O. mykiss*) (collectively, "Plan Species") which are under the jurisdiction of the National Marine Fisheries Service (NMFS).

On July 30, 1998, Public Utility District No. 1 of Douglas County (Douglas PUD) submitted an unexecuted form of an Application for Approval of the Wells Project Anadromous Fish Agreement and Habitat Conservation Plan (Wells HCP) to the Federal Energy Regulatory Commission (FERC) and NMFS. To expedite the FERC's completion of formal consultation, Douglas PUD prepared a biological evaluation of the effects of implementing the Wells HCP on listed species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS).

In a letter to the FERC, the USFWS requested consultation under Section 7 of the Endangered Species Act (ESA) regarding the effects of hydroelectric project operations on bull trout in the Columbia River (letter from M. Miller, USFWS, to M. Robinson, FERC, dated January 10, 2000). The request for consultation was based on observations of bull trout in the study area. In its reply to the USFWS, the FERC noted that there was virtually no information on bull trout in the mainstem Columbia River. To begin to address this information gap, an initial radio-telemetry study of bull trout in the mid-Columbia basin was requested by USFWS in 2000 and implemented from 2001 to 2004 by Douglas, Chelan, and Grant PUDs (BioAnalysts, Inc. 2004).

On November 24, 2003, Douglas PUD filed an application with the FERC for approval of the executed Wells HCP. The 2003 application for approval replaced the 1998 application with the executed form of the Wells HCP. On December 10, 2003, the USFWS received a request from the FERC for formal Section 7 ESA consultation to determine whether the proposed incorporation of the Wells HCP into the FERC license for Wells Project operations was likely to jeopardize the continued existence of the Columbia River distinct population segment (DPS) of ESA-listed bull trout, or destroy or adversely modify proposed bull trout critical habitat. In response to the FERC request, the USFWS issued a Biological Opinion (BO) pursuant to Section 7 of the ESA to assess the effects of implementing the HCP on bull trout and other listed species under the jurisdiction of the USFWS. The BO included an Incidental Take Statement outlining reasonable and prudent measures (RPMs) and associated terms and conditions to monitor and limit bull trout take at the Wells Project. On June 21, 2004, the FERC issued orders amending the license for the Wells Project to implement the terms of the Wells HCP. The FERC incorporated the USFWS bull trout RPMs and terms and conditions into the existing Wells Project license, which are detailed in license articles 61, 62, and 63.

Article 61 of the license requires Douglas PUD to file with the FERC a Bull Trout Plan for implementing the USFWS bull trout RPMs and terms and conditions, which were designed to monitor and limit bull trout take associated with Wells Project operations. Article 61 further requires that Douglas PUD prepare the Bull Trout Plan in consultation with the USFWS, NMFS, Washington Department of Fish and Wildlife (WDFW), and interested Indian Tribes (Colville Confederated Tribes and the Yakama Nation). Following consultation with these stakeholders, on February 28, 2005, Douglas PUD filed with the FERC the "*Wells Hydroelectric Project Bull Trout Monitoring and Management Plan, 2004-2008"* (Douglas PUD 2004), which is referred to as the "Bull Trout Plan" in this document. The Bull Trout Plan was approved by the FERC on April 19, 2005.

Article 62 of the license requires Douglas PUD to prepare and file with the FERC an annual report of the status of activities required by the Bull Trout Plan. On March 26, 2008, Douglas PUD with approval from USFWS filed a request for an extension of time to submit the 2007 annual bull trout monitoring report and to consolidate the 2007 annual report with the final bull trout monitoring report, required to be filed with the FERC by December 31, 2008. On April 16, 2008, the FERC issued an order granting this request and per the order, Douglas PUD filed with the FERC a 2005-2008 final monitoring report that summarized all data collected to meet the Bull Trout Plan objectives outlined in the USFWS bull trout RPMs and terms and conditions, and the Wells Project license articles 61 and 62.

The next reporting deadline associated with the Bull Trout Plan was March 31, 2009 (2008 Annual Report). However, because the 2005-2008 final report contained bull trout monitoring activities for most of 2008, Douglas PUD requested and was granted permission, via the FERC's April 16, 2008 letter to Douglas PUD, to eliminate the March 2009 filing of the 2008 Annual Report and instead include all remaining 2008 activities within the 2009 annual report**.** The former document was submitted in March of 2010, which summarized the results of those additional activities conducted in 2008 that were not completed in time for inclusion into the Bull Trout Plan 2005-2008 Final Report (LGL and Douglas PUD, 2008) and the ongoing Bull Trout Plan activities that were conducted in 2009. The current document follows a similar path as the 2009 annual bull trout compliance report. Although it is a comprehensive summary of all the bull trout research over the last ten years, it is focused largely on the monitoring and evaluation efforts conducted during 2010. This document is due to be filed with the FERC by March 31, 2011.

Article 63 was a reservation of authority by the FERC to require the licensee to carry out specified measures for the purpose of participating in the development and implementation of a bull trout recovery plan. The USFWS has only recently reactivated the bull trout recovery planning process following a multi-year hiatus. In response to compliance with article 63 of the Wells Project license, Douglas PUD has and will continue to participate in the development of future recovery planning documents for bull trout.

## 2.0 GOALS AND OBJECTIVES

The goal of the Bull Trout Plan is to identify, develop, and implement measures to monitor and address potential project-related impacts on bull trout from Wells Project operations and facilities. The Bull Trout Plan was intended to be an adaptive approach, where strategies for meeting the goals and objectives may be negotiated under a collaborative effort with stakeholders based on new information and ongoing monitoring results. The plan was designed specifically to: (1) address ongoing project-related impacts through the life of the existing operating license; (2) provide consistency with recovery actions as outlined in the USFWS Draft Bull Trout Recovery Plan; and (3) monitor and minimize the extent of any incidental take of bull trout consistent with Section 7 of the ESA.

The Bull Trout Plan has four main objectives: (1) identify potential project-related impacts on upstream and downstream passage of adult bull trout through the Wells Dam and reservoir and implement appropriate measures to monitor any incidental take of bull trout; (2) assess project-related impacts on upstream and downstream passage of sub-adult bull trout; (3) investigate the potential for bull trout entrapment or stranding in off-channel or backwater areas of Wells Reservoir; and (4) identify the core areas and local populations, as defined in the USFWS Draft Bull Trout Recovery Plan, for the bull trout that utilize the Wells Project Area.

Activities designed to support some objectives in the Bull Trout Plan were only intended to be conducted in the early phases of plan implementation (i.e., radio-tagging of bull trout at Wells Dam between 2005-2008 and comprehensive incidental take calculation for monitoring years 2001-2004 and 2005-2008). The results of these activities can be found in the Bull Trout Plan 2005-2008 Final Monitoring Report (LGL and Douglas PUD, 2008) and are considered completed tasks with the filing of that final report. For the purposes of continued annual reporting per Article 62, only ongoing Bull Trout Plan activities are reported herein.

Below is a brief summary of the Bull Trout Plan objectives. A more detailed strategic framework to implement each objective is summarized in the Bull Trout Plan 2005-2008 Final Monitoring Report (LGL and Douglas PUD, 2008).

## 2.1 Objective 1 - Adult Bull Trout Passage Monitoring

Strategy 1-1: Implement an adult bull trout telemetry program to monitor adult upstream and downstream passage in the Wells Project Area and implement appropriate measures to monitor any incidental take of bull trout.

Strategy 1-2: Analyze passage results and operational data to determine if correlations exist between passage times and passage events and project operations.

Strategy 1-3: Determine off-season adult bull trout passage through the adult fishway (numbers and times of year) at Wells for an experimental period 2004-2005. Per request by the USFWS, off-season fishway monitoring for adult bull trout passage has continued to date.

Strategy 1-4: Should upstream or downstream passage problems be identified, pursue the feasibility of options to modify upstream passage facilities or operations that reduce the impact to bull trout passage.

## 2.2 Objective 2 - Sub-adult Bull Trout Passage Monitoring

Strategy 2-1: The stakeholders agree at this time[1] that because of the inability to collect a sufficient sample size of sub-adult bull trout, it is not feasible to assess sub-adult passage at Wells. However, when encountered at the Wells Project, or in tributary traps, sub-adult bull trout will be PIT-tagged.

Strategy 2-2: Determine off-season sub-adult bull trout passage through the adult fishway (numbers and times of year) at Wells for an experimental period from 2004 to 2005. Per request by the USFWS, off-season fishway monitoring for sub-adult bull trout passage has continued to date.

## 2.3 Objective 3 - Bull Trout Entrapment and Stranding Evaluation

Strategy 3-1: Evaluate Wells inflow patterns, reservoir elevations, and backwater curves to determine if stranding or entrapment of bull trout may occur.

## 2.4 Objective 4 - Identification of Core Area and Local Populations of Bull Trout that Utilize the Wells Project Area

Strategy 4-1: Gather genetic samples from radio-tagged and PIT-tagged bull trout for comparison to baseline genetic samples from local populations and core areas.

Strategy 4-2: Work cooperatively with other agencies to obtain locations of radio-tagged fish outside the Project area.

# 3.0 STUDY AREA

## 3.1 Wells Bull Trout Plan Study Area

The study area for this report included all waters within the Wells Project, including the lower Okanogan and Methow rivers, the Wells Reservoir, Wells Dam, and Wells Tailrace, downstream to the "Gateway" location set at approximately 3 miles downstream from Wells Dam. Additional monitoring also took place at downstream hydroelectric projects and other accessible reaches of the mid-Columbia Basin including the Methow, Wenatchee, Entiat, and Okanogan rivers. PIT tagging activities also occurred in the Methow and Twisp rivers.

## 3.2 General Description of the Wells Hydroelectric Project Area

The Wells Project is located at river mile (RM) 515.6 on the Columbia River in the State of Washington. Wells Dam is located approximately 30 river miles downstream from the Chief Joseph Hydroelectric Project, owned and operated by the United States Army Corps of Engineers (COE), and 42 miles upstream from the Rocky Reach Hydroelectric Project owned and operated by Public Utility District No. 1 of Chelan County (Chelan PUD). The nearest town is Pateros,

[1] At the time that the Bull Trout Plan was prepared in 2004.

Washington, located approximately 8 miles upstream from the Wells Project at the mouth of the Methow River.

The Wells Project is the chief generating resource for Douglas PUD. It includes 10 generating units with a nameplate rating of 774,300 kW and a peaking capacity of approximately 840,000 kW. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. Fish passage facilities reside on both sides of the hydrocombine, which is 1,130 feet long, 168 feet wide, with a crest elevation of 795 feet mean sea level (msl) in height.

The Wells Reservoir is approximately 30 miles long. The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir. The Wells Project boundary extends approximately 1.5 miles up the Methow River and approximately 15.5 miles up the Okanogan River. The normal maximum surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet and usable storage of 97,985 acre-feet at elevation of 781 feet msl. The normal maximum water surface elevation of the reservoir is 781 feet msl (Figure 3.2-1).

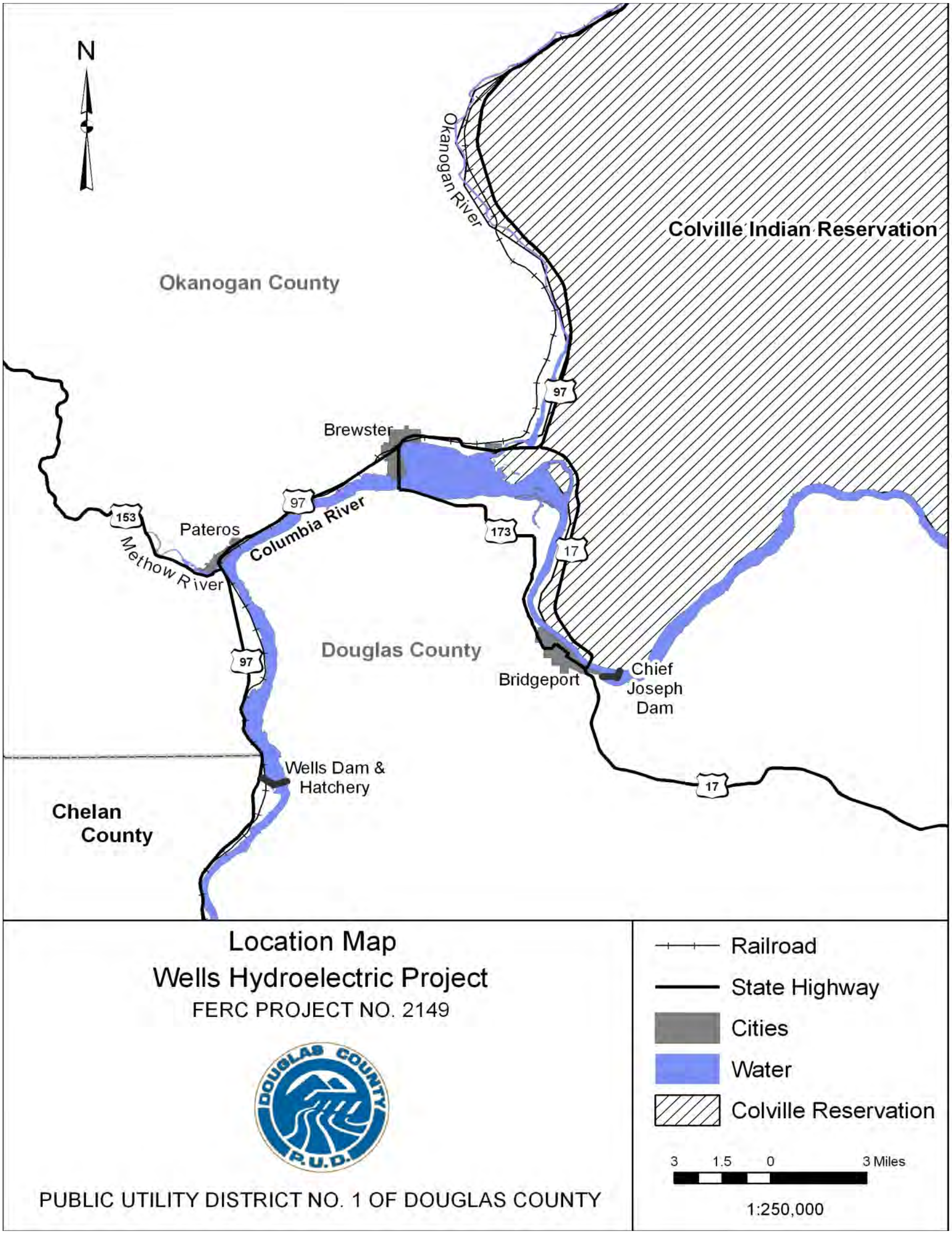



**Figure 3.2-1 Location map of the Wells Project.**

# 4.0 BACKGROUND AND EXISTING INFORMATION

## 4.1 Bull Trout Biology

Bull trout are native to northwestern North America, historically occupying a large geographic range extending from California north into the Yukon and Northwest Territories of Canada, and East to Western Montana and Alberta (Cavender 1978). They are generally found in interior drainages, but also occur on the Pacific Coast in Puget Sound and in the large drainages of British Columbia.

Bull trout currently occur in lakes, rivers and tributaries in Washington, Montana, Idaho, Oregon (including the Klamath River basin), Nevada, two Canadian Provinces (British Columbia and Alberta), and several cross-boundary drainages in extreme southeast Alaska. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta, and the Mackenzie River system in Alberta and British Columbia (Cavender 1978; McPhail and Baxter 1996; Brewin and Brewin 1997). The remaining distribution of bull trout is highly fragmented.

Bull trout are a member of the char group within the family Salmonidae. Bull trout closely resemble Dolly Varden (*Salvelinus malma*), a related species. Genetic analyses indicate, however, that bull trout are more closely related to an Asian char (*Salvelinus leucomaenis*) than to Dolly Varden (Pleyte et al. 1992). Bull trout are sympatric with Dolly Varden over part of their range, most notably in British Columbia and a small portion of the Coastal-Puget Sound region of Washington State.

Bull trout are believed to have more specific habitat requirements than other salmonids (Rieman and McIntyre 1993). Growth, survival, and long-term persistence are dependent upon habitat characteristics such as clean, cold, connected, and complex instream habitat (USFWS et al. 2000), and stream/population connectivity. Stream temperature and substrate type, in particular, are critical factors for the sustained long-term persistence of bull trout. Spawning is often associated with the coldest, cleanest, and most complex stream reaches within basins. However, bull trout may exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1995), and should not be expected to occupy all available habitats at the same time (Rieman et al. 1997).

Bull trout exhibit four distinct life history types: resident, fluvial, adfluvial, and anadromous. The fluvial, adfluvial, and resident forms exist throughout the range of the bull trout (Rieman and McIntyre 1993), although each form is not present everywhere. The anadromous life history form is currently known only to occur in the Coastal-Puget Sound region within the coterminous United States (Mongillo 1993; Kraemer 1994; McPhail and Baxter 1996; Volk 2000). Multiple life history types may be expressed in the same population, and this diversity of life history types is considered important to the stability and viability of bull trout populations (Rieman and McIntyre 1993).

The majority of growth and maturation for anadromous bull trout occurs in estuarine and marine waters, adfluvial bull trout in lakes or reservoirs, and fluvial bull trout in large river systems.

Resident bull trout populations are generally found in small headwater streams where fish remain their entire lives. Sexually mature resident bull trout are often much smaller at maturation than sexually mature adults of other life histories (McPhail and Baxter 1996).

For migratory life history types, juveniles tend to rear in tributary streams for 1 to 4 years before migrating downstream into a larger river, lake, or estuary and/or nearshore marine area to mature (Rieman and McIntyre 1993). In some lake systems, age 0+ fish (less than 1 year old) may migrate directly to lakes, but it is unknown if this emigration is a result of density dependent effects from limited stream rearing habitat, or if these young-of-the-year actually survive in the lake environment (Riehle et al. 1997). Juvenile bull trout in streams frequently inhabit side channels, stream margins and pools with suitable cover (Sexauer and James 1993) with maximum summer water temperatures generally less than 16ºC (Dunham et al. 2003) and areas with cold hyporheic zones or groundwater upwellings (Baxter and Hauer 2000).

## 4.2 Status

On June 10, 1998, the USFWS listed bull trout within the Columbia River basin as threatened under the ESA (FR 63(111)). Later (November 1, 1999), the USFWS listed bull trout within the coterminous United States as threatened under the ESA (FR 64(210)). The USFWS identified habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, and grazing; blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species as major factors affecting the distribution and abundance of bull trout. They noted that dams (and natural barriers) have isolated population segments resulting in a loss of genetic exchange among these segments (FR 63(111)). The USFWS believes many populations are now isolated and disjunct. In October 2002, the USFWS completed the first draft of a bull trout recovery plan intended to provide information and guidance that will lead to recovery of the species, including its habitat (USFWS 2002). Threatened bull trout population segments are widely distributed over a large area and because population segments were subject to listing at different times, the USFWS adopted a two-tiered approach to develop the draft recovery plan for bull trout (USFWS 2002). In November 2002, the USFWS published in the federal register a proposed rule for the designation of critical habitat for the Klamath River and Columbia River distinct population segments of bull trout (67 FR 71235). In October 2004, the USFWS published a final rule in the Federal Register designating critical habitat for the Klamath River and Columbia River populations of bull trout (69 FR 59995). New critical habitat was proposed throughout the range of bull trout in January 14, 2010 (75 FR 2270), including all of the Wells Project waters except the Okanogan River.

In April 2008, the USFWS completed the 5-year status review for Columbia River bull trout with two recommendations: maintain “threatened” status for the species, and determine if multiple distinct population segments exist within the Columbia River that merit protection under the ESA. The recommendations intend to facilitate analysis of project effects over more specific and biologically appropriate areas, ultimately allowing a greater focus of regulatory protection and recovery resources (USFWS 2008a). The review also identified specific issues that limit the overall ability to accurately and quantitatively evaluate the current status of bull trout. Seven recommendations were made to improve future evaluation and management decisions, all of which are largely based on improvement and standardization of monitoring and evaluation techniques, better delineation and agreement of core areas and Recovery Units, and multi-agency cooperation and management (USFWS 2008b).

The Wells Project is situated within the Upper Columbia River Recovery Unit[2] and the USFWS has identified the Wenatchee, Entiat, and Methow rivers as its core areas. A core area represents the closest approximation of a biologically functioning unit for bull trout. A core area may function as a metapopulation for bull trout. Not all core areas are equal and each has specific functions that are unique. For example, the Entiat Core Area depends heavily on the mainstem Columbia River to provide overwintering, migration, and foraging habitats. The Wenatchee Core Area has populations using lake and riverine habitat (both the Wenatchee and Columbia rivers) for overwintering, migration, and foraging. Within a core area, many local populations may exist. A local population is assumed to be the smallest group of fish that is known to represent a regularly interacting reproductive unit. Sixteen local populations have been identified in the Wenatchee (6), Entiat (2), and Methow (8) core areas (USFWS 2002).

## 4.3 2001-2004 Mid-Columbia Bull Trout Radio Telemetry Study

Bull trout have been counted at Wells Dam since 1998. In 2000, due to the potential for operations at mid-Columbia dams to affect the movement and survival of bull trout, the USFWS requested that the three mid-Columbia PUDs evaluate the movement and status of bull trout in their respective project areas. At that time, little was known about the behavior, migratory characteristics and habitat use of bull trout in the mid-Columbia River. Therefore, to assess the operational effects of hydroelectric projects on bull trout within the mid-Columbia, a three PUD coordinated radio telemetry study was implemented beginning in 2001. The goal of the study was to monitor the movements and migration patterns of adult bull trout in the mid-Columbia River using radio telemetry (Figure 4.3-1) to address the information deficit described above. The number of bull trout to be collected and tagged at each dam (Rock Island, Rocky Reach, and Wells) was based on the proportion of fish that migrated past those dams in 2000.

From 2001 to 2003, bull trout were collected from the Wells, Rocky Reach, and Rock Island dams, radio-tagged, and monitored through 2004. Multiple-telemetry techniques were used to assess the movement and behavior of tagged bull trout within the study area. At Wells Dam, a combination of aerial and underwater antennas was deployed. The primary purpose for this system was to document the presence of bull trout at the project, identify passage times and determine their direction of travel (i.e., upstream/downstream). In addition to these systems, a number of additional telemetry systems were deployed to address specific questions posed by the USFWS and Douglas PUD. At Wells Dam, several additional systems were installed to identify whether tagged bull trout could enter, ascend, and exit specific gates and fish ladders. All possible access points to the adult fish ladders and the exits were monitored individually during the study period from 2001-2004, allowing the route of passage to be determined as well as the ability to establish the exact time of entrance and exit from the ladder system.

[2] Note that while the USFWS refers to the area encompassing the Wells Project as the Upper Columbia Recovery Unit for bull trout, the section of the Columbia River from Chief Joseph Dam to the confluence of the Yakima and Columbia rivers is often termed the "mid-Columbia" for other purposes, and is the term used in this document when referring to the reach.

To assess bull trout movements into and out of the Wells Reservoir, fixed-telemetry monitoring sites were established at the mouth of the Methow and Okanogan rivers and periodic aerial telemetry surveys were conducted on the reservoir and throughout both watersheds (English et al. 1998, 2001). English et al. (1998, 2001) provide a detailed description of the telemetry systems at each of the dams and within the tributaries.

Successful bull trout upstream and downstream passage was observed at the Wells Project. In addition, no bull trout injury or mortality was observed associated with the Wells Project. Radio-tagged bull trout that migrated upstream past Wells Dam used the Methow River subbasin during the bull trout spawning period. Key findings of the 2001 to 2004 study are used in this document to assess the 6-year average take analysis as stipulated in the Bull Trout Plan (Objective 1, Strategy 1-1) and are summarized in the results section of this document.

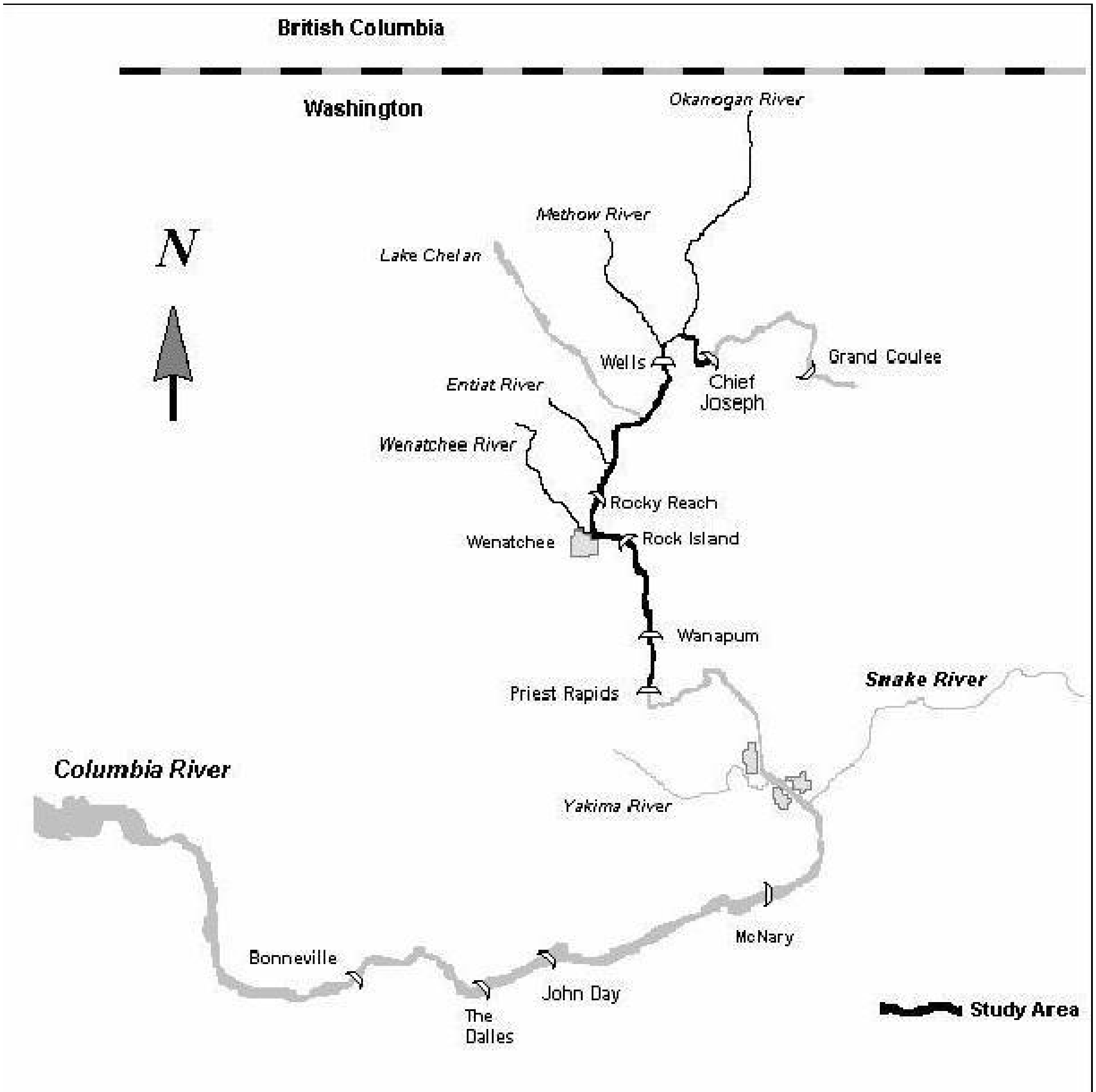



**Figure 4.3-1 Study area for assessing migration patterns of bull trout in the mid-Columbia River (2001-2004).**

## 4.4 2005-2008 Bull Trout Monitoring and Management Plan Activities

The goal of the Wells Project Bull Trout Plan is to identify, develop, and implement measures to monitor and address potential project-related impacts on bull trout associated with the operations of the Wells Project and associated facilities (Douglas PUD 2004). The Bull Trout Plan has four objectives, addressed by implementing various field study components from 2004 to 2008 at the Wells Project.

The first objective was to identify potential project-related impacts on upstream and downstream passage of adult bull trout (fish ≥ 400 mm in length) through Wells Dam and reservoir, and implement appropriate measures to monitor any incidental take of adult bull trout. To meet the first objective, radio telemetry was used to monitor upstream and downstream passage, and off-season video counting was done in the Wells Project fishways during the winter. Between 2005 and 2008, 26 adult bull trout were trapped at Wells Dam and radio-tagged. Concurrent with the implementation of the Bull Trout Plan, the USFWS and Chelan PUD radio-tagged and released 136 adult bull trout at other mid-Columbia River basin locations including the Methow River, and Rock Island and Rocky Reach dams (50 USFWS tags 2006-2008, 86 Chelan PUD tags 2005-2007).

From 2005 to 2008, 25 downstream passage events and 52 upstream passage events by 40 individual bull trout were recorded at Wells Dam. Of these, 17 downstream and 41 upstream passage events occurred within one year of tagging and release. Of all tags released from 2001 to 2004, there were 2 downstream passage events and 41 upstream passage events. Of these, 2 downstream and 38 upstream passage events occurred within one year of release date. The take estimates for the Wells Project were based upon the number of unique upstream and downstream passage events that took place within one year of each bull trout being tagged and released. During the six-year study and eight years of monitoring, 19 downstream and 79 upstream passage events took place at Wells Dam by radio-tagged bull trout within one year of release date. Taking into account all observed passage events a total of 27 downstream and 93 upstream passage events took place at Wells Dam. Radio-tagged bull trout passed downstream through the turbines or spillways as no downstream passage events were recorded via the fishways. Out of the 19 downstream passage events that occurred within one year of tagging, zero bull trout injury or mortality was observed at the Wells Project. Out of the 79 upstream passage events that occurred within one year of tagging, zero bull trout injury or mortality was observed at the Wells Project.

Upstream passage of adult bull trout through the fish ladders at Wells Dam has historically occurred between early May and late October, with peak passage typically occurring in May and June. During the 2005 and 2008 study, 214 adult bull trout were counted passing upstream through Wells Dam. The proportion of the bull trout population at Wells Dam that was radio-tagged was 24% (52/214 = 0.24).

Project operations did not appear to influence the movements of adult bull trout. Instead, adult bull trout passage events appeared to be more closely associated with water temperature, photoperiod and time of year with rather predictable patterns of upstream and downstream movement (LGL and Douglas PUD 2007; 2008). Because no take (injury or mortality) was observed during the study, there was no need to investigate how Project operations affected take at Wells Dam.

During the 2005-2008 monitoring period, no adult bull trout were counted during the 24-hour off-season fishway counting period (November 16 to April 30).

No upstream or downstream passage problems were identified during this study. Passage times upstream through the fishway appeared reasonable relative to the species migration and spawn timing. Because no passage problems were identified during the study, there was no need to develop recommendations to change or modify the fishway operations at Wells Dam.

The second objective was to assess project-related impacts on upstream and downstream passage of sub-adult bull trout (fish <400 mm in length). During the development of the Bull Trout Plan, stakeholders agreed that because of the inability to collect a sufficient sample size of sub-adult bull trout at Wells Dam, it was not feasible to assess sub-adult passage. However, when encountered at Wells Dam fishways, or in tributary traps, sub-adult bull trout would be PIT-tagged. Douglas PUD provided funding, equipment, training, and coordination for the sub-adult bull trout PIT tag program. From 2004 to 2008, 67 sub-adult bull trout were PIT-tagged in the Methow River sub-basin during standard tributary smolt trapping operations. Douglas PUD operated PIT tag detection systems year-round within the Wells Dam fishways during the study period (2005 to 2008) and no PIT-tagged sub-adult bull trout were detected. Additionally, sub-adult bull trout were to be PIT-tagged opportunistically when encountered at the Wells Project; however, no sub-adult bull trout have been encountered at Wells Dam to date. From 2008 to 2010 many sub-adult and adult bull trout have been PIT-tagged as a result of these efforts. Specifics of these efforts are included below in the results section.

The third objective was to investigate the potential for sub-adult entrapment or stranding in off-channel or backwater areas of Wells Reservoir. Field surveys were conducted at potential bull trout stranding sites during periods of low reservoir elevation. High resolution bathymetric information, reservoir elevations, backwater curves, and inflow patterns were used to identify potential stranding sites for the survey. No stranded or entrapped bull trout of any size were found during the field surveys conducted in 2006 and 2008. No surveys were conducted during 2005 or 2007 because river operations were not low enough to warrant a survey.

The fourth objective was to identify the core areas and local populations of bull trout that utilize the Wells Project. Data from radio-tagged bull trout tracked during the 2005 to 2008 study period were analyzed with data from the 2001 to 2004 study. Bull trout that pass Wells Dam (either upstream or downstream) migrated into the Methow, Entiat, and Wenatchee rivers during the spawning period. Observed tributary entrances of bull trout detected at Wells Dam from 2005 to 2008 were 86% Methow River, 10% Entiat River, and 2% Wenatchee River. Genetic samples of all fish tagged at Wells Dam were submitted to the USFWS for analysis. The USFWS is responsible for analyzing the genetic samples and providing those results. To further support this objective (Strategy 4-2: Work cooperatively with other agencies to obtain locations of radio-tagged fish outside the project area), Douglas PUD regularly coordinated bull trout data and monitoring activities with other agencies including the USFWS, WDFW and Chelan PUD.

In summary, no mortality or injury was observed for bull trout (adult and sub-adult) passing through or interacting with the operations of the Wells Project during the take monitoring studies conducted between 2001 and 2008. No incidental take of bull trout was observed at the Wells Project, and the Wells Project is presumed to be within the incidental take levels authorized by the USFWS Biological Opinion Incidental Take Statement (USFWS 2004).

# 5.0 METHODOLOGY

A more detailed description of the methodologies used to implement each Bull Trout Plan objective-strategy can be found in the Bull Trout Plan 2005-2008 Final Monitoring Report (LGL and Douglas PUD, 2008).

# 6.0 RESULTS

## 6.1 Strategy 1-1: Adult bull trout telemetry program

### 6.1.1 Bull trout tagged by Douglas PUD

As previously reported, an evaluation of station receiver data for the period of August 2008 to December 2009 at Wells Dam, Wells Dam Tailrace, the "Gateway" location (approximately 3 miles downstream from Wells Dam), and at stations located at the Methow and Okanogan river mouths yielded no additional detection data. During the latter half of 2008, bull trout would have already entered the Methow River to access spawning and overwintering habitat located outside of the Wells Project Area. By 2009, most of the tags activated in earlier years would have expired and been unavailable in providing additional data.

### 6.1.2 PIT tagging efforts and interrogations

Ninety-one adult bull trout were incidentally captured at the Twisp River weir (44-79 cm range) in 2010. To date, none of these fish have been observed at Wells or lower Wenatchee and Etiat River interrogation locations. Eighty seven of these fish were given new PIT tags, while 4 of them were recaptures from other Methow Basin tagging sites (Charlie Snow pers. comm.). A total of 460 bull trout observations were made in the Methow River Basin at 8 PIT-tag detection sites from Jan 8$^{th}$ 2010 to Dec 7$^{th}$ 2010. These observations came from 92 unique fish but were not evenly distributed among fish (One adult accounted for 111 of the 460 observations). Of the 92 unique fish, 72 were greater than 40 cm.

### 6.1.3 Movement and Behavior within the Methow Basin

Ninety-two unique fish were observed on at least one PIT tag interrogation station in the Methow Basin during 2010. Twenty-one of these 92 fish were observed at more than one interrogation station in the Methow, whereas the balance of fish, 71, was observed at only one Methow Basin location. These 71 fish were subsequently removed from any further behavior and migration analysis. Of the 21 fish remaining in the analysis, 16 (76%) had TWR (Twisp River Weir) as their first detection location. Fourteen of the 21 (67%) were both initially detected at TWR or MRT (Methow River at Twisp) and had their last detection location at LMR (Lower Methow

River).  It appears that the majority of these fish were detected making downstream movements towards and, presumably, into the lower Methow river.  Three more of these fish were last detected at the Gold Creek (GLC) detection site, another lower Methow location, after first being detected at TWR.  Thus, 81% of the multiple detected fish were recorded making downstream movements toward the lower Methow in 2010.  The lack of upstream detections is likely attributable to fish moving during a time of year when the PIT-tag detection systems are either operating at very low efficiency due to high water, have been removed to protect them from the high debris loads experienced during the spring run-off in May-July, or have been damaged because of debris and high flows during the spring freshet.  Information regarding these outages and removal can be found on the PTAGIS website (http://www.ptagis.org/ptagis/index.jsp).

All 14 fish that made downstream migrations from TWR to LMR, were detected at the mouth of the Methow between September 17th and December 6th 2010.  Therefore, these movements towards the Methow mouth are likely associated with behavioral movements to overwintering locations, and are consistent with previous radio-telemetry data.  In addition, similar seasonal observations were observed at Wolf Creek (WFC) by one small, 173 mm bull trout.  This fish may have been foraging upstream of WFC prior to September, when it moved downstream.  Only one fish made a documented upstream migration, which occurred when an adult fish entered the Methow (LMR) on June 16th and subsequently detected at the Twisp River Weir on Oct 11th 2010.  Together, 20 of the 21 fish or 95% (including 6 fish less that 224 mm) made downstream migrations in the late summer and fall, presumably into the Wells Project.

Together, three general trends exist for behavior of bull trout in the Methow River Basin:

1) Bull trout entering the Methow Basin do so in the spring and early summer.  They move quickly up river, presumably, to foraging and spawning locations.  It is unclear exactly where these locations are since these fish are not detected moving upstream throughout the basin, and thus they are likely moving quickly past arrays to higher elevation tributaries.  The lack of upstream migration data is indicative of high flow river conditions, debris damaging PIT tag arrays and lower detection efficiencies during these seasonal conditions.  However, radio-telemetry data confirms that upstream movements do take place in the spring and summer.
2) The most obvious location for spawning occurs in the Twisp River above the Twisp River Weir detection location, since the majority of the fish were detected at the Twisp River weir in September, but also in the late-summer and fall.
3) Both adult and sub-adult (157-720 mm) bull trout appear to make directed downstream movements into the lower Methow and likely the Wells Project after spawning and prior to the onset of winter.

## 6.2 Strategy 1-2: Correlations between passage events and Project operations

Results from the 2005-2008 radio-telemetry effort indicated bull trout movement was determined by seasonal conditions rather than project operations.  No additional analysis of passage events at Well Dam and Project operations were conducted in 2010.

Observations of bull trout at Wells Dam in the 2010 season remained similar to observations from previous years. Adult bull trout fishway counts at the Wells Project were 43, 43 and 44 respectively for the past three years. The largest numbers of fishway counts of adult bull trout over the last ten years occurred during 2001 (N = 107), with a ten year average of 65 bull trout annually. Adult bull trout begin seasonal usage of the Wells Dam fishways reliably in early to mid-May, with the bulk of their fishway use occurring from May through the end of June. Collectively, 90% of Wells Dam fishway use by adult bull trout occurs during this late spring period (May-June). The seasonal end to Wells Dam fishway use by bull trout has been less predictable, occurring sometime between July and November over the last decade. During the 2010 season 82% of all bull trout fishway observations were in the May-June period, with the last observation in late October. These 2010 observations are consistent with previous years where fishway usage was dependent on seasonal movement by adult bull trout. Off-season fishway monitoring continues to indicate that adult and sub-adult bull trout are not passing Wells Dam during the winter months.

## 6.3 Strategy 1-3: Off-season fishway passage of adult bull trout

Off-season video monitoring of both Wells Dam fishways continued for the 2009-2010 winter period (November 16 - April 30). During these monitoring periods, no adult bull trout were observed using the fishways. Consistent with observations from several years of year-round fishway counts, adult bull trout passage through Wells Dam primarily occurs in May and June each year.

## 6.4 Strategy 1-4: Modifications to passage facilities or operations

There have been no passage issues identified that limit upstream or downstream passage of adult bull trout at Wells Dam. Therefore, there is no need for modifications to current passage facilities or operations.

## 6.5 Strategy 2-1: Sub-adult PIT tagging program

Douglas PUD passively collected information from all PIT-tagged fish, including bull trout, as they passed through the fishways at Wells Dam. Douglas PUD also scanned all bull trout incidentally captured at rotary screw traps and adult brood collection facilities. The information collected at the dam and in the tributaries was posted on the PTAGIS website, which is operated and maintained by the Pacific States Marine Fisheries Commission.

Consistent with previous years, no sub-adult bull trout were observed or detected at Wells Dam. Douglas PUD continues to provide support to WDFW for PIT tagging bull trout incidentally collected at both on-site and off-site smolt collection facilities (Table 6.5-1). Tag information for all tagged fish was posted on the PTAGIS website (http://www.ptagis.org/ptagis/index.jsp). The PTAGIS database shows that none of the sub-adult bull trout PIT-tagged in the Methow River basin have been detected at Wells Dam or outside the Methow Basin at other Columbia Basin dams through December 31, 2010. One bull trout PIT-tagged in the Entiat River by the USFWS in 2008 was detected passing upstream through Wells Dam in June 2009. This is the first PIT-tagged bull trout to be detected at Wells Dam since monitoring started in 2001. In addition to the

87 adult bull trout PIT-tagged at the Twisp Weir, 24 sub-adult bull trout were PIT-tagged at the Twisp River Weir and 29 sub-adults were tagged at the Twisp River smolt trap. No bull trout were PIT-tagged at the Methow River screw trap in 2010.

Within the Methow Basin there are 15 separate PIT-tag interrogations facilities, making it one of the most extensive PIT-tag interrogation networks in the Columbia Basin. Of the bull trout that have been PIT-tagged by WDFW using Douglas PUD tags, numerous within basin detections have occurred, including 460 detections in 2010 (See sections 6.1.2-3). In 2008, 10 observations of PIT-tagged sub-adult bull trout took place at four different monitoring locations within the Methow Basin. Seven of these observations were at the one Twisp River in-stream interrogation site. In 2009, 11 observations of PIT-tagged sub-adult bull trout took place with all but one of these fish observed at the Twisp River monitoring station. In 2010, 20 bull trout (include 3 tagged by USGS) under 30 cm were detected in the Methow Basin. These fish accounted for 160 of the 460 total detections in the Methow in 2010, with 89 of these 160 coming from one sub-adult bull trout. The skewed contributed observations from this sub-adult bull trout is attributed to repeated observations at the MRT interrogation location. Specifically, this fish was first detected on Sept 1$^{st}$ at MRT and subsequently detected nearly every day, multiple times a day, until Oct 13$^{th}$. (A similar theme was observed for one adult October to November [111 detections]). These two fish were responsible for almost 43% of all 460 detections in the Methow River basin in 2010.) Detection sites where sub-adult bull trout have been observed in 2010 and previous years include the lower Methow, middle Methow, Chewuch, Beaver, Gold, Wolf and Eightmile Creek, Twisp River and the Twisp River weir detection sites. In summary, the majority of bull trout detections in the Methow River Basin occurred between July and November in 2010 (95%) at the MRT and the TWR interrogation locations (nearly 82% of all detections were at these two locations).

WDFW fish management staff incidentally captured and PIT-tagged 18 adult Methow Basin bull trout from Dec 2009 to March 2010 via hook and line sampling. All these adults were capture in the mainstem Methow River (mean size 547 mm; range 410-720). Winter tagging continues via hook and line however, only approximately 5 fish have been tagged as of January 31, 2011.

**Table 6.5-1 Sub-adult bull trout PIT-tagged in the Methow Basin, 2008-2010 (data from C. Snow, WDFW).**

| Year | Collection/tag site | # PIT-tagged/ # captured | # DNA sampled |
|---|---|---|---|
| 2008* | Methow River trap | 0/0* | 0* |
| 2008* | Twisp River trap | 13/14* | 0* |
| 2009 | Methow River trap | 6/6 | 5 |
| 2009 | Twisp River trap | 21/21 | 10 |
| 2010 | Methow River trap | 0/0 | 0 |
| 2010 | Twisp River trap | 29/29 | 10 |
| 2010 | Twisp River weir | 24/24 | 0 |

*August to December only: In early 2008 16 sub-adults were captures in the Twisp River trap and 10 DNA samples were taken from these fish. To see 2005-2008 data table similar to above refer to LGL and Douglas PUD (2008).

## 6.6 Strategy 2-2: Off-season fishway passage of sub-adult bull trout

Similar to off-season video monitoring of adult bull trout (Section 6.3), off-season video monitoring of the Wells Dam fishways for sub-adult bull trout continued for the 2008-2009 and 2009-2010 winter periods (November 16 - April 30). During these monitoring periods, no sub-adult bull trout were observed utilizing the fishways. To date, no sub-adult bull trout have been observed using Wells Dam fishways at any time during the year.

## 6.7 Strategy 3-1: Inflow patterns, reservoir elevations, and backwater curves

On November 5, 2008, Douglas PUD conducted several stranding surveys intended to document whether or not bull trout are stranded in the Wells Reservoir during lower than normal reservoir surface elevation operations (surface elevation at or below 773’ msl). The survey locations were selected based upon an analysis of detailed bathymetric maps produced in 2005 combined with Wells Reservoir hydraulic information. This effort identified several locations where stranding of sub-adult bull trout could potentially occur. Six total potential stranding locations were identified. These locations were the Methow River mouth, the Okanogan River mouth, the Kirk Islands, the shallow water habitat in the Columbia River directly across from the mouth of the Okanogan River, Schluneger Flats and the off-channel areas of the Bridgeport Bar Islands. Boat and foot surveys were conducted and included a combination of shoreline transects and inspection of isolated sanctuary pools. Similar to previous bull trout stranding surveys, no bull trout were observed during the 2008 survey which suggests that bull trout are able to avoid stranding and entrapment areas in the event of a Wells Reservoir drawdown. During 2009 and 2010, no entrapment surveys were conducted as low water events did not take place.

## 6.8 Strategy 4-1: Genetic sampling program

In 2010, 10 DNA samples were taken from juvenile bull trout in the Twisp River smolt trap (operated by WDFW), with no additional bull trout captured or sampled from the Methow River trap. Fifteen genetic samples were collected in 2009 from sub-adult bull trout captured during off-site smolt collection activities in the Methow River basin (Table 6.5-1). The samples collected in 2009 were provided to the USFWS in Wenatchee for analysis (Judy De La Vergne). The 10 DNA samples collected during 2010 are currently in the care of WDFW (Fish Management Biologist, Bob Jateff) and will be delivered to the USFWS. Genetic analysis results are not yet available, but are anticipated to be provided by USFWS in the future and when available will be included in future reports.

## 6.9 Strategy 4-2: Participation in information exchanges and regional efforts

Douglas PUD continues to coordinate with regional tribal, state, and federal agencies, to promote the exchange of bull trout information and to ensure that local and regional bull trout monitoring efforts are coordinated in the Upper Columbia River.

# 7.0 CONCLUSIONS

Six years of tagging results and eight years of monitoring results, as reported in the Bull Trout Plan 2005-2008 Final Report, demonstrate no project-related impacts to adult or sub-adult bull trout from passage through the Wells Project, nor by stranding/entrapment due to lowering of the reservoir elevation. Douglas PUD has also determined there are no apparent correlations between project operations and downstream passage events, and that there is no upstream movement of adult or sub-adult bull trout through the Wells Dam fishways during the November 16 through April 30 timeframe. Bull trout captured and tagged at Wells Dam were radio-tracked to the Methow and Entiat Core Areas during spawning periods, and have also demonstrated movement between these systems by successfully passing upstream and downstream through Wells Dam. Two of the 5 Adult bull trout PIT-tagged in 2010 at Wells Dam were later observed in the Methow and Twisp River basins.

Results of the 2010 implementation of the Bull Trout Plan remain consistent with the previous 9 years of monitoring and evaluation. Off-season fishway monitoring continues to document that adult and sub-adult bull trout are not passing Wells Dam during the winter months. To date, no sub-adult bull trout have been observed in Wells Dam fishways. Data collected from the Methow River basin smolt collection operations indicate that sub-adult bull trout are present outside of the Wells Project.

In 2010, 24 and 29 sub-adult bull trout were trapped in the Twisp River Weir and Twisp River smolt trap respectively, all of which were PIT-tagged. Ninety-one adults were captured at the Twisp River Weir. PIT tags were detected in four of these fish; the other 87 untagged fish were PIT-tagged and released upstream of the weir. An additional 18 adults were caught by hook in line in the Methow basin as a result of WDFW efforts; these fish were given PIT tags if they were not already carrying one. Tag codes for all PIT-tagged fish were uploaded to the PTAGIS database. Queries of the PTAGIS database show that none of these PIT-tagged bull trout have since been detected at Wells Dam but have been detected moving within several tributaries of the Methow River. To date, only one previously PIT-tagged adult bull trout has been detected at Wells Dam. This fish was detected moving upstream through the fishways at Wells Dam during June 2009, one year after being tagged in the Entiat River by the USFWS.

In 2010, genetic samples were taken from 10 fish during the implementation of off-site smolt collection activities and provided to the USFWS for future genetic analysis. In addition to coordinating monitoring efforts and information exchanges of Project specific bull trout data, Douglas PUD continues to participate in regional activities that support bull trout conservation and recovery.

# 8.0 REFERENCES

Baxter, C. V., and F. R. Hauer. 2000. Geomorphology, hyporheic exchange, and the selection of spawning habitat by bull trout (Salvelinus confluentus). Canadian Journal of Aquatic Science. 57:1470-1481.

BioAnalysts, Inc. 2004. Movement of bull trout within the Mid-Columbia River and tributaries, 2001-2004. Report prepared by BioAnalysts for Public Utility District No.1 of Chelan County, Public Utility District No.1 of Douglas County, and Public Utility District No.2 of Grant County.

Brewin P. A. and M. K. Brewin. 1997. Distribution maps for bull trout in Alberta. Pages 206-216 in: Mackay, W.C., M. D. Brewin and M. Monita, editors. Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Cavender, T. M. 1978. Taxonomy and distribution of the bull trout, Salvelinus confluentus (Suckley) from the American Northwest. California Fish and Game 64:139-174.

Douglas PUD (Public Utility District No. 1 of Douglas County). 2004. Wells Hydroelectric Project Bull Trout Monitoring and Management Plan, 2004-2008. Prepared by Public Utility District No. 1 of Douglas County, East Wenatchee, WA.

Dunham, J., B. Rieman, and G. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management, 23:894–904.

English, K. K., T. C. Nelson, C. Sliwinski, and J. R. Stevenson. 1998. Assessment of passage facilities for adult sockeye, Chinook, and steelhead at Rock Island and Rocky Reach dams on the mid-Columbia River in 1997. Report to Public Utility District No. 1 of Chelan County, Wenatchee, WA.

English, K. K., C. Sliwinski, B. Nass, and J. R. Stevenson. 2001. Assessment of passage facilities for adult steelhead at Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells dams on the mid-Columbia River in 1999. Report to Public Utility District No. 1 of Chelan County, Wenatchee, WA.

Kraemer, C. 1994. Some observations on the life history and behavior of the native char, Dolly Varden (Salvelinus malma) and bull trout (Salvelinus confluentus) of the North Puget Sound Region. Washington Department of Wildlife. Draft.

LGL and Douglas PUD. 2008. Wells bull trout monitoring and management plan 2005-2008 final report. Report to Public Utility District No. 1 of Douglas County, East Wenatchee, WA.

LGL and Douglas PUD. 2007. Wells Hydroelectric Project No. 2149 2006 Annual Report - Wells Bull Trout Monitoring and Management Plan. Report to Public Utility District No. 1 of Douglas County, East Wenatchee, WA.

McPhail, J. D. and J. S. Baxter. 1996. A review of bull trout (Salvelinus confluentus) life history and habitat use in relation to compensation and improvement opportunities. Fisheries management report no. 104. University of British Columbia. Vancouver, B.C.

Mongillo, P. E. 1993. The distribution and status of bull trout/Dolly Varden in Washington State. Washington Department of Wildlife. Fisheries Management Division, Report 93- 22. Olympia, Washington. 45 pp.

Pleyte, Kay A., S. D. Duncan, and R. B. Phillips. 1992. Evolutionary relationships of the fish genus Salvelinus inferred from DNA sequences of the first internal transcribed spacer (ITS 1) of ribosomal DNA. Molecular Phylogenetics and Evolution, 1(3): 223-230.

Riehle, M. W. Weber, A. M. Stuart, S. L. Thiesfeld and D. E. Ratliff. 1997. Progress report of the multi-agency study of bull trout in the Metolius River system, Oregon. In Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force. Calgary, (Alberta). Pages 137-144.

Rieman, B. E., and J. D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Forest Service, Intermountain Research Station. General Technical Report INT-302.

Rieman, B. E., and J. D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of American Fisheries Society. Vol. 124 (3): 285-296.

Rieman, B. E., D. C. Lee and R. F. Thurow. 1997. Distribution, status and likely future trends of bull trout within the Columbia River and Klamath Basins. North American Journal of Fisheries Management. 17(4): 1111-1125.

Sexauer, H. M. and P. W. James. 1993. A survey of the habitat use by juvenile and prespawning adult bull trout, Salvelinus confluentus, in four streams in the Wenatchee National Forest. Ellensburg, WA, Central Washington University.

U.S. Fish and Wildlife Service, National Marine Fisheries Service, Plum Creek Timber Company, Inc., and CH2M Hill. 2000. Final Environmental Impact Statement and Native Fish Habitat Conservation Plan – Proposed Permit for Taking of Federally Listed Native Fish Species on Plum Creek Timber Company, Inc. Lands. September, 2000.

U.S. Fish and Wildlife Service. 2002. Chapter 22, Upper Columbia Recovery Unit, Washington. 113 p. In: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

U.S. Fish and Wildlife Service. 2004. Biological Opinion and Conference Opinion for the License Amendment to incorporate the Rocky Reach, Rock Island and Wells Anadromous Fish Agreement and Habitat Conservation Plans. Federal Energy Regulatory Commission (FERC). FWS Reference Number: 04-W0203. U.S. Fish and Wildlife Service, Central Washington Field Office, Wenatchee.

U.S. Fish and Wildlife Service. 2008a. News Release: Status Review of Bull Trout Completed. Contacts T. Koch and J. Jewett. Portland, OR.

U.S. Fish and Wildlife Service. 2008b. Bull Trout (*Salvelinus confluentus*). 5-Year Review: Summary and Evaluation. Portland, OR.

Volk, E. C. 2000. Using otolith strontium to infer migratory histories of bull trout and Dolly Varden from several Washington State rivers. Submitted to Olympic National Park in fulfillment of Contract #2550041. Washington Department of Fish and Wildlife, Olympia.

# 2011 AQUATIC NUISANCE SPECIES MONITORING POWERPOINT PRESENTATION

# Douglas ANS monitoring 2011

1. Zebra/Quagga Mussels
   - Monitoring/early detection
2. Macrophytes
   - Distribution update (rec/swimming areas)
3. Crayfish
   - Permitting and distribution in Wells Project 2012
4. Northern Pike
   - Box Canyon reservoir: Staying informed

# Zebra & Quagga


1. Veliger plankton tows
   - Three samples taken this year- sent to WDFW for analysis
2. Settlement substrates
   - Examined four X this year with no presence of adults
   - Continued vandalism at these locations (docks): Brewster, Pateros, & Bridgeport
     - Relocated two samplers

No Zebras or Quagga mussels in Wells Project to date

# Macrophytes

- Contacted by city stakeholders

Douglas Rec. Management Plan requires management of aquatic veg. in rec. areas: Pateros, Brewster, and Bridgeport

Photo: Bridgeport swimming area Sept 2011

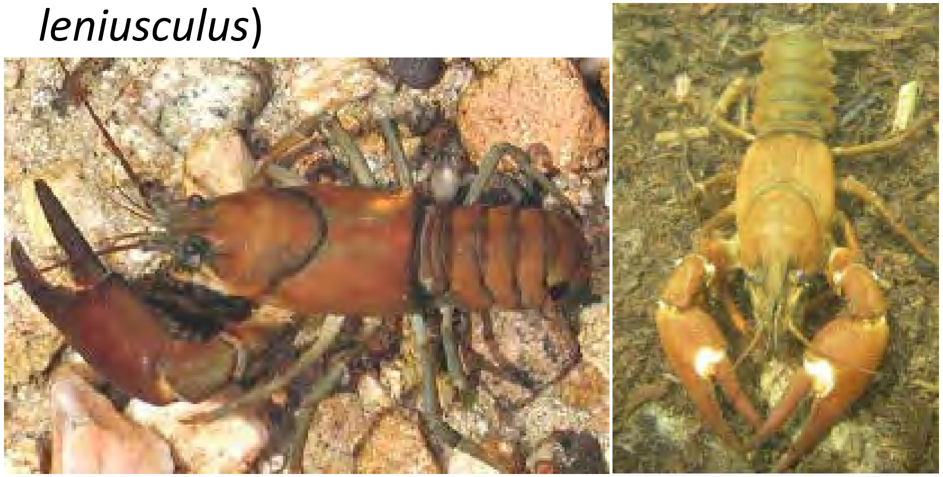
- Sept 30th evaluated dpp. dominance in swimming areas
  - n = 26 substrate samples following Le and Kreiter 2005
  - Results summarized in a memo dated Oct 5th to the Dept. of Ecology (Can share with group if interested)
  - EWM: not dominant in any of the samples. Sub-dominant in 15% of the samples
  - Treatment options being considered: Herbicide? Others include mats, and physically removing

# Crayfish

- Northern crayfish (*Orconectes virilis)* found in the Brewster swimming area late June 2011
  - Dr. J. Olden (UW) confirmed its ID via pictures
- Absence of baseline crayfish data
  - Permit to capture in 2012 spring/summer
  - Development of informal study plan through the winter
  - Collection 2012

Wells Project July 2011- Northern Crayfish

Native Signal Crayfish (*Pacifasticus leniusculus*)



DOUGLAS COUNTY PUD

# Northern Pike- Staying informed

- Box Canyon (5th Project upstream):
  - 300 in 2004 → Estimated 10,000 in 2011
- Few, but have been, reported in Lake Roosevelt
- Unclear impact on salmonids/bull trout
- Biology:
  - Piscivorous, apex fish species
  - Ideal water temp is 17-21 C
  - Spawn between ~2-8 C
  - Eggs adhere to macrophytes
  - Broadcast- no parental care
- Not to be confused with Northern pikeminnow

July 22 2011 L. Roosevelt *Esox L.*

***Ptychocheilus oregonensis***

***Esox lucius***

DOUGLAS COUNTY PUD

# Going forward

- Continued veliger tows, and substrate samples for Z and Q mussels in 2012
- Aquatic veg. control
- Crayfish sampling plan development
- Northern Pike watch during AS and HCP activities
  - potential regional coordination/participation
  - Additional info on NP available at CBB: http://www.cbbulletin.com/411841.aspx "*Invasive Northern Pike Disaster For Pend Oreille Native Fish; Will Move Further Into Columbia Basin*?" Posted on Friday, Aug. 26, 2011

# 2011 AQUATIC MACROPHYTE SPECIES SURVEY LETTER TO ECOLOGY

Commissioners:
T. JAMES DAVIS
LYNN M. HEMINGER
RONALD E. SKAGEN

General Manager:
WILLIAM C. DOBBINS

Public Utility District No. 1 of Douglas County

1151 Valley Mall Parkway • East Wenatchee, Washington 98802-4497 • 509/884-7191 • FAX 509/884-0553 • www.douglaspud.org

# MEMORANDUM

**TO:** Pat Irle, Washington Department of Ecology

**FROM:** Andrew Gingerich, Senior Aquatic Resource Biologist

**DATE:** Oct 05, 2011

**SUBJECT:** Wells Project swimming areas macrophytes

On Friday September 30th 2011, Scott Kreiter (Douglas PUD Land Use Representative) and I sampled aquatic macrophyte species composition within the three developed swimming areas of the Well Project (Figure 1). These areas are within the parks of Pateros (Figure 2), Brewster (Figure 3) and Bridgeport (Figure 4) Washington. We collected ten samples at both the Pateros and Brewster swimming areas, five of which were deep samples (approximately three meters) and five of which were shallow samples (approximately 1.5 meters). Only six shallow samples were taken at the Bridgeport swimming area since this site was entirely composed of shallow water habitat. We collected 26 samples in total, following the methods described in Le and Kreiter (2005).

*General observations*

The most common aquatic plant in these samples was common waterweed (*Elodea canadensis*) which dominated 73.1% of the samples, followed by leafy pondweed (*Potamogeton pusillus*), which dominated the remaining 26.9% of our samples. Our results are consistent with previous findings that Eurasian water-milfoil (*Myriophyllum spicatum*) is rarely dominant in the Wells Reservoir (Le and Kreiter 2005). No samples (n=26) were dominated by Eurasian water-milfoil. We did however visually observe Eurasian water-milfoil in each location. Eurasian water-milfoil was the second most abundant aquatic plant in 15.4% of our samples. Leafy pondweed and curly leaf pondweed (*Potamogeton crispus*) were the second most abundant species in 61.6% of our samples, each representing approximately 30%. The only other aquatic plant observed was coontail (*Ceratophyllum demersum*), which was rare but occurred occasionally in the samples.

Analyses were performed using simple Chi-squared tests where depth and location and both dominant and subdominant species were used as independent and dependent variables respectively. These statistics are weak given the low sample sizes however, there were no location or depth trends by species (*P* values range from 0.06 to 0.9). A proportional summary of the relative dominance by species in all samples (n= 26) is provided in Table 1.

**Table 1. Relative dominance by species in pooled samples (n=26).**

| | Dominance Rank | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| CWW | 73.1% | 15.4% | 9.5% | 0.0% |
| LPW | 26.9% | 30.8% | 9.5% | 0.0% |
| CLPW | 0.0% | 30.8% | 28.6% | 25.0% |
| CT | 0.0% | 3.8% | 23.8% | 75.0% |
| EWM | 0.0% | 15.4% | 28.6% | 0.0% |

Where CWW = Common Waterweed, LPW = Leafy Pondweed, CLPW = Curly Leaf Pondweed, CT = Coontail and EWM = Eurasian Water Milfoil.

*Other aquatic life*
We did not incidentally observe any obvious signs of salmonids in the swim areas. However, these habitats are not expected to be preferred habitats for salmonids based on their environmental characteristics (slower, warmer water, and void of coarse woody debris and rocky/cobble substrate). Fishes incidentally observed in the swimming areas included various species of the sunfish, sucker, and minnow families.

*Control options*
The Wells Project Recreation Management Plan (RMP) requires that Douglas PUD control aquatic vegetation in designated public swimming areas:

> "*Aquatic plant control: Aquatic plants will be controlled in designated swimming areas at Peninsula Park* (Pateros Swimming area), *Columbia Cove Park* (Brewster Swimming area), *and Marina Park* (Bridgeport Swimming area)," and that "*Aquatic plants will be controlled in swimming areas on an as needed basis, using the most feasible methods. Methods may include, but not be limited to, harvesting, application of herbicide, or installation of liners or barriers*" (Table 5.2-1).

Partners representing recreational users in these areas have expressed concern about health and human safety related to recreational use of the public swimming areas. In response to these concerns and because of the requirements in the RMP, Douglas PUD is pursuing options for treatment of these swimming areas. Douglas PUD would prefer to implement methods that do not use direct harvest, due to concerns that fragmentation of Eurasian water-milfoil and the potential for these fragments to increase establishment or abundance of this non-native nuisance species. Instead, Douglas PUD is seeking comment regarding the use of herbicide control with the expectation that both the HCP Coordinating Committee (CC) and Wells Aquatic Settlement Work Group (Aquatic SWG) (including the representation from the Washington Department of Ecology) will consulted regarding the use of this control method. Given their bay like characteristics, all three sites have low water exchanged compared to the main Columbia, which may be a factor when considering management options. Treatment is proposed to tale place in 2012 and will be based on an approved window of time if herbicide is used.

As referenced above, the Macrophyte Identification and Distribution Study (Le and Kreiter 2005), and Douglas PUD's Recreation Management Plan can be found at Douglas PUD's relicensing webpage using the respective links:

http://relicensing.douglaspud.org/documents/pud_relicensing_documents/study_reports.asp
http://relicensing.douglaspud.org/documents/pud_relicensing_documents/management_plans.asp

Please contact me at 509-881-2323 (andrewg@dcpud.org) or Scott Kreiter at 509-881-2327 (scottk@dcpud.org) if you have additional questions. Maps of the swimming area locations are provided below.

Andrew Gingerich.
Senior Aquatic Resource Biologist

CC:
Scott Kreiter, Douglas PUD
Shane Bickford, Douglas PUD
Beau Patterson, Douglas PUD
Charlie McKinney, Washington Department of Ecology
Jenifer Parsons, Washington Department of Ecology
Bao Le, Long View Associates

**Figure 1. Google Earth satellite photo of the Wells Project and swimming area locations within the Project. These three locations are blown up in figures 2-4.**

**Figure 2. Google Earth satellite photo of the Pateros swimming area located in the town of Pateros and at the confluence of the Methow and Columbia rivers.**

**Figure 3. Google Earth satellite photo of the Brewster swimming area located in the town of Brewster.**

**Figure 4. Google Earth satellite photo of the Bridgeport swimming area located in the town of Bridgeport and at the upper end of the Project boundary.**