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March 27, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC, PJ-12
888 First Street, N.E.
Washington, D.C. 20426

RE: Priest Rapids Hydroelectric Project No. 2114 License Compliance Filing – Article 401(a)(11) – White Sturgeon Management Plan Annual and Biological Objectives Status Report

Dear Secretary Bose,

Please find enclosed the 2012 White Sturgeon Management Plan (WSMP) Annual and Biological Objectives Status Report consistent with the requirements of Article 401(a)(11) and the Washington Department of Ecology (WDOE) 401 Water Quality Water Quality Certification Condition (Reporting Section of Appendix C) for the Priest Rapids Project (Project).

This report summarizes annual activities for year 2012. The planning process was initiated in winter 2011, in consultation with the Priest Rapids Fish Forum (PRFF) with implementation planned for the spring of 2012. This report contains current information regarding the white sturgeon supplementation programs that are being implemented in the mid- and upper Columbia River regions (Kootenai and Upper Columbia White Sturgeon Recovery Initiative). Both of these programs were established for the upper Columbia River and have experienced various degrees of success. The Yakama Nation is also in development of a white sturgeon supplementation program to serve the mid-Columbia River. Public Utility District No. 2 of Grant County, Washington (Grant PUD) is currently coordinating with the Yakama Nation's efforts to satisfy supplementation program requirements for the Project in 2012 and beyond.

On February 20, 2013, Grant PUD prepared and disseminated the draft 2012 WSMP Annual and Biological Objectives Status Report for a thirty day comment period to members of the PRFF including the WDOE, U.S. Fish & Wildlife Service (USFWS), Washington Department of Fish & Wildlife (WDFW), Colville Confederated Tribes, Yakama Nation, the Columbia River Inter-Tribal Fish Commission, Bureau of Indian Affairs, and the

Confederated Tribes of the Umatilla Indian Reservation. A request for comments on the draft plan was also distributed to the Wanapum Indians, and other participating stakeholders; these comments can be found in Appendix E and comment/comment response summary table (showing the agency comment and Grant PUD's response) is attached to the report as Appendix F. Based on comments received, Grant PUD modified the report to reflect appropriate revisions and edits. On March 22, 2013, WDOE approved the Biological Objectives Status Report (Appendix G).

Federal Energy Regulatory Commission staff with any questions should contact Tom Dresser at 509-754-5088, ext. 2312, or at tdresse@gcpud.org.

Sincerely,

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2012
White Sturgeon Management Plan
Annual and Biological Objectives Status Report

Priest Rapids Hydroelectric Project (FERC No. 2114)

Prepared for:

Public Utility District No.2 of Grant County
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Ephrata, WA 98823

Prepared by:

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March 2013

Executive Summary

On April 17, 2008, the Federal Energy Regulatory Commission (FERC) issued Public Utility District No. 2 of Grant County, Washington (Grant PUD) a 44-year license to operate the Priest Rapids Hydroelectric Project (FERC No. 2114) located in the mid-Columbia River. Article 401 of the FERC license, consistent with the provisions of the Washington Department of Ecology Section 401 Water Quality Certification for the Priest Rapids Project (401 Certification) requires that Grant PUD develop a White Sturgeon Management Plan (WSMP) and conduct an on-going Monitoring and Evaluation (M&E) program to evaluate the effects of the Project on white sturgeon (*Acipenser transmontanus*) populations within the Project area. The 2012 M&E program was developed in context with the Grant Public Utility District (PUD) WSMP, with the overall goal to restore populations of white sturgeon in the Project area to levels commensurate with the carrying capacity of available habitats. In 2012, the following tasks were completed under the M&E program:

- Prepared to tag and release 2011BY juvenile white sturgeon, the progeny of a 1 X 1 parental cross. The proposed release number of 722 juveniles was 1/9 of the annual release target of 6500 juveniles, as prescribed in the WSMP, which assumes a minimum 3x3 factorial cross. Due to a low-grade viral infection of the 2011BY, the Priest Rapids Fish Forum (PRFF) agreed that the fish should not be released.
- Broodstock set line sampling was conducted daily from June 15 to June 28; in total, 23,447 hook-hours of sample effort were expended below Rock Island Dam in Wanapum Reservoir. Guide-assisted angling, conducted daily over the same period, resulted in an estimated 504 hook-hours of sample effort. Both sample methods used a combination of specialty baits and salmon to increase the probability of capturing larger brood candidates and reduce capture of smaller sturgeon. In total, 20 wild and 27 Columbia River Inter-Tribal Fish Commission (CRITFC) hatchery white sturgeon were captured by set line. In addition, 10 wild fish and 11 CRITFC hatchery fish were caught by angling. One female and four male white sturgeon were assessed as viable broodstock candidates and successfully transported to the Marion Drain Hatchery (MDH).
- Habitats selected by juvenile 2010BY white sturgeon were identified using mobile acoustic telemetry surveys and selected habitat attributes were measured using an Acoustic Doppler Current Profiler (ADCP) and underwater cameras, following the methodology developed during the 2011 M&E program.
- Continued monitoring the dispersal of the 2010BY juvenile white sturgeon. Telemetry data were used to determine the extent of outmigration from the Priest Rapids Project Area (PRPA) and identify differences in movement patterns among the three 2010BY release groups, the Upper Columbia Wild (UCW), Middle Columbia Wild (MCW), and Lower Columbia Captive (LCC). Mobile tracking confirmed the location of 19 juveniles from the 2010BY releases (11 LCC, 5 MCW, and 3 UCW). Based on the detection of 58 PIT-tags from the MCW group at a known bird colony in the Rock Island Dam forebay, avian predation was identified as a potentially significant factor affecting early survival of hatchery reared juvenile white sturgeon in upper Wanapum reservoir.
- A pilot juvenile white sturgeon indexing program was implemented to assess the effectiveness of gill nets as a capture method and provide a preliminary population estimate of the 2010BY. Gill net sampling in the PRPA was conducted from August 29 to

September 2, 2012. In total, 79 overnight duration benthic gill net sets were deployed for 1,705.8 hours of fishing effort. Only one 2010BY white sturgeon was captured. This fish had been released by Chelan PUD biologists in Rocky Reach Reservoir and had emigrated into the Project area from upstream. Catch of incidental coarse fish species in the gill nets was high, with over 1,700 northern pikeminnow (*Ptychocheilus oregonensis*) and other species captured.

- An adult mark-recapture program was conducted in fall 2012 from September 10 to September 16 (Session 1), and from October 1 to October 8 (Session 2) to assess the current population of wild white sturgeon and hatchery white sturgeon released by the CRITFC in 2003. In 2012, 118,550 hook-hours of set line sample effort was expended during the mark-recapture sessions conducted in the Project area (Priest Rapids and Wanapum reservoirs) during the two GRTS population sample sessions. The combined sample effort from both sessions resulted in the capture of 313 white sturgeon (includes recaptured fish) composed of two 2010BY fish, 278 CRITFC hatchery fish, and 33 wild fish for an overall CPUE of 0.26 fish/100 hook-hours.

This report summarizes the methods and results from 2012, the first year of a three year M&E program to be undertaken by Golder Associates Ltd. As such, the report provides a preliminary interpretation of the data collected. A more comprehensive interpretative report will be produced in 2014.

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List of Abbreviations

401 Certification	Washington Department of Ecology Section 401 Water Quality Certification for the Priest Rapids Project
BY	Brood Year
CF	Culture Family
CPUE	Catch-Per-Unit-Effort
CRITFC	Columbia River Inter-tribal Fisheries Commission
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FL	Fork Length
FFSBC	Freshwater Fisheries Society of British Columbia
Grant PUD	Public Utility District No. 2 of Grant County, Washington
KTH	Kootenay Trout Hatchery (location of the white sturgeon Conservation Aquaculture Facility)
LCC	Lower Columbia Cultured 2010BY
MCW	Middle Columbia Wild 2010BY
MDH	Marion Drain Hatchery
M&E	Monitoring and Evaluation
OTC	Oxytetracyline
PDX	Polydioxanone violet monofilament
PIT	Passive Integrated Transponder
Project	Priest Rapids Project
PRPA	Priest Rapids Project Area (Rock Island Dam downstream to Priest Rapids Dam)
PRFF	Priest Rapids Fish Forum
RM	River Mile
TL	Total Length
UCW	Upper Columbia Wild (2010BY)
UCWSRI	Upper Columbia white sturgeon Recovery Initiative
UTM	Universal Transverse Mercator
WDFW	Washington Department of Fish and Wildlife
WF	Wild Family
WSMP	White Sturgeon Management Plan

1.0 INTRODUCTION

1.1 Background

The Priest Rapids Hydroelectric Project (Project) consists of two hydroelectric developments and their respective reservoirs, Wanapum and Priest Rapids dams built in the late 1950s and early 1960s, respectively (Figure 1). A 44-year license to operate the Project was issued to Public Utility District No. 2 of Grant County, Washington (Grant PUD) by the Federal Energy Regulatory Commission (FERC) (FERC No. 2114). Article 401 of the FERC license required that Monitoring and Evaluation (M&E) programs be conducted to evaluate the effects of the Project on white sturgeon (*Acipenser transmontanus*) populations within the Project area. Objectives of the M&E program were outlined in Grant PUD white sturgeon Management Plan (WSMP) and included identification of critical habitat associated with spawning, feeding, and rearing, and evaluation of impacts within the Project area that could potentially affect feeding, food availability, spawning behavior, and spawning migrations. The overall goal of the WSMP is to restore populations of white sturgeon in the Project area to levels commensurate with the carrying capacity of available habitats. To achieve this goal, conservation aquaculture was identified as the best approach in conjunction with implementation of the M&E program.

Article 401 of the FERC license specifically references the M&E approach outlined in the WSMP, allowances for an "adaptive management" approach are also considered by FERC as an acceptable method to meet license obligations. Under this approach, management objectives could be potentially modified based on review of M&E study data by an independent panel of stakeholders, collectively termed the Priest Rapids Fish Forum (PRFF). The forum participants include representatives from Grant PUD, Washington Depart of Fish and Wildlife (WDFW), US Fish and Wildlife Service (USFWS), Washington Department of Ecology (WDOE), the Yakima Nation (YN), Bureau of Indian Affairs (BIA), and Columbia Inter-Tribal Fisheries Commission (CRITFC). The mandate of the PRFF is to review licensing objective requirements in context with the implementation and results of the M&E study components, and based on this review, and through consensus, provide recommendations to amend and improve the M&E program in response to findings in order meet the overall WSMP management objective. Recommendations by the PRFF and their implementation are accepted by FERC as binding changes to Article 401 of the license.

Since issuance of the FERC license in 2008, field components of the Year 3 and 4 M&E programs were conducted in 2010 and 2011 by Golder Associates Inc. The M&E program outlined in the WSMP identified six specific biological studies and sampling programs, that when implemented according to a predefined schedule, would contribute to the meeting the overall management objectives and obligations in accordance the Article 401 requirements. Following the schedule outlined by the M&E program, studies or tasks were to be first conducted as a pilot to determine feasibility, and later on, conducted at regular intervals, as prescribed, towards meeting the WSMP management objectives. The M&E study tasks and a brief summary of results obtained during the 2010 and 2011 studies are provided below as context for the development and implementation of the 2012 study program.

Task 1: Update status of the white sturgeon population in the Project area.

In 2010, spawn monitoring and summer distribution and abundance studies were conducted using the same methodologies applied during the 1999-2002 study program (Golder 2003). The objective of the 2010 study was to identify if substantive changes to the white sturgeon population in the PRPA had occurred in the past decade.

Spawn monitoring below Rock Island Dam and Wanapum Dam confirmed that white sturgeon continue to use the tailrace area of both dams during the spawning season, and that the spawn timing recorded in 2010 was comparable to previous study results. Installation of the Wanapum fish bypass since the 1999-2002 study has resulted in a substantial change in tailrace hydraulic and flow patterns. Spawning activity below Wanapum Dam was identified in 2010, but due to the low number of spawning events detected, changes in spawning timing, intensity, and location in relation to the 1999-2002 study results could not be determined.

Adult population indexing using systematic set line sampling was conducted in September and October 2010. In total, 130,640 hook-hours of set line sample effort was expended during the mark-recapture sessions conducted in Priest Rapids and Wanapum reservoirs. This effort resulted in the capture of 602 white sturgeon (includes recaptured fish) composed of 544 hatchery and 58 wild fish for an overall CPUE of 0.46 fish/100 hook-hours. The large cohort of sub-adult hatchery fish (i.e., 90% of the catch), which were absent from the 1990-2002 population, were the progeny of captive broodstock from below Bonneville Dam, that were released into Rock Island Reservoir, as a cooperative effort between CRITFC, the USFWS, and the Oregon Department of Fish and Wildlife (ODFW). In total, 20,600 hatchery juvenile white sturgeon were released in 2003 and since then, an unknown portion of these fish have moved downstream into the Project area. CPUE of wild sturgeon also increased in 2010 compared to the 1999-2002 study and the 58 wild sturgeon captured included the recapture of five fish tagged during the 1999-2002 study. All recaptured wild fish had increased in fork length (FL) and weight, with an average gain of 30.6 cm FL (range = 13 to 73 cm) and 15.8 kg (range = 3.5 to 26.3 kg) (Golder 2011a).

Using a sequential Bayes' algorithm estimator, the 2010 population of CRITFC hatchery white sturgeon was estimated at approximately 7,038 fish (95% CI =3,927 to 14,637) in Wanapum Reservoir and 3,096 fish (95% CI =1,304 to 5,227) in Priest Rapids Reservoir. Population estimates for wild white sturgeon could not be determined using conventional mark-recapture estimation procedures, due to the absence of recaptures. Extrapolation using ratios of hatchery to wild white sturgeon suggested that the population estimate of wild white sturgeon in 2010 for Wanapum Reservoir (872 wild fish) was similar to the 1999-2002 study population estimate (817 wild fish). Estimates for Priest Rapids Reservoir were substantially lower in 2010 (99 wild fish) than in the 1999-2002 study (1,161 wild fish), although the 1999-2002 estimate was based on only one recapture.

Task 2: Conduct a white sturgeon broodstock capture program with the goal of capturing a sufficient numbers of adult broodstock within the Project area to achieve the WSMP target of a 3x3 partial factorial breeding matrix.

In 2010 and 2011, Grant PUD implemented study plans to assess the feasibility of collecting white sturgeon broodstock from the Project area. The ability to successful collect sufficient numbers of broodstock was identified as a key component of the conservation aquaculture compensation component in the WSMP. In both years, broodstock capture efforts were conducted, with over 25,000 hook-hours of sample effort was applied each year prior to the seasonal start of white sturgeon spawning. Biologists and hatchery staff from the YN Marion Drain Hatchery (MDH) also conducted a comparable level of broodstock capture effort over the same period, but focused their efforts downstream from the Project area. Despite the substantial capture effort expended, only a single viable female and two viable males were captured in 2010. Broodstock capture success in 2011 was even lower, with only one female and one male captured. The resulting crosses (i.e., 1Fx2M in 2010 and 1Fx1M in 2011) did not achieve the annual target of a 3x3 factorial cross identified in the WSMP as a minimum mating cross criteria to promote genetic diversity for a given release group. All fish culture activities were conducted by MDH hatchery staff in consultation with the PRFF.

Task 3 Annual release of hatchery juvenile white sturgeon

Based on a 3Fx3M factorial breeding matrix, up to 5,000 hatchery juveniles were scheduled for release in Wanapum Reservoir and 1,500 hatchery juveniles in Priest Rapids Reservoir during each of the first five years of the M&E program. Breeding and release plans are developed and reviewed annually in consultation with the PRFF. Due to the low number of broodstock captured in 2010, the PRFF consulted white sturgeon hatchery managers and specialists in white sturgeon genetic research about supplementation of the 2011 juvenile release with progeny derived from broodstock with genetic lineages from outside the mid-Columbia region. After considerable deliberation, a decision was made by the PRFF to release 9,117 juveniles from the 2010BY into the Project area. These fish were from three distinct geographic areas and were designated as follows:

- Upper Columbia Wild (UCW): The progeny of broodstock captured in the Upper Columbia River in Canada and raised at the Kootenay Trout Hatchery (KTH);
- Middle Columbia Wild (MCW): The progeny of broodstock captured in the Project area and raised at the Marion Drain Hatchery (MDH).
- Lower Columbia Cultured (LCC): The progeny of captive broodstock originally captured below Bonneville Dam in the lower Columbia River and raised at the Marion Drain Hatchery (MDH).

The release of the three different groups was designed as an experiment to assess possible relationships between genetic make-up and post-release movement patterns, growth, and survival. The 2010BY fish were released at select sites in Wanapum Reservoir (near Rock Island Dam) and in Priest Rapids Reservoir (Wanapum Dam tailrace), with 77% of fish release in Wanapum Reservoir and the remainder in Priest Rapids Reservoir. All PIT-tagging and scute marking of MCW and LCC fish were conducted by MDH staff in conjunction with LGL; Golder staff assisted with the release of these hatchery fish. The UCW fish were tagged and released by KTH hatchery staff.

Task 4 Tracking of acoustic-tagged adult and juvenile fish

Movements of acoustic-tagged juvenile and adult white sturgeon were monitored to determine movements, and identify important habitats. Acoustic telemetry tags were opportunistically deployed in wild adult white sturgeon during the broodstock capture programs in 2010 and 2011, as well as during adult population indexing conducted in 2010. During marking and tagging of the 2010BY juveniles, 1% of the total release (i.e., 91 hatchery juveniles) were acoustic-tagged. The number of acoustic tags allocated to each three genetic release groups was equal to their portion of the total release. Hatchery juveniles were equipped with a 3-year tag while adults received a 10-year tag. An array of 12 moored acoustic receivers was deployed throughout the Project area, with 6 receivers in Wanapum Reservoir, 5 in Priest Rapids Reservoir, and 1 receiver below Priest Rapids Dam (upper McNary Reservoir). The monitoring array was downloaded and serviced quarterly and will continue to passively monitor fish movements continuously up to Year 10 of the M&E program. In 2011, based on mobile telemetry tracking of juveniles, a pilot habitat assessment was conducted at identified fish locations using an Acoustic Doppler Current Profiler (ADCP) and underwater camera.

Task 5 Juvenile population indexing

In alignment with white sturgeon supplementation programs developed for the Upper Columbia River, the Grant PUD M&E program includes the development of a juvenile population indexing program. The objectives of this program are to monitor the supplementation program effectiveness by the evaluation of emigration rates, survival rates, growth rates, fish distribution, habitat selection, habitat use, habitat availability, and habitat suitability. As outlined in the WSMP, monitoring efforts to determine program effectiveness were scheduled for implementation in Years 4, 5, 6, 8, and then every 3rd year for the term of the New License. However, this schedule was contingent on the success of broodstock aquaculture component of the M&E program and assumed an annual release of 6,500 hatchery brood in Years 1 through 4.

The WSMP identified gill nets as the most effective live-capture method for juvenile white sturgeon. This was based on the documented efficacy of gill nets to capture juvenile (≤age 4) white sturgeon in other areas of the Columbia River Basin to assess natural recruitment and evaluate supplementation efforts (Burner et al. 2000; Golder 2007, 2011b; Howell and McLellan 2008). Unlike other fish species, which become gilled and asphyxiate in a gill net, white sturgeon are typically caught by either a fin or their mouthparts when they come in contact with the net and are nearly always alive even after several hours in the net. UCWSRI studies indicated highest catch rates occurred when nets were set overnight versus daytime sets (Golder 2007); however, the most significant incidental catches and mortalities also occurred during night sets. Capture and mortality of ESA listed Bull Trout was also identified by state and federal regulatory agencies as a potential consequence of both adult and juvenile white sturgeon population indexing studies, and the approach to minimize risk to ESA listed species was considered in the development of the population indexing study design and sample methods.

Task 6 Assess natural production and adult population status

The WSMP requires that periodic spawning surveys be conducted to address the objective of identifying the natural production potential and natural recruitment of white sturgeon in the Project area. This objective also requires the periodic re-assessment of the status of the adult white sturgeon population. The frequency of surveys and the methodological approach chosen was to be determined in consultation with the PRFF as part of an adaptive management approach.

In 2010, spawning was recorded downstream of both Wanapum and Rock Island dams. A total of six spawning events were detected in Wanapum Reservoir downstream of Rock Island Dam, and three spawning events in Priest Rapids Reservoir downstream of Wanapum Dam (Golder 2011a). In total, 1,259 white sturgeon eggs were collected, with 1,185 eggs collected downstream of Rock Island Dam and 74 eggs collected downstream of Wanapum Dam. The timing and environmental condition under which these spawning events occurred were typical of other wild sturgeon populations in the upper Columbia River (e.g., on the descending trend of hydrograph, in late June to early July, and at water temperatures between 14°C and17°C). Spawning activity in 2010, in terms of the number, location and timing of spawn events were similar to spawning activity documented in 2000 and 2002 during the 1999-2002 study (Golder 2003).

1.2 2012 Study Objectives

As a component of the report for the 2011white sturgeon M&E program, Grant PUD requested that Golder develop a study plan for implementation in the 2012 (Year 5) M&E activities as prescribed in the WSMP (Golder 2012). This plan was developed and then reviewed and approved by the PRFF for implementation in the Year 5 M&E program. The specific objectives of the program are presented below in order of their planned implementation in 2012:

- Develop a release strategy for the 2011 brood year (2011BY) that takes into account the number of progeny available from the results of the 1 X 1 parental cross, the actual number to be released, and the health of the fish.
- Conduct broodstock sampling using set lines and guide-assisted angling for 14 days in June 2012. Use a combination of specialty bait and salmon to increase the probability of capturing larger brood candidate and reduce capture of smaller fish. Transport viable broodstock candidates to the Yakima Nation's Marion Drain Hatchery (MDH).
- Identify and monitor habitats use by juvenile white sturgeon using acoustic telemetry, an ADCP, and underwater cameras following the methods developed during the 2011 pilot habitat assessment study.
- Continue to monitor dispersal of 2010BY juvenile white sturgeon, based on the movement of acoustic-tagged fish within each release group, determine the extent of outmigration, and identify differences in movement patterns evident among the three genetic 2010BY groups released in April, 2011.
- Conduct a pilot juvenile white sturgeon indexing program to assess the effectiveness of gill nets as a capture method and provide a preliminary population estimate of the 2010BY.
- Conduct an adult mark-recapture program to assess the current population status of white sturgeon in the Project area.

The following sections of this report summarize the methods used and the results obtained for each of these tasks completed by the Golder Associates Inc. team in 2012.

1.3 Consultation

Pursuant to the reporting requirements, Grant PUD provided a complete draft of the 2012 WSMP Annual and Biological Status Update Report to the PRFF on February 20, 2013 for review. Written comments were received by WDFW on March 18th. Those comments and Grant PUD's response are included in Appendix F, PRFF Agency and Tribal Comment Response Table.

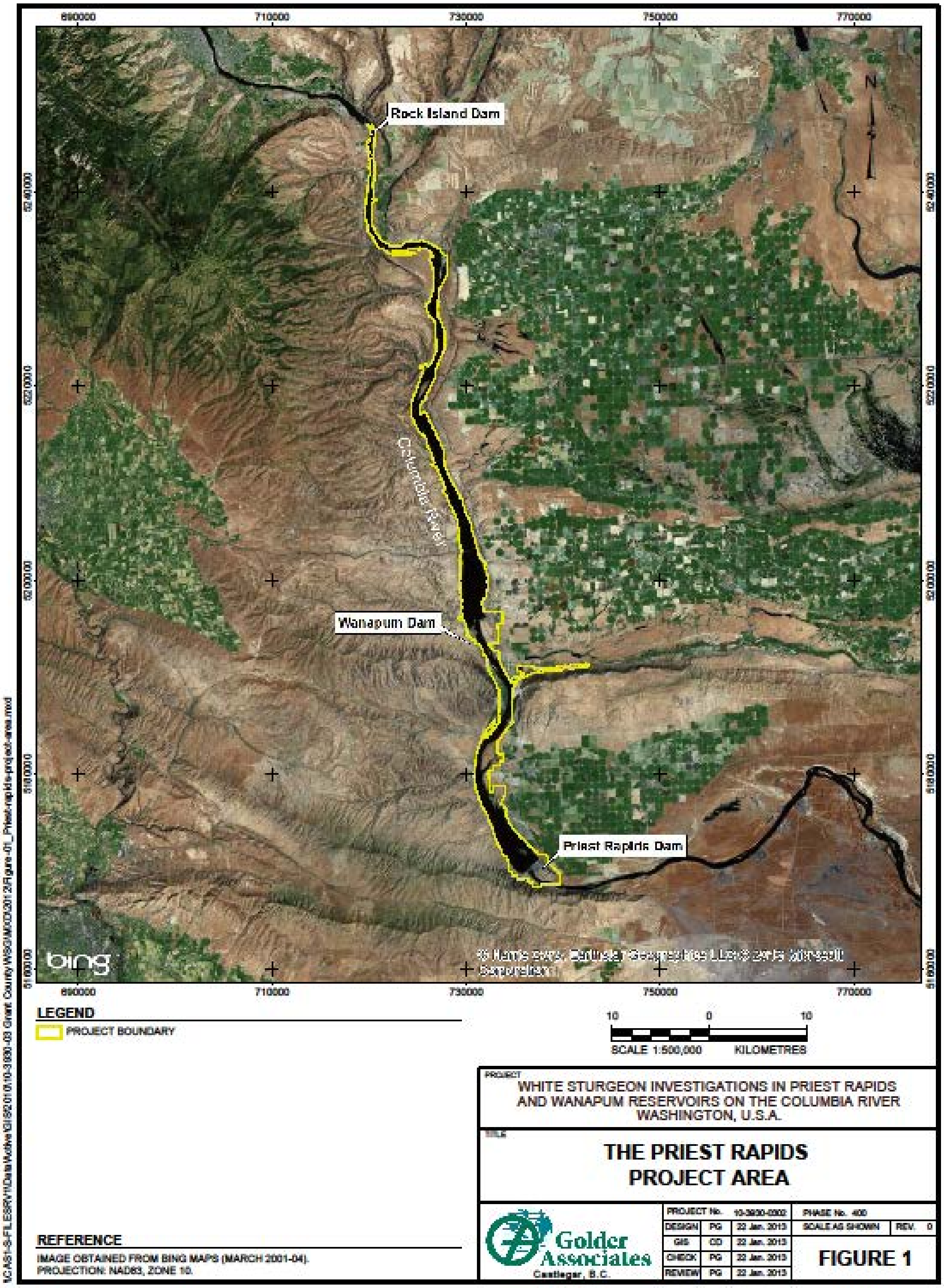


Figure 1 The Priest Rapids Project area.

2.0 METHODS

Custom queries specific to the databases developed by Golder were used to extract and process white sturgeon capture data and telemetry movement data. Broodstock CPUE calculations, summary tables, and simple figures were produced in Excel® using pivot tables and data filters. More complicated figures with multiple axes were created in R using the package ggplot2 (Wickham 2009). Telemetry data were screened prior to analysis to remove suspect detections that either did not meet established criteria based on aspects of white sturgeon life history or were inconsistent with other detection data. If data were not directly entered into a field database, customized datasheets and/or manifests were used to record information during the juvenile release, broodstock transport, VR2W download and servicing, and mobile telemetry tracking. These datasheets were scanned and a copy saved to a server.

2.1 Environmental Variables

2.1.1 Discharge and Temperature

Discharge and water temperature were considered relevant environmental variables likely to affect white sturgeon life history attributes and behavior. Discharge data recorded below Rock Island Dam were assumed representative of flow conditions within the Project area. Mean daily total discharges from Rock Island Dam from January 1 to December 31, 2012 were obtained from the Columbia River Data Access in Real Time webpage (University of Washington Columbia Basin Research; www.cbr.washington.edu/dart/river.html). A review of water temperature data from monitoring stations throughout the Project determined that the Wanapum Dam tailrace data was representative of average water temperature within the Project and was the most complete data set. Mean daily water temperature data recorded in the Wanapum Dam tailrace from January 1 to December 27, 2012 were obtained from the above web page.

Due to the short water residence time of both reservoirs in the Project area, thermal heating and stratification is minimal and water temperature is essentially homogenous (i.e., within 0.5°C from top to bottom) throughout the Project area. A review of mean daily water temperature data from the forebay and tailrace of the Rock Island Dam, Wanapum Dam, and Priest Rapids Dam determined that the Wanapum Dam tailrace temperature data set was the most complete. Water temperatures below Wanapum Dam also reflect the small amount of thermal heating that occurs during the summer in Wanapum Reservoir. Therefore, mean daily water temperature recorded below Wanapum Dam was considered representative of mean daily water temperature throughout the Project.

2.2 BY2011 Marking and Release

The 2011 broodstock collection program resulted in the capture of only 1 female and 1 male that could be successfully mated at the MDH. This resulted in the production of only one family and consequently, the PRFF decided to reduce the number of 2011BY juveniles released from the annual WSMP target of 6500 juvenile (i.e., based on the contributions of nine families from a 3x3 cross) to 722 juveniles (1/9th of the original 6,500 release group). This decision was based concerns of potential future genetic issues related to release of large numbers of related offspring. The 2011BY were to be distributed between Wanapum and Priest Rapids reservoirs at approximately a 3:1 ratio distributed between Wanapum (77% or 556 fish) and Priest Rapids reservoirs (23% or 166 fish).

For reasons discussed in Section 3.2, the PRFF and regulatory agencies decided against releasing any of the 2011BY. Consequently, the PIT-tags and acoustic tags purchased for marking the 2011BY were reserved for the 2012BY.

2.3 Broodstock Capture

Broodstock capture was conducted from June 15 to June 28, 2012 and was limited to the area below Rock Island Dam in Wanapum Reservoir. In an attempt to supplement broodstock capture efforts using setlines as was done in 2010 and 2011, guide assisted angling was conducted concurrently with set line sampling over the entire 2012 broodstock capture effort.

2.3.1 Set Lines

A combination of short, medium, and long set lines were deployed at known or suspected white sturgeon holding and staging areas from June 15 to June 28, 2012. The number of hooks on each set line and the length of set line used depended on the size and flow characteristics of the area being sampled. In fast flowing water or in small back eddies, short and medium length set lines, between 20 and 50 m long, were used and set with between 4 and 12 hooks. Set line deployment orientation to flow was dependent on the flow velocity and water depth at the deployment site. All set lines were tied to shore and were either set parallel with flow or at an oblique angle, typically at an angle of incidence of no more than 45° to the direction of flow. In very fast flowing locations where set line deployment was not feasible, jug sets (a weighted single hook with a float retrieval line) were used. Barbless hooks were used to facilitate fish release and reduce the severity of hook-related injuries.

High flows in 2012 precluded extensive use of set lines below Rock Island Dam; however, three to four locations where set lines could be effectively and safely deployed were identified and these locations were regularly sampled during the brood capture program. Due to other duties of the crew (e.g., the requirement to process fish captured by the fishing guide; see Section 2.3.2 and 2.3.3), typically no more than three long set lines were deployed at suspected staging areas. In addition to the three long set lines, two or three short set lines or jug sets were opportunistically deployed. As during previous broodstock capture efforts in 2010 and 2011, long set lines were approximately 183 m long and consisted of anchored 0.64 cm diameter nylon mainline with up to 30 circle halibut hooks attached at 4.6 m intervals. Hook gangions were 0.7 m length and consisted of a swivel-snap, a length of round- tarred ganging and a single barbless circle hook. In 2012, effort was made to reduce capture of the CRITFC juveniles and increase capture of large wild white sturgeon by using large circle hooks (20/0) and specialty bait that included large pieces of wild salmon and large specialty-brined squid. The specialty bait was substantially larger than the commercial pickled squid and was expected to increase the capture of large adults and reduce the capture of smaller, juveniles. Use of salmon, a familiar food source for white sturgeon, was used in an attempt to increase the capture of wild fish. Due to limited quantities of bait, only two set lines per day could be deployed with the specialty bait. The remaining set lines deployed each day were baited with the commercially available pickled squid.

Set lines were deployed and retrieved in an identical manner as during the 2010 and 2011 capture sessions. Sample and capture data were directly entered into an Access® database.

2.3.2 Angling

Angling effort in 2012 was conducted daily by a local angling guide (Hurd's Guide Services) between dawn and dusk to supplement set line catches of white sturgeon for the broodstock program. Angling was conducted in high current areas that could not be effectively sampled using set lines. Two attempts to fish early morning and late evening were conducted to assess fish capture at these hours. Although exact angling effort was not always documented by the guide, on average, four rods were fished each sample day and each sample day was approximately 8-hours long. Hatchery CRITFC origin fish (see Section 1.1) caught by angling were scanned and implanted with a PIT-tag if required, by the fishing guide. Once the PIT-tag number was confirmed, fork length was recorded and the fish released at the capture location. Larger wild white sturgeon that were potential candidates for broodstock were held in the water until the Golder team arrived at the capture location and transferred the fish to the Golder sampling boat. If captured later in the day and too late to allow processing, fish were held overnight in a deep pool, secured with a tail noose to a tree. The angled fish were processed in the same way as fish caught by set line (see Section 2.3.3).

2.3.3 Fish Handling, Processing, and Transport

Fish were handled and processed in a similar manner as the 2011 broodstock capture program. In 2012, a canopy was installed over the rear half of the research boat to shield fish from direct sunlight; this reduced overall thermal stress and exposure to UV radiation during processing. The sun canopy also served to protect the work area and equipment during rain.

Sex and maturity was assessed by surgical examination of the gonads for all wild white sturgeon that were large enough to be potential candidates for broodstock (i.e., in excess of 150 cm FL). The assessment of the sex and maturity adhered to the methods used in the upper Columbia River white sturgeon recovery program (Table 1; UCWSRI 2006). Due to limitations in optical resolution, internal inspection and photographing images of the gonads with an endoscope camera, conducted in 2011, was not repeated in 2012. All internal inspections to determine sex and maturity were based on visual inspection with a traditional otoscope.

Table 1 Sexual maturity codes for white sturgeon (adapted from Bruch et al. 2001).

Sex	Code	Developmental State Description
Male	Mv	**Virgin male juvenile**; Testes are ribbon-like in appearance with lateral creases or folds , dark grey to cream colored attached to a strip of adipose fat tissue.
	M1	**Developing male**; Testes are tubular to lobed, light to dark grey, and embedded in substantial amounts of fat. Testes moderately to deeply lobed have distinct lateral folds.
	M2	**Fully developed male**; Testes large, cream to whitish in color, deeply lobed and filling most of the abdominal cavity. If captured during active spawning, may release sperm if stroked posteriorly along the abdomen.
	M3	**Spent/recovering male**; Testes size are much reduced, with very distinct lobes and whitish to cream color.
	M0	**Male based on previous capture**; general unknown maturity
Female	Fv	**Virgin female juvenile**; small feathery looking, beige ovarian tissue attached to a thin strip of adipose fat tissue.
	F1	**Early developing female**; pinkish/beige ovarian tissue with brain-like folds and smooth to rough surface, imbedded in heavy strip of fat tissue. The visible whitish eggs are <0.5 mm in diameter. Ovarian tissue of F1 females that have previously spawned is often ragged in appearance.
	F2	**Early "yellow egg" female**; Yellowish/beige ovarian tissue with deep "brain-like folds embedded in extensive fat tissue giving it a bright yellow appearance. Eggs, 1 to 2 mm in diameter with no apparent grayish pigmentation.
	F3	**Late "yellow egg" female**; large yellowish ovaries with deep lateral folds and reduced associated fat. Yellow/greenish to grey eggs 2.5 mm in diameter. May indicate next year spawning.
	F4	**"Black egg" female**; Large dark ovaries filling much of the abdominal cavity. Exhibiting a distinct "bulls-eye". Very little fat, Eggs are still tight in the ovary, dark grey to black, shiny and large, >3 mm in diameter.
	F5	**Spawning female**; Loose flocculent-like ovarian tissue with eggs free in body cavity shed in layers from deep ovarian folds. Eggs large, from grey to black, similar to F4.
	F6	**Post spawn female**; ovaries immediately after spawning are folded with a mushy pinkish and flaccid appearance, with little or no associated fat. Post spawn females display a characteristic abdominal mid-line depression. Large dark degeneration eggs buried amongst small oocytes.
	F0	**Female based on previous capture**; general unknown maturity
Unknown	97	adult based on size, (i.e. 1.5 m FL or greater) no surgical examination
	98	juvenile/sub-adult based on size, (i.e. no surgical examination
	99	gonad undifferentiated or not visible during surgical examination

In 2011, broodstock transfers (from transport boat to transport trailer) were conducted at the Crescent Bar boat launch (RM 440.8), approximately 25 minutes by boat from the white sturgeon capture location below Rock Island Dam (RM 450.0 to 453.0). In 2012, candidate broodstock were transferred at the Columbia Siding launch (RM 450.6). Use of this new site substantially reduced travel time between the capture location and the transport trailer. After the transfer, the field crew was also able to more quickly return to the sample area, which increased sampling effort. The close proximity of the transport trailer to the capture location also allowed for the transfer of a second fish without substantially increasing the holding time of the first fish that was transferred to the transport trailer. Limited use of the Columbia Siding launch area by the public, compared to the Crescent Bar launch, allowed transfers to proceed more smoothly (i.e., without interruptions and distractions).

2.4 VR2W Telemetry Array Download and Maintenance

In 2012, a total of 12 VR2W stationary telemetry receivers (model VR2W, Vemco-Amirix Systems Inc., Halifax, NS) were used to monitor movements of acoustic-tagged white sturgeon within the Project area at locations throughout both reservoirs and in the tailwater of Priest Rapids Dam (Table 2). Receivers were downloaded and serviced in a manner identical to the methodology applied during 2011 (Golder 2012). In 2012, monitors were downloaded and serviced during three inspection periods: May 17 to 18, July 17 to 18, and October 3 to 8.

During the May inspection period, crews were unable to locate the monitor at RM 396.1 downstream of Priest Rapids Dam. This station was last downloaded and inspected in October 2011 and at that time, was in good condition. A replacement station was installed on May 18 further downstream near RM 392.0 at a site below Vernita Bar and near a potential white sturgeon holding area. As water velocities below Priest Rapids Dam typically are fast due to the gradient drop between the dam tailrace (i.e., 129.5m (425 ft.) elevation to 124.7m (409 ft.)), detection efficiency of acoustic monitors within the Project area below Priest Rapids Dam was estimated to be low.

An additional VR2W monitor (VRRM 437.1) was installed in Wanapum Reservoir on May 17, 2012 to detect white sturgeon in transit between overwintering areas near RM 426 and RM 442. The new station was located approximately 400m upstream of a narrow section of the river (i.e., approximately 500m wide) and adjacent to west bank. Tag detection probability of at this site was estimated to be moderate to good, in that fish likely stay in range of the receiver for an extended period of time.

The anchoring design of the new stations at RM 392.0 and RM 437.1 was nearly identical to previous installations. Due to corrosion noted on some of the aluminum crimps used in arrays deployed in 2010, copper crimps were used in 2012 to eliminate this problem. Inspection of the aluminum crimps in 2012 determined the crimps were not corroding as fast as previously thought and should last many years before they need to be replaced.

During the May inspection, the monitor in the Wanapum forebay near RM 416.1 could not be located visually from shore and was assumed lost. During a follow-up site inspection in July, the station was found, suspended by the backup foam bullet float. This was the second time in three years this station had lost its primary float, and had to be retrieved using the backup float. Inspection of the cable that had been attached to the primary float indicated it was cleanly severed. Due to the ongoing loss of the primary floats at this monitoring location, the decision was made to redeploy the station suspended only by the bullet float after all connections were inspected and reinforced.

During the final download and service in October 2012, the structural integrity of all stations was inspected and determined to be sound. The loss of additional stations during the 2012/2013 winter low flow period suggests that some of these losses are due to either deliberate tampering or inadvertent damage (e.g., sheared by propellers).

Table 2 VR2W receiver station location, deployment date, and status in the Project area as of October 2012.

			UTM				
Station Name	**River Mile**	**Zone**	**Easting**	**Northing**	**Reservoir**	**Deployment Date**	**Station Status**
VRRM392.0	392.0	11	284680	5167847	McNary	18-May-12	Active
VRRM396.1	396.1	11	278273	5168339	McNary	20-Sep-10	Lost
VRRM398.1	398.1	11	276897	5170976	Priest Rapids	22-Jun-10	Active
VRRM404.0	404.0	11	272861	5180011	Priest Rapids	22-Jun-10	Active
VRRM410.5	410.5	11	276868	5188281	Priest Rapids	23-Jun-10	Active
VRRM413.5	413.5	11	274586	5192162	Priest Rapids	23-Jun-10	Active
VRRM415.5	415.5	11	274044	5195579	Priest Rapids	19-Sep-10	Active
VRRM416.1	416.1	11	273719	5196719	Wanapum	7-Oct-10	Active
VRRM418.5	418.5	11	275059	5200077	Wanapum	24-Nov-10	Lost
VRRM421.0	421.0	11	273966	5203545	Wanapum	20-Jun-10	Lost
VRRM426.5	426.5	10	727309	5211953	Wanapum	23-Jun-10	Active
VRRM432.5	432.5	10	725538	5220726	Wanapum	20-Jun-10	Lost
VRRM437.1	437.1	10	726171	5227514	Wanapum	17-May-12	Active
VRRM442.0	442.0	10	725506	5234769	Wanapum	21-Jun-10	Active
VRRM446.9	446.9	10	719589	5237495	Wanapum	29-Jun-11	Active
VRRM449.5	449.5	10	720138	5242290	Wanapum	21-Jun-10	Lost
VRRM452.4	452.4	10	720484	5246202	Wanapum	20-Sep-10	Active

2.5 Juvenile Movement

Juvenile movement and telemetry data obtained in 2012 from sonic tagged 2010BY juvenile white sturgeon released into Wanapum and Priest Rapids reservoirs in April 2011 and remains ongoing. As discussed in Section 3.2, 2011BY juveniles were not released into the Project area in 2012.

Telemetry data downloaded in 2012 were screened for spurious detections, which were defined as either: 1) sonic tag IDs that were detected only once during a 24 h or longer period; or, 2) detections that would have required the fish to swim at 9 m/s (~ 20 mph) or faster between stations. This speed cut-off value was chosen since the literature reported considerably lower swimming speeds for sturgeon (Webber et al. 2007; Kelly and Klimley 2011). Both types of spurious detections were removed from the dataset prior to analysis.

The screened data were analyzed as presence/absence data. If a fish was detected at a receiver more than once in a day (i.e., the detection was defined as non-spurious), it was considered to be present near that receiver on that day. This approach allowed the examination of temporal patterns of presence/absence rather than simply reporting the numbers of detections recorded at each VR2W station. Daily presence/absence data were then used to estimate a monthly residency ratio, calculated as the number of days an individual fish was present at each receiver station out of the available number of days in that month. During the month of fish release, the ratio was adjusted to account for the date of release; i.e., the ratio of residency was estimated as:

days.present/(days.in.month- date of release+1) .

Individual residency ratios were then used to calculate mean residency ratios across fish from the same genetic family, same rearing hatchery, or same release site, depending on the analysis.

Cumulative values of net upstream and downstream movement were calculated for each individual fish using differences in river mile values between the VR2W stations and time of detection. All upstream and downstream movements (positive and negative increments of river miles) were summed to provide monthly cumulative values of individual fish activity. Upstream movements were also used to confirm that a tagged fish was still alive. For each tag, we tabulated the time of the last upstream movement, distance traveled, and the total number of upstream movements the fish undertook since being tagged. This analysis was then repeated for downstream movements.

All data analyses were performed in the statistical environment R, v. 2.15.1 (R Development Core Team 2012). Plots were created in R using the package ggplot2 (Wickham 2009).

2.6 Juvenile White Sturgeon Habitat Use

In 2012, boat-based mobile acoustic telemetry tracking was used to locate both adult and juvenile white sturgeon equipped with acoustic transmitters within the Wanapum and Priest Rapids reservoirs. The mobile telemetry tracking equipment consisted of a Vemco VR100 receiver equipped with both directional and omnidirectional hydrophones. In both reservoirs, the survey was conducted in a downstream direction, starting within the tailwater of the upstream-most dam (i.e., Rock Island Dam in Wanapum Reservoir and Wanapum Dam in Priest Rapids Reservoir). The VR100 with an omnidirectional hydrophone was deployed over the full length of each reservoir for 6 minutes at 800 m intervals, with both the boat engine and boat depth sounder turned off. This monitoring duration was approximately 1 minute longer than the maximum tag transmission interval. At locations in the upstream portion of each reservoir with high water velocity, the boat would typically drift between 200 and 400m downstream during the 6 minute monitoring period. At these high velocity locations, multiple monitoring attempts were conducted in an attempt to decoded audible tag signals that were not successfully decoded during the initial pass. The directional hydrophone was used to detect tagged fish in locations that could not be accessed by boat (e.g., upstream of the danger signs at Rock Island Dam) or at locations where the river channel was very wide (e.g., Wanapum Dam forebay).

When a juvenile white sturgeon tag code was identified by the VR100 and omnidirectional hydrophone, both the tag identification number and the maximum signal strength were recorded. Using both the directional and omnidirectional hydrophone, an approximate location of the fish was determined based on signal strength and direction. Due to the time interval between transmissions (170 to 310 seconds), on average only 15 to 16 signals per hour were transmitted and the probably of detection of these signals was affected by both physical factors (e.g., river bottom topography, water velocity, turbulence) and signal interference from other tagged fish in the area. Considering the time required to survey both reservoirs in the 5 days allocated for this task, and that the fish were not necessarily stationary relative to the VR100 receiver, the actual fish location could have been from 100m to 400m from the estimated position.

Once an approximate location of a juvenile white sturgeon was determined, habitat attributes (current direction, velocity, and water depth) were measured using an Acoustic Doppler Current Profiler (ADCP) along a cross-sectional transect at the estimated fish location. Additional transects were conducted upstream and downstream to record habitat attributes in the general area the fish was found. Typically, three or four transects were conducted at each fish location. Finally, an Aqua-Vu™ underwater video camera was used to document and qualitatively inspect substrate composition and other benthic habitat features (e.g., presence of aquatic macrophytes, large boulders, and woody debris) in the same area as the ADCP transects. At each location where juvenile white sturgeon were found, three to five ADCP transects were conducted in the area presumed to be the habitat occupied by the fish. In total, 32 ADCP complete transects were conducted at nine locations where 2010BY juvenile white sturgeon were located. Graphical plots of ADCP water velocity, direction and, depth data recorded at fish locations were developed. As the exact location of the fish could not be determine, only general habitat preference could be determine based on the ADCP velocity and depth transects, and inspection of the substrate with an underwater camera.

2.7 Juvenile Indexing

Small-mesh (5.1 cm stretch mesh) gill nets were used to target the 2010 BY hatchery sturgeon released into the Project area in April 2011. Nets were 91.4 m long by 3.7 m deep and were identical in construction and dimension to those used for indexing white sturgeon recruitment in other areas of the Columbia and Snake rivers (Burner et al. 2000; Howell and McLellan 2008). Gill net deployment generally followed the methods described by Howell and McLellan (2008). Nets were deployed from boats equipped with hydraulic gill net reels and were set on the river bottom parallel to shore so that they fished efficiently in areas of appreciable current and reduced the risk of capturing ESA listed salmonids.

Sampling was based upon a Generalized Random Tessellation Stratified (GRTS) survey design (Stevens and Olsen 2004) with sample sites generated using the SPSURVEY package (Kincaid 2012) in the R statistical program (The R Development Core Team) and ArcMap10 (ESRI, Redlands, CA). To limit by-catch of ESA listed species, sampling was confined to areas where water depths were ≥10 m. Bathymetric geospatial data files for the PRSA were obtained from Grant PUD, and 10 meter depth contour polygons were extracted using ArcMap (Figure 2). Sample sites were drawn from within these polygons for each reservoir separately, with the number of samples based upon relative surface area of each reservoir. Available sampling area for Wanapum Reservoir was approximately 4,030 hectares (~75% of total Project area ≥10 m) and for Priest Rapids Reservoir approximately 1,343 hectares (~25% of total Project area ≥10m). Since the total intended effort expenditure during the study was 80 overnight gill net sets, 60 sites were drawn for Wanapum Reservoir and 20 for Priest Rapids Reservoir. The draw for each reservoir included an oversample equal to the magnitude of intended sampling effort to allow for replacement of those sites that were unsuitable for sampling due to high water velocity, beds of aquatic macrophytes, or rough river bottom.

Sample sites were uploaded to onboard chart plotters to facilitate navigation to sampling locations. Nets deployment commenced as close to the nominal GRTS sampling point as possible and GPS coordinates were recorded at the beginning and end points of the net deployment process. Distances between the recorded locations of the start of each gill net deployment and its respective nominal GRTS GPS coordinates ranged from 1-170 m (mean = 28m). Water depth was monitored during the deployment process using an echo sounder and minimum and maximum observed depths were recorded. Water depth for the set was then estimated as the average of these minimum and maximum readings. Date and time were recorded at the conclusion of each net deployment, and at the start of subsequent retrieval. Sample duration was estimated as the difference between these two times.

Gill net sampling in the Project area was conducted from August 29 to September 2, 2012. During this time a total of 79 overnight duration benthic gill net sets were deployed for a total of 1,705.8 hours of fishing effort (Table 3).

Sturgeon were measured for fork length (FL; nearest mm) and total length (TL; nearest mm), weighed (nearest gram), and scute scar patterns were recorded. The entire body surface was scanned with an AVID PowerTracker VIII reader for presence of a PIT-tag. Gross physical abnormalities were recorded, if present. Sturgeon condition was estimated by calculating relative weight based on the standard weight equation determined for white sturgeon: Ws = 2.735 E-6 * FL-3.232 (Beamesderfer 1993). Incidental catch in the gill nets was identified, enumerated, and recorded.

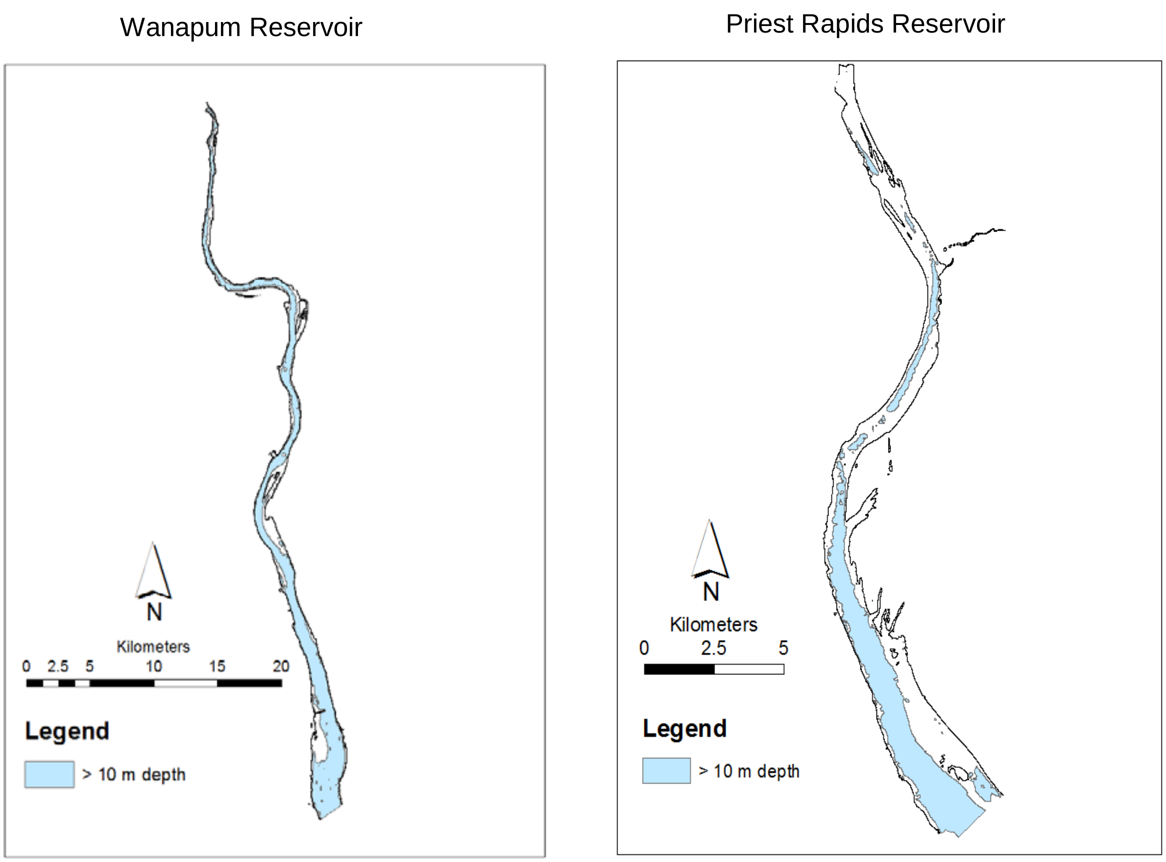


Figure 2 Maps of the Priest Rapids Project area illustrating areas of water depth ≥ 10m.

Table 3 Summary of juvenile sturgeon gill net effort in the Priest Rapids Project area, 2012.

	Priest	Wanapum
Time period	August 29-30	August 30 to September 2
# overnight sets	19	60
Mean (range) set duration (hr)	20.9 (17.9-25.0)	21.9 (17.4-27.2)
Total effort (hr)	396.7	1,309.1
Mean (range) set depth (m)	17.0 (10.3-29.6)	19.0 (9.5-32.3)
Mean daily water temp. (^{o}C)[1]	18.6	18.0

1/ Data retrieved from Columbia River DART http://www.cbr.washington.edu/dart/

2.8 Spawning Migration Upstream Movement Rates

Telemetry data for adult White Sturgeon equipped with acoustic tags were examined to identify movement rates during upstream spawning migrations. In addition, migration movements were used to estimate the probability of fish detection on each VR2 receiver between overwintering sites and the spawning site.

The telemetry dataset selected for analysis was restricted to movements that occurred between April and August of each year. In addition, fish movements were only analyzed if at least one year had passed since tagging, due to the potential that tagging can influence fish behavior. All tagged fish that were not detected at the spawning site (RM 452.4) were removed from the dataset. Only movements that were in line with known migration behavior were analyzed. For example, multiple up- and downstream migrations between overwintering and spawning sites were deemed unlikely to be related to spawning, while fast unidirectional movements were retained as likely spawning migrations.

At each location, date and time the fish left its previous location and the date and time of arrival to its current location were recorded. The last detection at the previous location and the first detection at the new location were used to estimate relocation speed. To average differences in behavior, average speed of migration were estimated by using the overwintering and spawning sites as the points of departure and arrival and omitted the detections recorded between these sites.

2.9 Detection Probability during Spawning Migration

The average migration speed calculated for each fish in the previous section was used to estimate detection probability for each receiver found between the overwintering and the spawning sites. Detection radius was assumed to be 300m for all receivers, based on previous data from range tests. The average speed of the fish, and its minimum and maximum tag bursts were used to estimate the number of times the tag was likely to emit a signal while within the 300 m detection radius. The number of recorded detections at each day and each river mile was corrected for ping collisions using Vemco's "collision calculator" (http://www.vemco.com/education/Collision/ShowResults.php) to create a table of time required to detect a tag vs. number of tags found in the area. The corrected number of tag detections was then divided by the estimated number of pings to yield detection probability. These estimates assume: 1) constant detection radius; 2) constant swimming speed between overwintering and spawning sites; 3) 100% detection at spawning sites; and, 4) correct collision rates (i.e., constant presence of all fish detected at the site).

2.10 Adult Population Assessment

A mark-recapture study was conducted in fall 2012 from September 10 to September 16 (Session 1), and from October 1 to October 8 (Session 2), to obtain population data on adult and sub-adult white sturgeon in Wanapum and Priest Rapids reservoirs. In previous studies, the highest white sturgeon capture rates were recorded in early fall from September to October (Golder 2003, 2011b). Furthermore, white sturgeon are less aggregated at this time and can be captured near summer feeding locations after they disperse from early summer spawning habitat and before they migrate and aggregate in overwintering areas.

Long set lines with 30 baited circle hooks per line were used during the population assessment program. The barbs on all hooks were removed to facilitate fish release and reduce the severity of hook related injuries. Each setline was approximately 182 m in length and deployed with 10 small hooks #7 (12/0), 10 medium size hooks #5 (14/0), and 10 large hooks #3 (16/0) to allow capture of all size classes of fish. Ten hooks of each size were placed in random order on each line. Set line hooks were baited with commercially available pickled squid. Set lines were set overnight and pulled approximately every 24 hours.

Sampling was conducted by both Golder and CCT field crews. Golder set line deployment gear and methods were essentially identical to the set line methodology used during 2012 Broodstock sampling (See Section 2.3.1). Both the Golder and CCT setlines were of identical length, with the same hook design and deployment configuration. The primary difference between the Golder and CCT sample methodology was that the CCT deployed and retrieved setlines from a 8.2m (27 ft.) Almar landing craft outfitted with a hydraulic line hauler. Use of line hauler allowed set lines to be rapidly deployed and retrieved. The hydraulic line hauler also required use of a thinner 6.35 mm (0.25") diameter tarred three-strand main setline. Two 13.6 kg (30 lbs) lead pyramid anchors were used to ballast the ends of the setline. In high flow area, a claw anchor was attached to the upstream anchor to provide additional anchoring. Both Golder and CCT crews deployed setlines parallel to the prevailing current or the shore.

Set line locations were selected using a general random tessellation stratified (GRTS) design, which is a spatially balanced random sampling strategy (Stevens and Olsen 2004). The GRTS sample locations were determined with the SPSURVEY package (Kincaid 2007) developed for the R statistical program (The R Development Core Team). The area of Wanapum and Priest Rapids reservoirs were determined based on water perimeter data provided by the U.S. Geological Services (http://nhd.usgs.gov/data.html), from which shape files were generated for use by SPSURVEY.

The sample design divided the Project area into two main sample strata by reservoir. Based on reservoir area, 60 GRTS sample locations were generated for Wanapum Reservoir and 31 sample locations for Priest Rapids Reservoir. Wanapum Reservoir was further stratified into two substrata north of the I90 Bridge crossing to Rock Island Dam (WR_N) and south of the bridge crossing to the face of Wanapum Dam (WR_S). Strata WR_S was considered the least riverine and more lake-like in terms of hydrology and consisted of a broad inundated area of former terrestrial habitat. Due to the areal extent of WR_S, the area encompassed almost half of the GRTS sample and oversample sites. Previous capture efforts in WR_S during 2010 adult population indexing captured few fish, which suggested a low use of this area by white sturgeon (Golder 2011a); consequently, only 10 of the 60 sample sites were allocated to WR_S, with the remainder of the sample effort allocated to WR_N.

In total, 182 GRTS sites were sampled over two sample sessions in fall 2012 (i.e., 91 sites sampled per session). This effort was comparable to that expended during the 2010 indexing study, which captured 602 fish, or approximately 5.5% of Project area white sturgeon population based on the combined SBA population estimates of CRITFC hatchery fish and wild fish of both reservoirs Golder 2011a). An underlying assumption used to estimate the 2012 sample effort was that capture bias during the 2010 systematic sampling program was minimal and that comparable numbers of fish would be captured using the GRTS sampling approach. The GRTS sites generated for Session 1 were not reused and a new set of GRTS sites were generated for Session 2 to eliminate sampling bias and ensure complete randomization of sample locations for each session.

Prior to the start of each session, the randomly generated GRTS sample locations were reviewed in Google Earth® and sites that were determined as unsuitable for setline sampling were replaced with one of the 91 GRTS oversamples (i.e., 50% of sample effort) drawn in order as generated by SPSURVEY. Similarly, if during field sampling a site was determine unsuitable, that site was replaced with an oversample drawn in order. Criteria that invalidated a sample site were based on limitations that precluded gear deployment (e.g., very shallow water, dense milfoil, high flows, safety barriers, etc.). Due to greater CCT sampling efficiencies gained by use of a hydraulic line hauler, sample sites were distributed in a 2:1 ratio between the CCT and Golder crews, with the CCT sampling 60 sites to 31 sites sampled by Golder per session. Due to greater sampling efficiency, sampling time was reduced from 11 days to 7 days per session, which reduced the chance of experiencing substantial change in environmental conditions (e.g., flow, temperature, etc.) within a sample session.

2.10.1 Bayesian Population Estimates

A Bayesian probability implementation of the Petersen method for closed population mark-recapture data was used to estimate the abundance of white sturgeon in the Wanapum and Priest reservoirs. The analysis was implemented using the statistical environment R, v. 2.15.1 (R Development Core Team, 2012), interfaced with WinBUGS v. 1.4.3 (Lunn et al., 2000) through the R2WinBUGS package (Sturtz et al., 2005). WinBUGS distributions and functions are defined in Table 4. The classic Petersen model for two capture sessions assumes a closed population and equal recapture probability, and estimates the total number of individuals in the population (N) with the formula:

$N=Mn/m$ where:

M = the number of individuals marked during the first sample;

n = the total number of fish (marked and unmarked) in the second sample; and

m = the number of marked fish recaptured in the second sample.

In the Hierarchical Bayesian implementation of the Petersen model, catch ability was estimated based on the number of recaptures in each of the two reservoirs (see **Table 5**) for full list of parameters used). The total number of fish present in each reservoir was modeled as a binomial function of the number of untagged fish captured in the second session and the catch ability value. The analysis was stratified by reservoir, so that catch ability was allowed to vary between the Wanapum and Priest reservoirs (i.e., site was modeled as a random effect on catch ability). The prior distributions for all parameters were vague or considered as an uninformative prior

(Table 6). The complete model specification used is shown in Table 7, and the model code can be provided on request.

Table 4 WinBUGS distributions and functions used in the Bayesian models.

Distribution/function	Description
dbin(p, n)	Binomial distribution with n trials and p probability of success
dnorm(μ, τ)	Normal distribution with a mean μ and 1/variance τ
dpois(λ)	Poisson distribution with a mean λ
dgamma(κ, θ)	Gamma distribution with a shape parameter κ and a rate parameter θ
log(x)	Natural logarithm function
logit(x)	Logit function

Mean and median values of abundance estimates as well as 95% credibility intervals were calculated in WinBUGS. The Monte Carlo (MC) error for each parameter estimate was recorded. The MC error quantifies the variability in the estimates that is due the sampling error in the simulation-based solution for Bayesian analysis. We chose simulation run lengths so that MC error was <5% of the posterior standard deviation for a parameter (Kery, 2010). The posterior distributions, which were estimated using Gibbs sampling (Kery, 2010), were derived from 1,500 Markov Chain Monte Carlo (MCMC) simulations, reduced from 5,000 runs of three MC chains of 10,000 iterations in length. Model convergence was confirmed by ensuring that R-hat (the Gelman-Rubin Brooks potential scale reduction factor) was less than 1.1 for each of parameters in the model (Kery, 2010).

Table 5 Variables and parameters in the Bayesian analysis of white sturgeon abundance in the Priest Rapids Project area.

Variable/parameter	Description
logit.mu.p_i	The expected mean of logistic catch ability of white sturgeon in reach *i*
mu.p_i	Logistic catch ability of white sturgeon in reach *i*
mu	Mean of the expected mean of logistic catch ability; hyper parameter
sigma	SD of the expected mean of logistic catch ability; hyper parameter
tau	Precision of the expected mean of logistic catch ability; hyper parameter
p_i	The catch ability of white sturgeon in reach *i*
etaU_i	Log sturgeon abundance in reach *i*
m.wana, m.priest	Number of white sturgeon tagged in the first session in Wanapum and Priest reservoirs
u.wana, u.priest	Number of unmarked white sturgeon tagged in the second session in Wanapum and Priest reservoirs
U.wana, U.priest	Number of untagged white sturgeon at large in Wanapum and Priest reservoirs
Total.priest, Tota.wana	Total number of white sturgeon in Wanapum and Priest reservoirs

Table 6 Prior probability distributions in the Bayesian analysis of white sturgeon abundance in the Priest Rapids Project area.

Variable/parameter	Description
logit.mu.p_i	dnorm(mu, tau)
m.wana; m.priest	dbin(mu.p_i, n.wana); dbin(mu.p_i, n.priest)
u.wana; u.priest	dbin(mu.p_i, U.wana); dbin(mu.p_i, U.priest)
mu	dnorm(0, 0.01)
sigma	dunif(0, 10)

Table 7 Dependencies between variables and parameters in the Bayesian analysis of white sturgeon abundance in the Priest Rapids Project area.

Variable/parameter	Dependency
logit(mu.p_i)	logit(mu,p_i)
U.wana; U.priest	exp(etaU_i)
tau	1/sigma^2
Total.wana; Total;priest	U.wana + m.wana; U.priest + m.priest

3.0 RESULTS

3.1 Physical Parameters

3.1.1 Discharge and Temperature

Discharge and water temperature are two environmental variables that can substantially affect aspects of white sturgeon life history, and therefore, may affect study results over a multi-year study. Due to the absence of large tributaries inputs to either Wanapum or Priest Rapids reservoirs, the daily average discharge at the upstream-most dam (i.e., Rock Island Dam) is very similar to the discharge at the next two downstream dams (i.e., Wanapum and Priest Rapids dams) during high flow conditions. As flows reduce, Wanapum Reservoir capacity can be used to meet power generation requirements by providing power on short notice in response to demand. Due to this storage capacity, the amount and timing of discharge releases from Wanapum Dam can differ from Rock Island Dam, with these differences most apparent during periods of seasonal low flow. For the purpose of this study, mean daily discharge from Rock Island Dam was considered representative of flows for the entire Project area based on the assumption that differences in discharge releases from downstream facilities would not have a substantial biological effect.

Similar to 2011, discharge in 2012 exhibited high sustained flows from early spring to mid-summer. Peak mean daily discharge from Rock Island Dam in 2012 ranged from a high of 9149 m^3/s on June 26 (Figure 3) to a low of 292m^3/s on October 12. Discharge during specific study components will be discussed in context with sampling results within specific sections within this report.

In 2012, the maximum mean daily water temperature in the tailrace of Wanapum Dam ranged between 2.0°C on January 24 and19.0°C on August 19. Water temperatures in the Project area reached 14°C on July 7 and exceed 16°C on July 24. Previous spawning assessments in the Project and elsewhere have identified that this temperature window typically corresponds with initiation of white sturgeon spawning in the Middle and Upper Columbia (Golder 2011a). Water temperature during specific study components will be discussed in context with sampling results within the specific section within this report.

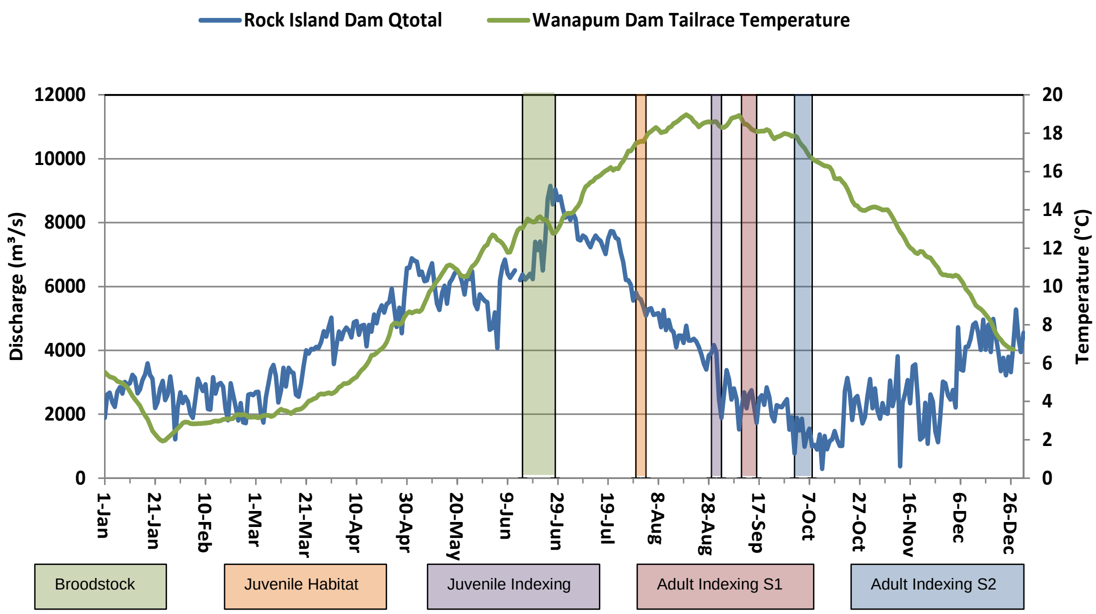


Figure 3 **Mean daily discharges (Qtotal from Rock Island Dam) and water temperatures (Wanapum Dam tailrace) of the Columbia River in the Priest Rapids Project area, 2012.**

3.2 2011BY Juvenile Marking and Release

As previously discussed in Section 2.2, the capture of only 1 viable female and 1 viable male in 2011, resulted in the production of only one family from the 2011 brood collection program. Over the winter period, the progeny from this mating exhibited poor growth and by the scheduled April 2012 tagging and release session, the 2011BY were still too small to process and tag. Attempts to increase size of the fish by increasing feed, water temperature, and reducing fish densities per pen were initiated over the next two months resulted in limited in success and histological tests conducted in July 2012 eventually confirmed the presence of white sturgeon iridovirus (WSIV) indicators (USFWS 2012). Given the presence of WSIV, the small size of the juveniles, and the small number of fish in the 2011BY release group, the PRFF and regulatory agencies decided against release of the 2011BY juveniles.

3.3 Broodstock Capture

Broodstock capture efforts were focused at locations identified during previous studies as habitat suitable for staging/holding by pre-spawning white sturgeon. Due to low captures of broodstock below Wanapum Dam in 2011, all broodstock collection efforts in 2012 were conducted below Rock Island Dam. Set line sampling was generally constrained to locations with low to moderate water velocity. Guide assisted angling was used to sample habitats with higher water velocity. Advice provided by the fishing guide was also considered and used to determine sample locations. Due to high flows in 2012, sample locations suitable for set line deployment in the vicinity of the spawning habitat below Rock Island Dam were limited. Mean daily discharge from Rock Island Dam during the broodstock collection period ranged between 6,220 m^3/s on

June 16 and 9,149 m³/s on June 26; mean daily water temperature over this period ranged between 12.8°C and 13.6°C.

3.3.1 Set line Sampling

Set line sampling in 2012 was conducted daily from June 15 to June 28. In total, 1,111 baited hooks were set overnight for a total sample effort of 23,447 hook-hours.

Set line sampling captured 27 CRITFC hatchery fish and 20 wild white sturgeon. Overall catch-per-unit-effort (CPUE) for hatchery and wild white sturgeon in each reservoir was 0.20 fish/100 hook-hours (Table 8) and was comparable the 2011 CPUE of 0.22 fish/100 hook-hours. However, the 2012 catch rate of wild fish (i.e., 0.09 fish/100 hook-hours) was two times higher than rates in 2010 (0.05 fish/100 hook-hours) and three times higher than in 2011 (i.e., 0.03 fish/ 100 hook-hours). A summary of capture, life-history, and tagging information for all white sturgeon caught by set line in 2012 is provided in Appendix A, Table A1.

Table 8 Comparisons of set line sampling effort and catch-per-unit-effort (CPUE) of CRITFC hatchery and wild white sturgeon captured in Wanapum Reservoir below Rock Island Dam during broodstock capture programs in 2010, 2011, and 2012.

Year	Sample Effort (hook-hours)	Catch (No. of fish)			CPUE (fish/100 hook-hours)		
		Hatchery	Wild	Total	Hatchery	Wild	Hatchery & Wild
2012	**23,447**	**27**	**20**	**47**	**0.12**	**0.09**	**0.20**
2011	*30,364*	*57*	*10*	*67*	*0.19*	*0.03*	*0.22*
2010	*33,421*	*108*	*18*	*126*	*0.32*	*0.05*	*0.38*

The higher 2012 CPUE for wild white sturgeon may have been due in part to the use of large pieces of salmon and specialty brined large squid (Table 9). These baits were used in attempt to increase the probability of capture of wild fish that may selectively choose these baits over the commercially available small pickled squid that was used in the previous broodstock collection programs. Although the preliminary data suggests that larger wild white sturgeon may prefer salmon over other bait, substantial bias was applied in the distribution of baited hooks, with crews preferentially deploying salmon baited gear in locations with assumed higher probability of capturing larger fish. In addition to the lack random distribution of baited hooks by bait type, other factors, such the uniformity of bait size and the quality of the bait likely also affected capture success.

Table 9 Set line captures of white sturgeon by bait type during the 2012 broodstock capture program.

White Sturgeon Catch	Bait Type		
	Salmon	Squid Large	Squid Small
CRITFC Hatchery	5	5	17
Wild	10	7	3
Total Fish Caught	15	12	20

Total Weight of Fish Caught (kg)	683	377	276
No. of Hook-Hours	10,568	6456	6291
No.Fish/100 hook-hours	0.14	0.19	0.32
Kg/Fish/100 hook-hours	6.46	5.84	4.38

3.3.2 Angling

Guide assisted angling was conducted concurrently with set line sampling and was found to be highly effective. Angling effort was conducted daily by the guide and up to four other anglers on the guide's boat. Golder staff were not always present on the guide boat to document guide angling effort; therefore, effort was determined using a combination of records from field crews and estimates from the guide. During the 2012 broodstock capture program, was estimated at 504 hook-hours (4 hooks deployed for 9 hours per day for 14 days) of guide angling effort captured 21 white sturgeon, comprised of 11 CRITFC hatchery fish and 10 wild fish, for an overall CPUE of 4.2 fish/100 hook-hours.

Wild fish were held by the guide until they could be processed by the Golder crew. Hatchery fish were processed by the guide who was trained and provided with equipment that allow him to scanned each fish for a PIT-tag, apply a PIT-tag if required, and record the fork length. The life history data from fish captured by angling are provided in Table 10.

Table 10 Capture information of CRITFC hatchery and wild white sturgeon caught by angling during the 2012 broodstock capture program.

Date	Origin	Fork Length (cm)	Weight (kg)	Sex / Maturity[1]	PIT-tag#
16-Jun-12	W	173.0	57.0	M1	985120018253368
17-Jun-12	W	262.0	137.0	M2	985120025202096
17-Jun-12	H	78.5	n/a	98	985120018760748
17-Jun-12	H	75.0	n/a	98	985120019382977
18-Jun-12	H	140.0	n/a	98	985121020821078
18-Jun-12	W	157.0	34.0	98	985120021737357
19-Jun-12	W	194.5	73.0	F3	411063146F
19-Jun-12	H	117.0	n/a	98	985121020820110
19-Jun-12	H	106.0	n/a	98	985121020805884
19-Jun-12	H	102.0	n/a	98	985121022022562
19-Jun-12	W	124.0	n/a	98	985121020797974
20-Jun-12	W	187.0	57.2	M1	985120021749486
20-Jun-12	W	205.0	76.2	M1	985120025255880
20-Jun-12	W	172.0	52.6	30	985120025201012
20-Jun-12	H	127.0	n/a	98	985121020799977
21-Jun-12	W	167.0	41.3	M2	985121021188795
21-Jun-12	H	129.0	n/a	98	985121020814466
23-Jun-12	W	247.0	127.5	F3	985120018705716
26-Jun-12	H	118.0	n/a	98	985120019509610
27-Jun-12	H	121.0	n/a	98	985120019509610
28-Jun-12	H	95.0	n/a	98	985121020822412

[1] See Table 2 for definitions of Sex / Maturity codes.

3.4 Broodstock Catch Size Distribution and Frequency

The average length of hatchery white sturgeon captured by set line and by angling during the 2012 broodstock program below Rock Island Dam (n = 38) was 112.0 cm FL (range from 68.5 cm to 140.0 cm FL). The average length of wild white sturgeon (n = 30) captured was 184.0 cm FL (range from 120.0 cm to 262.0 cm FL). The length-frequency distributions of hatchery and wild white sturgeon captured are present in Figure 4. The majority (80% or 24 of 30 fish) of wild fish were captured by June 23, with the greatest single day capture (n = 7) of wild fish on June 19. Only five wild fish were captured over the remainder of the program from June 24 to June 28 (Figure 5). The large number (n = 16) of CRITFC hatchery fish captured on June 16 was due to greater sample effort applied at a known overwintering area near RM 442 in an attempt to capture wild fish on route to the spawning area.

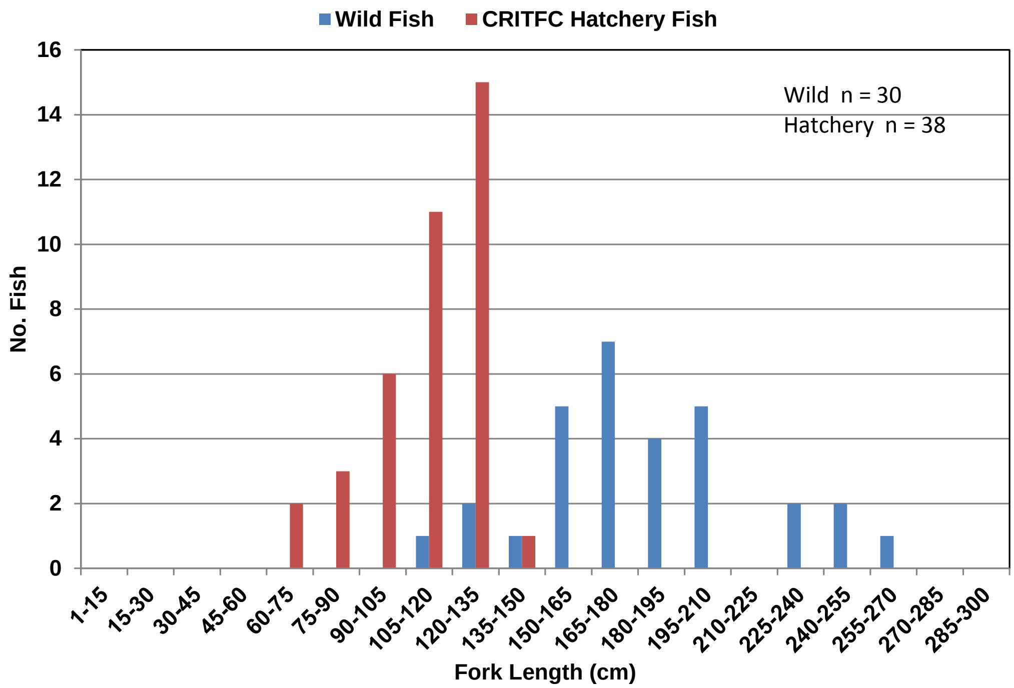


Figure 4 **Length-frequency of CRITFC hatchery and wild white sturgeon captured in Wanapum Reservoir below Rock Island Dam during the broodstock capture program, June 15 to June 28, 2012.**

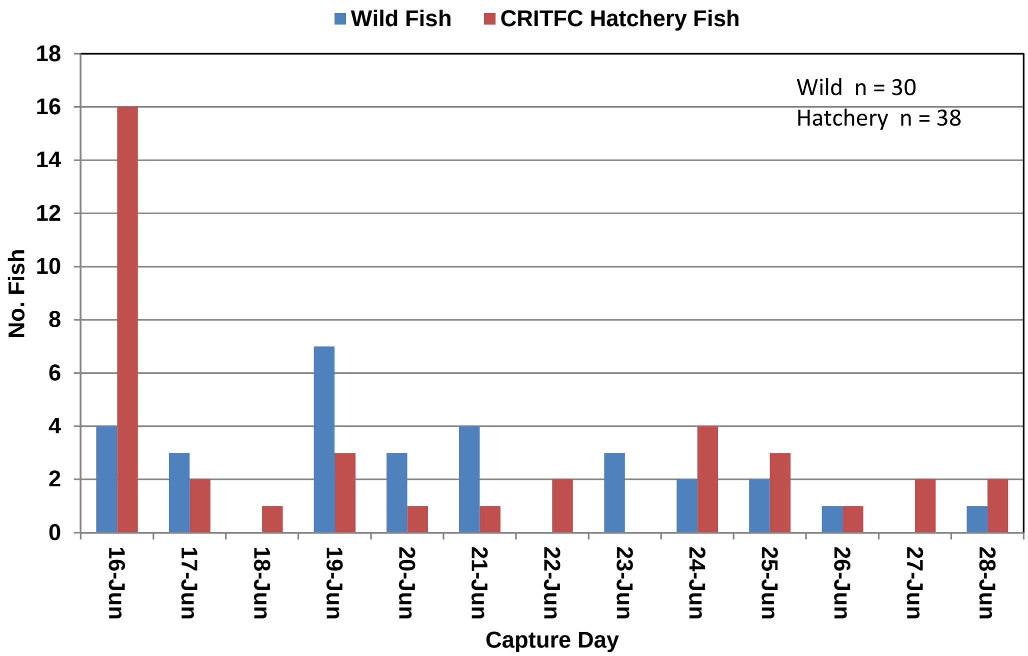


Figure 5 **Daily capture frequency of CRITFC hatchery and wild white sturgeon in Wanapum Reservoir below Rock Island Dam during the broodstock capture program, June 15 to June 28, 2012.**

3.5 Broodstock Transportation

In total, five fish (four males and one female) were identified as candidate broodstock and transported to MDH (Table 11). Three fish (two males and the one female) were captured by set line; the other two males were captured by angling. The female was identified as a mature pre-spawner (i.e., F5) based on egg size and egg color. All male fish were expressing milt at capture. Fish were transported to the MDH in the Grant PUD sturgeon transport trailer following the protocol established in 2010 (Golder 2011a). At the hatchery, transport crews assisted MDH hatchery staff in weighing and moving the fish from the transport trailer into a holding pen. All fish were successfully spawned at MDH on June 28 to produce 4 half-sibling families (i.e., a 1Fx4M cross). Once spawned, hatchery personnel successfully returned the brood to Wanapum Reservoir by mid-July.

Table 11 **Information from candidate broodstock captured in Wanapum Reservoir below Rock Island Dam and transported to Marion Drain Hatchery, 2012.**

Capture Date	PIT-tag Number	Fork Length (cm)	Weight (kg)	Sex/Maturity[1]
17-Jun-12	985120025202096	262.0	137.0	M2
20-Jun-12	985120021791545	184.0	48.1	M2
20-Jun-12	985120021770455	199.5	69.4	M2
21-Jun-12	985120021771735	234.5	145.0	F5
22-Jun-12	985121021188795	167.0	41.3	M2

[1] See Table 2 for definitions of Sex / Maturity codes.

3.6 Acoustic Telemetry Tagging

In 2012, 15 wild white sturgeon were tagged with acoustic telemetry transmitters before being released. All acoustic tags were deployed during the 2012 broodstock capture program. The fish tagged included all the candidate broodstock that were transported to MDH, as well as potential future broodstock candidates that, based on maturity and size, may spawn in the next two years. A summary of life history and tagging information of acoustic-tagged fish is provided in Table 12.

Table 12 Information from white sturgeon captured in Wanapum Reservoir below Rock Island Dam and tagged with an acoustic telemetry transmitter during the broodstock capture program, 2012.

Capture Date	Fork Length (cm)	Sex / Maturity [1]	PIT-tag#.	Acoustic Transmitter Model	Acoustic Transmitter ID code
16-Jun-12	173	M1	985120018253368	V13	48702
16-Jun-12	241.5	F3	985120017812453	V16	19360
17-Jun-12	262	M2	985120025202096	V16	19368
19-Jun-12	194.5	F3	411063146F	V16	30697
19-Jun-12	175.5	M1	420401477D	V16	30693
19-Jun-12	199.5	M2	985120021770455	V16	30695
19-Jun-12	199.5	30	985120017142964	V16	30699
19-Jun-12	184	M2	985120021791545	V13	48698
20-Jun-12	205	M1	985120025255880	V16	30691
21-Jun-12	167	M2	985121021188795	V16	48724
21-Jun-12	234.5	F5	985120021771735	V16	30700
23-Jun-12	247	F3	985120018705716	V16	30694
23-Jun-12	199	F3	985120017148889	V16	30696
24-Jun-12	205	M2	42033F7126	V16	30698
28-Jun-12	236.5	F6	985120021740441	V16	30692

[1] See Table 2 for definitions of Sex / Maturity codes.

3.7 2010BY Juvenile White Sturgeon Movement

As discussed in Section 1.1, three groups of fish comprised the 2010BY release. These three groups were from geographically separate sections of the Columba River and as such, likely differed in terms of their genetic makeup. Two of the three release groups were raised at MDH. The first release group was produced from wild brood, 1 female and 2 males, captured in the Project area in 2010 below Priest Rapids Dam. This group was designated a Middle Columbia Wild (MCW) and was composed of equal numbers of fish from two families (designated as WF1 andWF2) produced from the 1Fx2M cross. A second group of fish raised at MDH was the progeny of broodstock with Lower Columbia River genetic origins and part of the MDH fish culture program. This group of progeny was designated Lower Columbia Cultured (LCC) group and consisted of three families (designated CF1, CF2, and CF3). The third release group was the progeny of Upper Columbia River wild broodstock captured in the Canadian portion of the Columbia River and raised at KTH. This release group was designated as Upper Columbia Wild (UCW) and consisted multiple genetic families (i.e., a 3x3 factorial cross or greater) designated as “Mixed”. Approximately 9117 2010BY fish, including 91 acoustic-tagged fish, were released in the Project area between April 26 and April 29, 2011. A summary of the 2010BY release by stock source, hatchery of origin, tag application, and release location is provided in Appendix B

Table B1. Telemetry data collected from these acoustic-tagged fish since their release in 2011 was examined to assess possible differences in post-release dispersal patterns of the three 2010BY release groups from their release locations in Wanapum and Priest Rapids reservoirs.

3.8 Dispersal Patterns of 2010B

3.8.1 Wanapum Reservoir Releases

When movement and residence were compared by release groups, cultured fish (LCC group) tended to move downstream, while wild fish (UCW and MCW groups) moved upstream or remained close to the release sites (Figure 6 and 7). After release in Wanapum Reservoir, both the UCW and MCW fish tended to initially move upstream to near RM 452.4 below Rock Island Dam. As many as 14 fish were detected in this area until December 2011, after which time only two fish were detected at this location. After March 2012, juvenile white sturgeon were not detected near RM 452.4. Two UCW fish moved downstream after the release and were recorded at RM 442.0 in both April and May 2011. In June 2011 two MCW fish were detected at RM 442.0 as well. One MCW fish and two UCW fish were eventually detected at RM437.1, the downstream-most detection location for both the UCW and MCW groups.

The cultured LCC group released in Wanapum Reservoir initially exhibited a predominant downstream movement. Seven and ten LCC fish were detected at RM 442.0 in April and May 2011, respectively, and four and five LCC juveniles were detected at RM 426.5 in May and June 2011. Later in the study LCC fish were detected at RM 437.1, with two to four fish recorded in each month between June and September 2012. Four fish from the LCC group moved upstream either immediately after release or in late fall 2011, and were detected near RM 452.4, however, residency time of all these fish but one (ID 44540) at these upstream locations was limited and all of the LCC fish eventually moved to downstream locations. In total, seven LCC fish were detected downstream of RM 426.5; two in the forebay of Wanapum Dam near RM 416.1, and five downstream Wanapum Dam in Priest Rapids Reservoir. In general, the LCC fish tended to move downstream, comparatively, to the UCW and MCW fish, which had the highest amount of cumulative upstream movement out of the three release groups (Figure 8).

Based on the last valid detection, the relative location and dispersal of the three Wanapum release groups were plotted in relation to their released location and Wanapum and Priest Rapids dams (Figure 9). As of October 2012, 85% (17 of 20) of the UCW group, 70% (21 of 30) of the MCW group, and 100% (20 of 20) of the LCC group had been detected had been detected at least once by one or more receivers in Wanapum Reservoir.

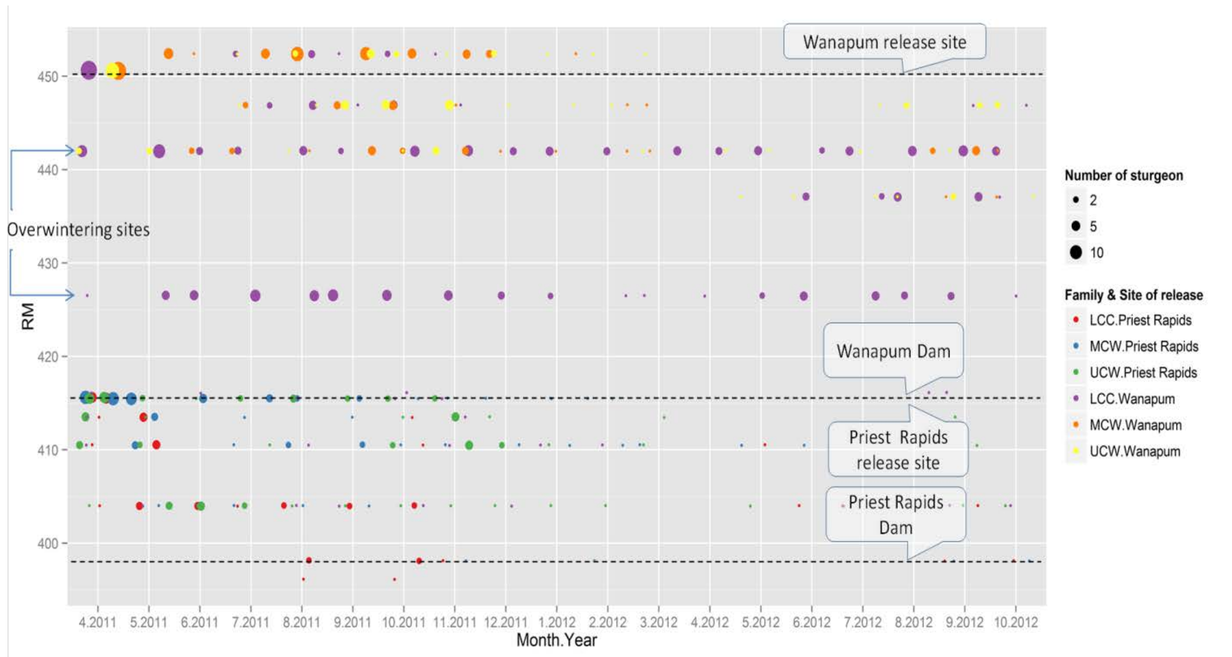


Figure 6 **Monthly counts of acoustic-tagged 2010BY juvenile white sturgeon detected at each VR2W station in the Priest Rapids Project area. Bubble color represents a combination of release group (Upper Columbia Wild-UCW, Middle Columbia Wild-MCW, and Lower Columbia Cultured-LCC) and release site (Priest Rapids or Wanapum Reservoir). Bubble size is proportional to the number of sturgeon present at each site in each month.**

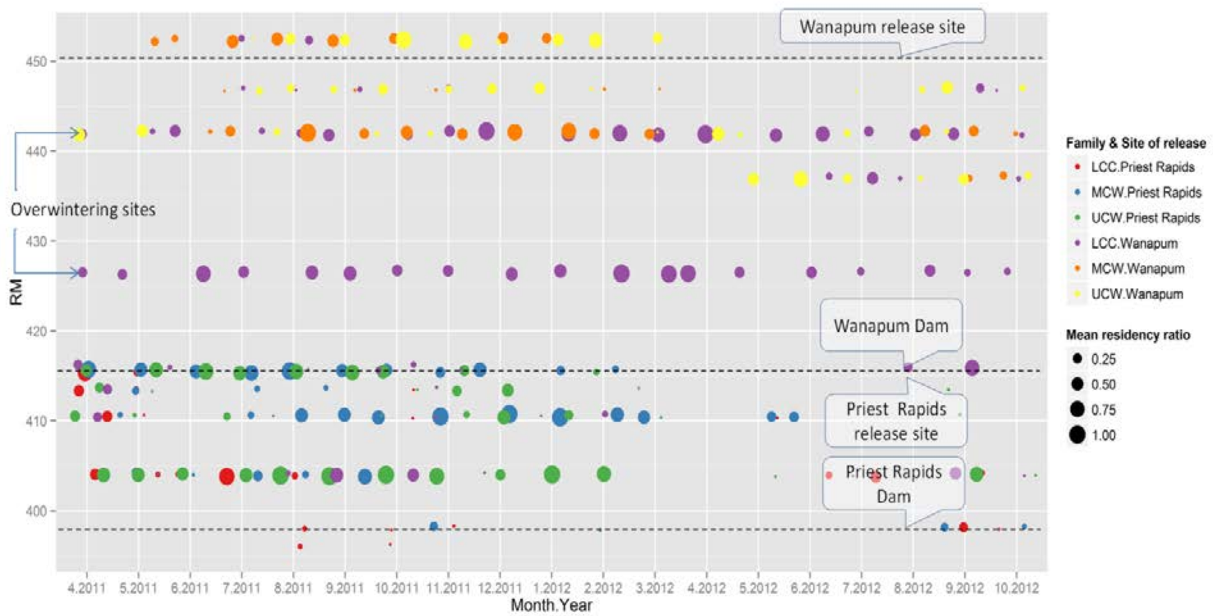


Figure 7 **Monthly residency ratio of 2010BY juvenile White Sturgeon throughout the Priest Rapids Project area, averaged across fish from the same release group and release site. Residency ratio is the number of days an individual fish was present at each receiver station out of the available number of days in that month; the plot shows mean ratios, averaged across fish from the same release group and release site. Bubble color represents a combination of release group (Upper Columbia Wild-UCW, Middle Columbia Wild-MCW, and Lower Columbia Cultured-LCC) and release site (Priest Rapids or Wanapum Reservoir). Bubble size is proportional to the average residency ratio.**

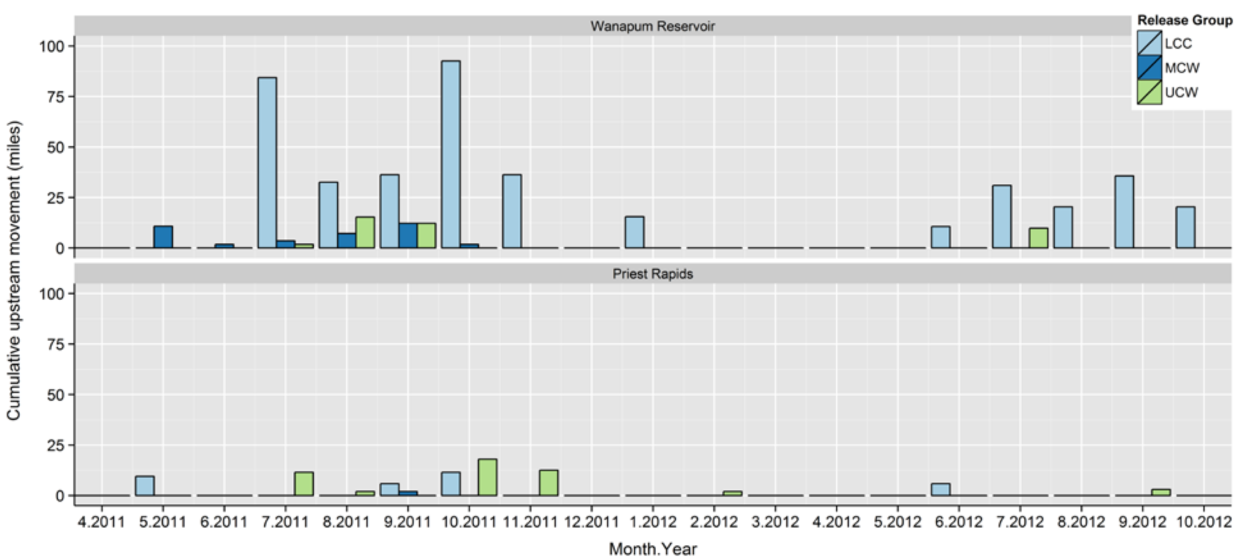


Figure 8 **Cumulative upstream movements exhibited by each release group of acoustic-tagged juvenile white sturgeon released in Wanapum and Priest rapids reservoirs from April 2011 to October 2012.**

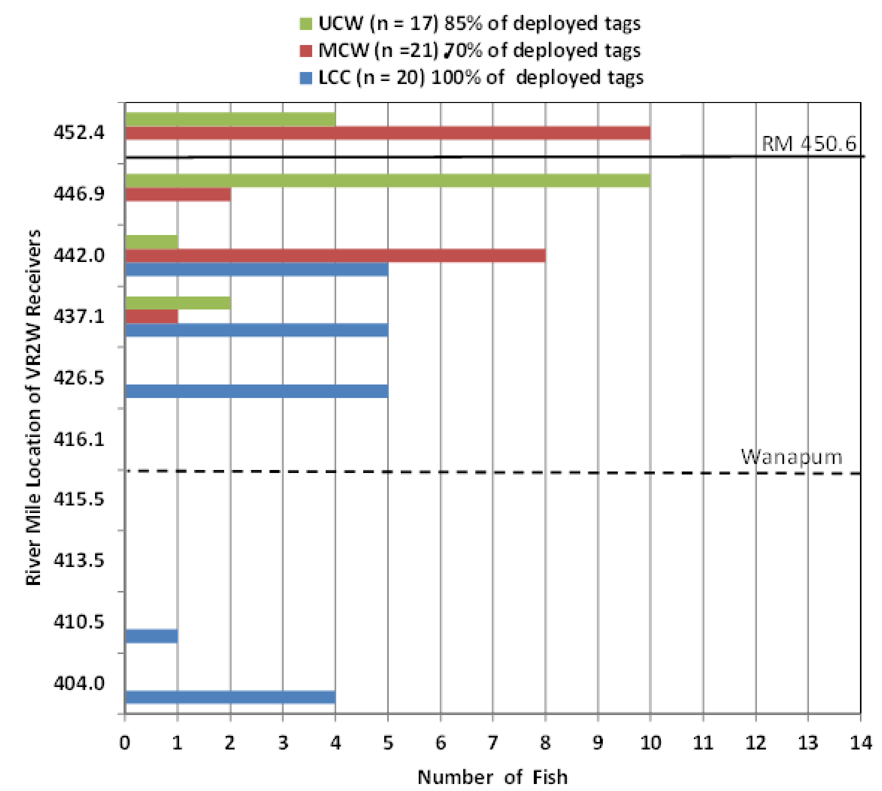


Figure 9 **Last known location, as of October 2012, of acoustic-tagged juvenile white sturgeon from the three 2010BY release groups (Upper Columbia Wild-UCW, Middle Columbia Wild-MCW, and Lower Columbia Cultured-LCC) released in Wanapum Reservoir near RM 415.6 in April, 2011.**

3.8.2 Priest Rapids Reservoir Releases

Substantially fewer fish were equipped with acoustic tags and released in Priest Rapids Reservoir for each of the UCW (n = 6), MCW (n = 9), and LCC (n = 6) groups. However, the post-release dispersal patterns of the release groups were similar to that recorded in Wanapum Reservoir. The majority of the UCW and MCW fish generally remained in the upstream portion of the reservoir, while the majority of the LCC fish moved into the downstream portion of the reservoir and two of the LCC fish moved below Priest Rapids Dam into McNary Reservoir (Figure 6 and 7).

After release, the MCW fish exhibited a high fidelity to the tailrace release location near RM 415.6. Eight of nine MCW fish remained upstream of RM 410.5; one fish moved downstream and resided near RM 398.1. Upstream movements of MCW fish were very limited, a reflection of their high fidelity to the upper portion of the reservoir (Figure 8).

About half the UCW fish remained in the upper portion of the Priest Rapids Reservoir after release; the others moved downstream to a location near RM 404.0. Two UCW fish eventually returned back upstream in late fall. Highest residency levels were registered for UCW fish at RM 404.0 and RM 415.5 (Figure 7).

All members of the LCC group moved downstream soon after release, and by July 2011, the greatest number of LCC detections near RM404.0. Two LCC fish did move briefly upstream above RM 413.5 in October 2011 and June 11 2012, but returned downstream to RM 404 or below. The single receiver station below Priest Rapids Dam confirmed the entrainment of two LCC fish.

Based on the last valid detection, the relative location and dispersal of the three Priest Rapids Reservoir release groups were plotted in relation to their released location and Priest Rapids Dam (Figure 10). As of October 2012, all acoustic-tagged fish released into Priest Rapids Reservoir had been detected at least once by one or more receivers in the reservoir.

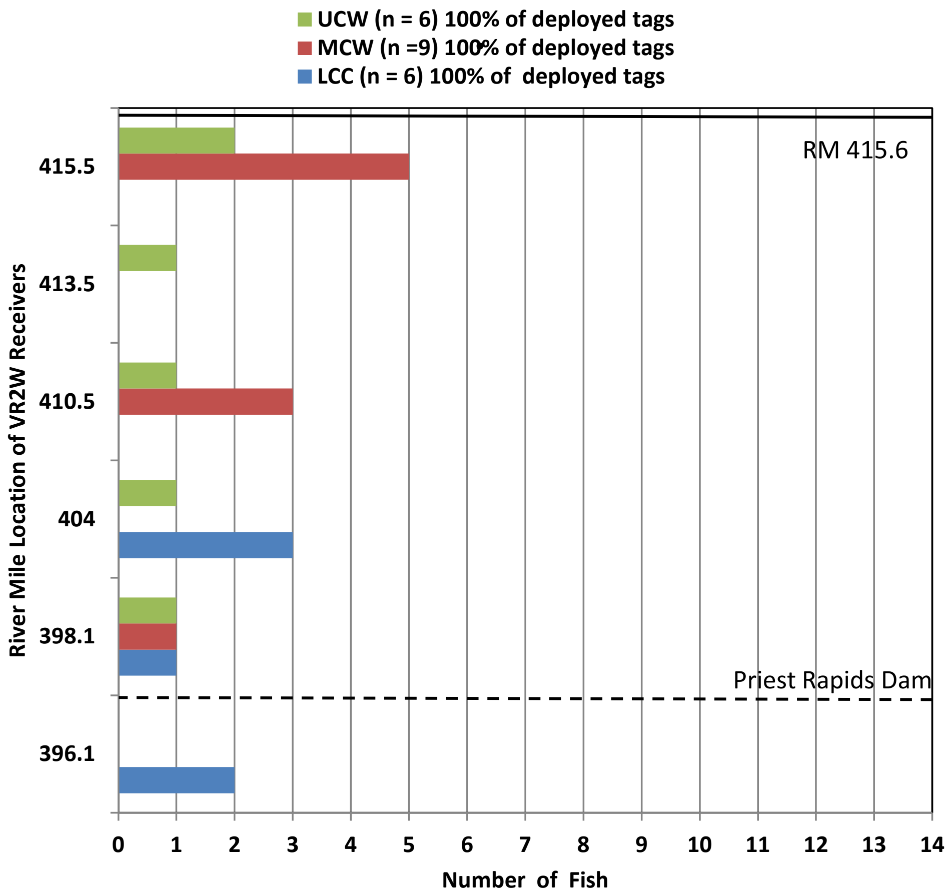


Figure 10 Last known location, as of October 2012, of acoustic-tagged juvenile white sturgeon from the three 2010BY release groups (Upper Columbia Wild-UCW, Middle Columbia Wild-MCW, and Lower Columbia Cultured-LCC) released into Priest Rapids Reservoir near RM 415.6 in April, 2011.

3.9 Juvenile White Sturgeon Habitat

3.9.1 Fish locations

Mobile telemetry tracking and habitat use assessments of acoustic-tagged 2010BY white sturgeon were conducted from July 30 to August 3. Mean daily discharge from Rock Island Dam during the survey range between 5,811m³/s on July 30 and 5086m³/s on August 3. Water temperatures during the survey ranged between 17.2°C and 17.8°C.

As discussed in Section 3.7 and 3.8, seasonal movements of acoustic-tagged juvenile white sturgeon were assessed based on the telemetry data recorded at the 12 fixed VR2W telemetry stations deployed within the Project area. However, for fish that did not exhibit substantial seasonal movement or that resided in areas between VR2W receivers, mobile telemetry tracking allowed detection of these fish, and the types of habitats used.

Mobile telemetry tracking in Wanapum and Priest Rapids reservoirs identified the location of 19 juvenile white sturgeon at locations assumed to represent juvenile summer rearing and feeding habitat. Due to long delay interval between tag signals, only a general fish position could be determined during telemetry tracking and in most cases, whether the fish was moving relative to the receiver (i.e., confirmation that the fish was alive) could not be determined. One exception was Fish 44504 near RM 401. This fish was tracked on two separate days to two locations approximately 500 m apart, which indicated the fish was alive. A second fish, Fish 44545, either moved volitionally or was entrained from the Wanapum Reservoir into Priest Rapids Reservoir and was located during mobile tracing near RM 400. Given the considerable distance this fish had moved, it was likely alive when it travelled this distance. However, due to limit positional accuracy of the mobile telemetry data, whether Fish 44545 was alive at the time it was encountered during mobile tracking could not be determined. A summary of the locations where 2010BY juvenile white sturgeon were found is provided in Table 13.

Table 13 The location of juvenile white sturgeon 2010BY in the Priest Rapids Project area, from upstream to downstream, based on mobile telemetry tracking from July 30 to August 3, 2012.

Date	Acoustic Tag ID	2010BY Release Group	Release Reservoir	Release RM	Current Reservoir	Location RM
3-Aug-12	44493	MCW	Wanapum	450.6	Wanapum	450.5
3-Aug-12	20525	UCW	Wanapum	450.6	Wanapum	450.0
1-Aug-12	20527	UCW	Wanapum	450.6	Wanapum	450.0
3-Aug-12	44552	MCW	Wanapum	450.6	Wanapum	443.0
1-Aug-12	44524	LCC	Wanapum	450.6	Wanapum	442.0
3-Aug-12	44549	LCC	Wanapum	450.6	Wanapum	442.0
1-Aug-12	44526	LCC	Wanapum	450.6	Wanapum	440.0
1-Aug-12	44536	LCC	Wanapum	450.6	Wanapum	440.0
3-Aug-12	44540	LCC	Wanapum	450.6	Wanapum	440.0
2-Aug-12	44539	LCC	Wanapum	450.6	Wanapum	427.0
1-Aug-12	44546	LCC	Wanapum	450.6	Wanapum	427.0
31-Jul-12	44532	LCC	Wanapum	450.6	Wanapum	422.0
2-Aug-12	20508	UCW	Priest Rapids	415.6	Priest Rapids	408.0
31-Jul-12	44521	MCW	Priest Rapids	415.6	Priest Rapids	408.0
2-Aug-12	44523	LCC	Priest Rapids	415.6	Priest Rapids	402.0

30-Jul-12	44543	LCC	Priest Rapids	415.6	Priest Rapids	401.0
30-Jul-12	44504	MCW	Priest Rapids	415.6	Priest Rapids	401.0
2-Aug-12	44504	MCW	Priest Rapids	415.6	Priest Rapids	401.0
30-Jul-12	44545	LCC	Wanapum	450.6	Priest Rapids	400.0

3.9.2 2012 Juvenile White Sturgeon Habitat Assessment

A review of the ADCP transect data indicated that at locations where juvenile white sturgeon were found, a portion of the habitat in these areas was low velocity habitat with a mean column water velocity of 0.5 m/s or less (Appendix C). In channelized sections of the river where fish were found, habitat with low water velocity was typically located along the river margins within 50 m from shore, usually associated with a bench or shelf adjacent to the thalweg. Juvenile white sturgeon also were found in low water velocity areas associated with eddy features (e.g., Columbia Cliffs Eddy near RM 442.0), and at these locations, habitat areas with lowest velocity were located in the center of the eddy feature. Further downstream in the reservoir, water velocity in areas used by juvenile white sturgeon was uniformly low (i.e., 0.5 m/s or less) at all locations were fish were found.

An exact depth preference could not be determined based on the uncertainty of the fish’s horizontal position along the river bottom or its vertical position in the water column. In Wanapum Reservoir, fish were found in areas with water depths greater than 10 m, whereas in Priest Rapids Reservoir, some fish were detected in areas where the majority of potential habitat had a water depth of less than 10 m (e.g., near RM 408.0). However, at most locations, habitat of substantially greater depth (e.g., 20 m or more) was available.

Inspection of the river bottom with an underwater camera at locations where juvenile white sturgeon were found identified areas of habitat with sand substrate and evidence of large quantities of unidentified bi-valve shells. Bivalves appear to be present in the Project area in high densities and likely serve as food resources for juvenile white sturgeon.

3.10 Juvenile Population Indexing

Over the four day juvenile population indexing period, mean daily discharge from Rock Island Dam ranged between a low between 1,892 m^3/s on September 2 and a high of 4,163 m^3/s on August 30. Mean daily water temperature ranged between 18.3°C and 18.6°C.

One white sturgeon was captured during the gill net survey. This fish was a hatchery juvenile captured on September 2, 2012 in Wanapum Reservoir at RM 434.1 in 28.9 m of water. This fish measured 43.2 cm FL, weighed 610 g (estimated relative weight of 115%) and was PIT-tagged (985.121023402524) and scute marked (removal pattern of 1st, 2nd, and 3rd left lateral anterior to the origin of the dorsal fin). These marks identified the fish as a Chelan County PUD hatchery juvenile released into Rocky Reach Reservoir on April 21, 2011. At release, this fish measured 21.7 cm FL and thus had grown 21.5 cm during 500 d at large, an average rate of 0.43 mm/d or 15.7 cm/y. Incidental catch during the survey totaled 2,358 fish from 13 species, with northern pikeminnow dominant in the catch (Table 14; Figure 11).

Table 14 Summary of incidental catch by gill nets during the juvenile white sturgeon indexing survey in the Priest Rapids Project area, 2012.

Common name	Scientific name	PRIEST RAPIDS				WANAPUM			
		n	% of Total Catch	Ep[1]	CPUE[2]	n	% of Total Catch	Ep[1]	CPUE[2]
Northern Pikeminnow	*Ptychocheilus oregonensis*	520	83.9	1.00	27.4	1,043	60.0	0.98	17.4
Peamouth	*Mylocheilus caurinus*	79	12.7	0.84	4.2	652	37.5	0.92	10.9
Chiselmouth	*Acrocheilus alutaceus*	10	1.6	0.21	0.5	16	0.9	0.18	0.3
Suckers	*Catostomus spp.*	4[3]	0.6	0.11	0.2	12[4]	0.7	0.17	0.2
Walleye	*Sander vitreus*	1	0.2	0.05	0.1	2	0.1	0.03	<0.1
Yellow Perch	*Perca flavescens*	-	-	-	-	10	0.6	0.10	0.2
Smallmouth Bass	*Micropterus dolomieui*	-	-	-	-	1	0.1	0.05	<0.1
Black Crappie	*Pomoxis nigromaculatus*	1	0.2	0.05	0.1	-	-	-	-
Pumpkinseed	*Lepomis gibbosus*	1	0.2	0.05	0.1	-	-	-	-
Lake Whitefish	*Coregonus clupeaformis*	-	-	-	-	1	0.1	0.05	<0.1
Sculpins	*Cottus spp.*	4	0.6	0.21	0.2	-	-	-	-
	Total	620	100.0	1.00	32.6	1,738	100.0	1.00	29.0

1/ Effort Positive: the proportion of gill net sets where catch was >0 (Uphoff, 1993)
2/ The mean average of catch per overnight gill net sets
3/ All Bridgelip sucker
4/ 1 Bridgelip sucker; 3 Largescale sucker; 8 Longnose sucker

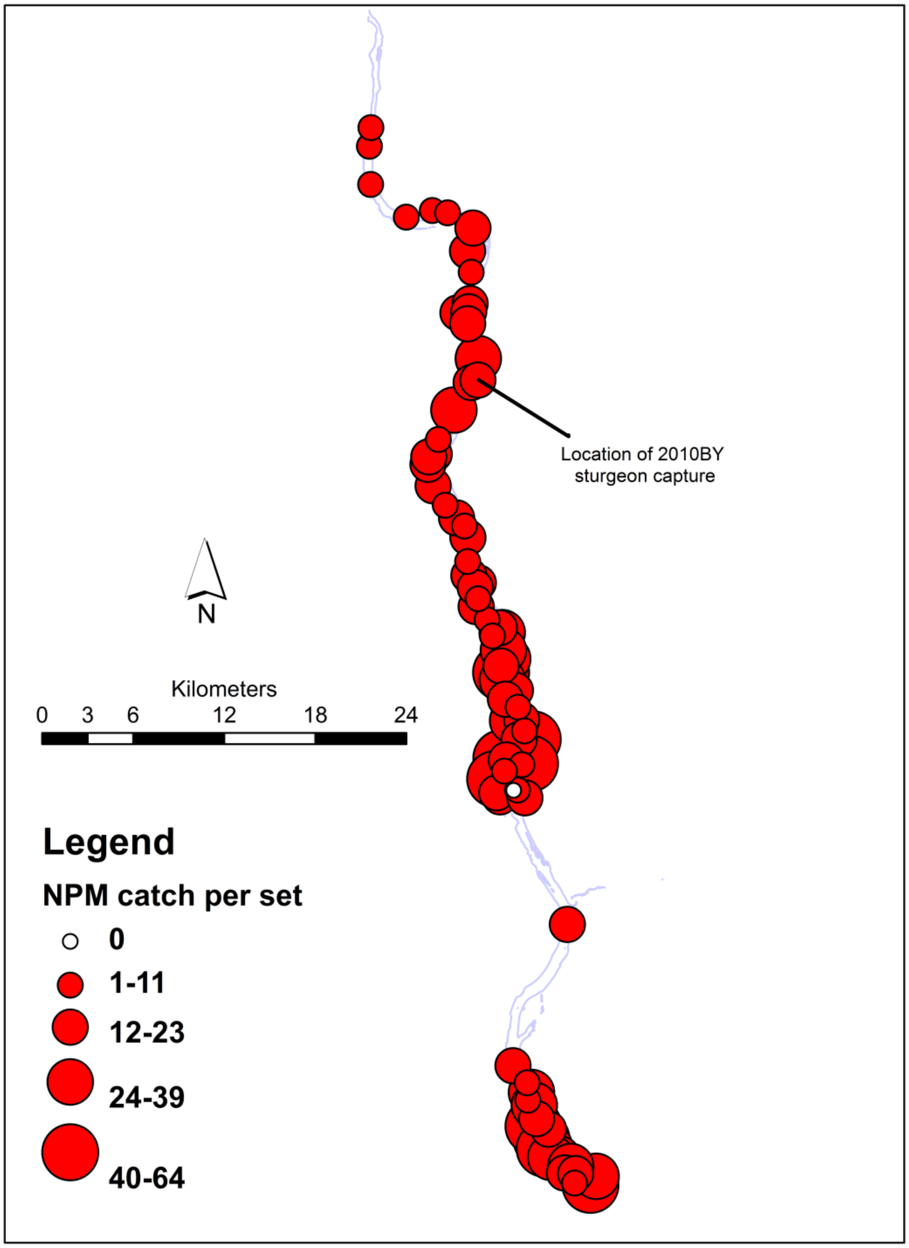


Figure 11 Catch distribution of northern pikeminnow in the Priest Rapids Project area during the juvenile white sturgeon indexing survey, 2012. All gill net sets deployed during the survey are shown.

3.11 Spawning Migration Upstream Movement Rates

During the April to August periods of 2011 and 2012, acoustic tagged adult white sturgeon were detected mainly at the two known overwintering sites (RM 426.5 the lower site and at RM 442.0 the upper site) and at the spawning site (RM 452.4, Table 15). During putative upstream spawning migrations of 22 fish in 2011 and 26 fish in 2012, swimming speeds ranged between 0.01 kph (0.003 m/s; ID 48695 in 2011) and 3.96 kph (1.1 m/s; ID 48696 in 2012). Apart from the 3.96 kph record, swimming speeds were similar across 2011 and 2012, with medians of 0.40 kph (0.1 m/s) and 0.42 kph (0.1 m/s), respectively (Figure 12).

Table 15 **Number of acoustic-tagged white sturgeon detected from April to August of 2011 and 2012, by VR2W receivers situated in Wanapum Reservoir between RM 426.5 (the downstream overwintering area) and RM 452.4 (the spawning area below Rock Island Dam).**

	2011					2012				
RM	**April**	**May**	**June**	**July**	**August**	**April**	**May**	**June**	**July**	**August**
426.5	67,142	44,623	15,973	26,435	53,283	47,934	11,219	3,508	7,145	56,904
437.1	-	-	-	-	-	-	644	76	494	1,174
442.0	37,965	16,333	6,520	2,336	4,138	39,059	12,387	522	161	3,160
446.9	-	-	-	187	369	232	264	77	264	641
452.4	2,912	16,221	18,976	38,973	29,440	4,506	42,782	49,598	12,480	36,848

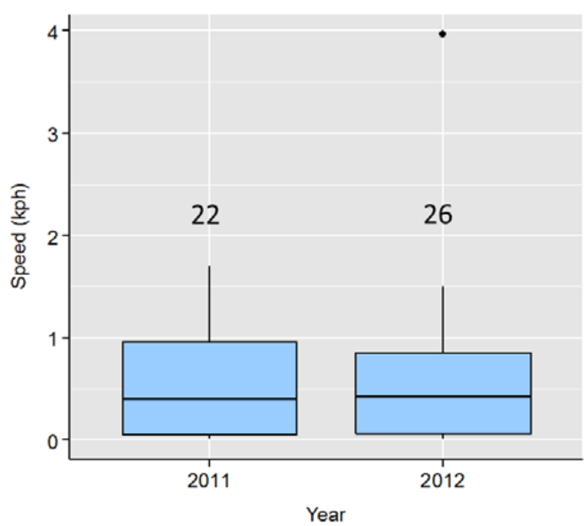


Figure 12 **Swimming speeds of White Sturgeon during putative spawning migrations in 2011 and 2012. The middle line of the boxplot represents the median (50th quantile), while the bottom and the top lines represent the 25th and 75th quantiles, respectively. Whiskers extend to 1.5 times the interquantile range; values more extreme than this range are shown as individual data points. The number of fish within each group is provided above the corresponding box.**

3.12 VR2W Tag Detection Probability

Detection probabilities differed across the receivers (Figure 13). The receiver at RM 437.1 had the lowest detection probability (2.5%), however this was an artifact of the short time the unit was in operation (i.e., installed in May 2012), which is why there were no detections at the site in 2011. In 2012, one fish (ID 19366) was recorded on this receiver during a spawning migration; 26 pings were detected on the unit. The receiver had other fish detections, but those were deemed not related to spawning migrations and were removed from the analysis.

The receiver at RM 446.9 had intermediate (below 50%) detection efficiencies. The unit was installed in late June 2011, which is why only three fish were detected in 2011. The highest efficiencies were recorded at RM 442.0, the upstream overwintering site, with one efficiency estimate over 100%. These high numbers can be the result of two processes. First, fish migrating from the lower overwintering site may linger at the upstream site, resulting in more pings than predicted by the constant-speed model. In addition, the predicted number of detections at each receiver was corrected for tag collisions based on the number of fish present at the site. Many white sturgeon were either overwintering or passing by the receiver at RM 442.0, where simultaneous fish counts ranged from 1 to 9. Therefore, the vast majority of daily ping counts had to be corrected, which resulted in a considerable increase in the predicted number of detections. If the actual rate of collision was lower, this would cause an upward bias in efficiency rates. Indeed, the two highest efficiencies (125% and 92%) were estimated for the receiver at RM 442.0, when there were 6 and 9 tags simultaneously present, respectively.

One of the five females tracked to the spawning site in 2011 (Figure 13) was in stage F4 in 2010, which suggests probable spawning activity in 2011. This female (ID 48729) moved to the spawning site at an average speed of 0.78 kph. The remaining three females were identified as post-spawning in 2010 (stage F6). Hence, their migration upstream was not for spawning purposes. Four out of the five females tracked to the spawning site in 2011 also performed the migration in 2012 as well. Out of the five females migrating to the spawning site in 2012, one fish was in stage F3 in 2011, indicating probable spawning activity. This female (ID 19359) moved to the spawning site at an average speed of 0.02 kph.

A total of 16 and 20 males performed the upstream migration in spring 2011 and 2012, respectively (Figure 13). In 2011, the majority of the males were in stage M2 or M1 in 2010 (7 fish in each group). In 2012, the majority of the males were in stage M2 or M1 in 2010 (7 and 8 fish, respectively). Nine of the males tracked to the spawning site in 2011 also performed the migration in 2012.

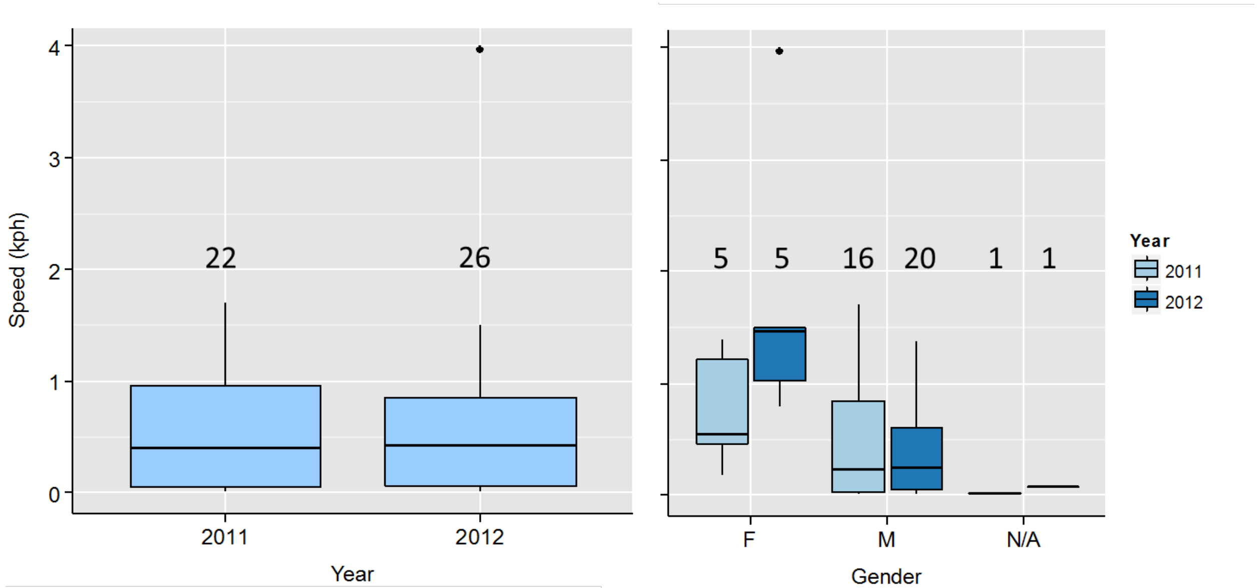


Figure 13 Swimming speeds of White Sturgeon during putative spawning migrations in 2011 and 2012; data separated by year (left panel) or by year and gender (right panel). The middle line of the boxplot represents the median (50th quantile), while the bottom and the top lines represent the 25th and 75th quantiles, respectively. Whiskers extend to 1.5 times the interquantile range. The number of fish within each group is provided above the corresponding box.

3.13 Adult White Sturgeon Population Assessment

During the first sample session from September 10 to September 16, mean daily discharge from Rock Island Dam range between 1,732 m^3/s and 2,749 m^3/s, respectively. Mean daily water temperature over this period ranged between 18.1°C and 18.8°C. In comparison, flows during the October 1 to October 8 session were lower (between 776 m^3/s and 1,879 m^3/s) and mean daily water temperatures were cooler m (between 16.7°C and 17.9°C).

In 2012, 118,550 hook-hours of set line sample effort was expended during the mark-recapture sessions conducted in the Project area (Priest Rapids and Wanapum reservoirs) during the two GRTS population sample sessions (Table 16). The combined sample effort from both sessions resulted in the capture of 313 white sturgeon (includes recaptured fish) composed of two 2010BY fish, 278 CRITFC hatchery fish (CRITFC releases) and 33 wild fish for an overall CPUE of 0.26 fish/100 hook-hours.

Table 16 Total set line sample effort, catch, and CPUE in the Priest Rapids Project area during the adult white sturgeon population assessment program, September 10 to October 8, 2012.

Session[a]	Sample Effort (hook-hours)	Catch (No. of fish)			CPUE (fish/100 hook-hours)		
		Wild	Hatchery[b]	Total	Wild	Hatchery	Wild &Hatchery
S1 PR	20333	2	44	46	0.01	0.22	0.23
S2 PR	19773	1	43	44	0.01	0.22	0.22
S1 WR	39312	17	122	139	0.04	0.31	0.35
S2 WR	39132	13	71	84	0.03	0.18	0.21
S1 PR&WR	59645	19	166	185	0.03	0.28	0.31
S2 PR&WR	58905	14	114	128	0.02	0.19	0.22
GRAND TOTAL	**118550**	**33**	**280**	**313**	**0.03**	**0.24**	**0.26**

[a] Sample Session 1 (S1), September 10 to 16, 2012; Sample Session 2 (S2), October 1 to 8, 2012; PR = Priest Rapids Reservoir; WR = Wanapum Reservoir; Project

[b] 278 CRITFC fish (released 2003); 2 2010BY (released 2011)

3.14 White Sturgeon Size Distribution

The average length of wild fish captured during the 2012 adult population indexing program in Wanapum Reservoir (n = 30) was 190.5 cm (range = 60.5 cm to 258.0 cm FL; Figure 14). In 2010, the average length of wild fish captured in Wanapum Reservoir (n = 53) was 170.0 cm (range = 116.0 cm to 241.0 cm FL). Substantially fewer wild fish were captured in Priest Rapids Reservoir in both 2010 (n = 5) and in 2012 (n = 3) than in Wanapum Reservoir. In 2012, the average length of wild white sturgeon captured in Priest Rapids Reservoir was 163.0 cm (range = 118.0 cm to 205.5 cm FL). During the 2010, the average length of wild fish in Priest Rapids Reservoir was 166.5 cm (range = 137.5 cm to 205.0 cm FL).

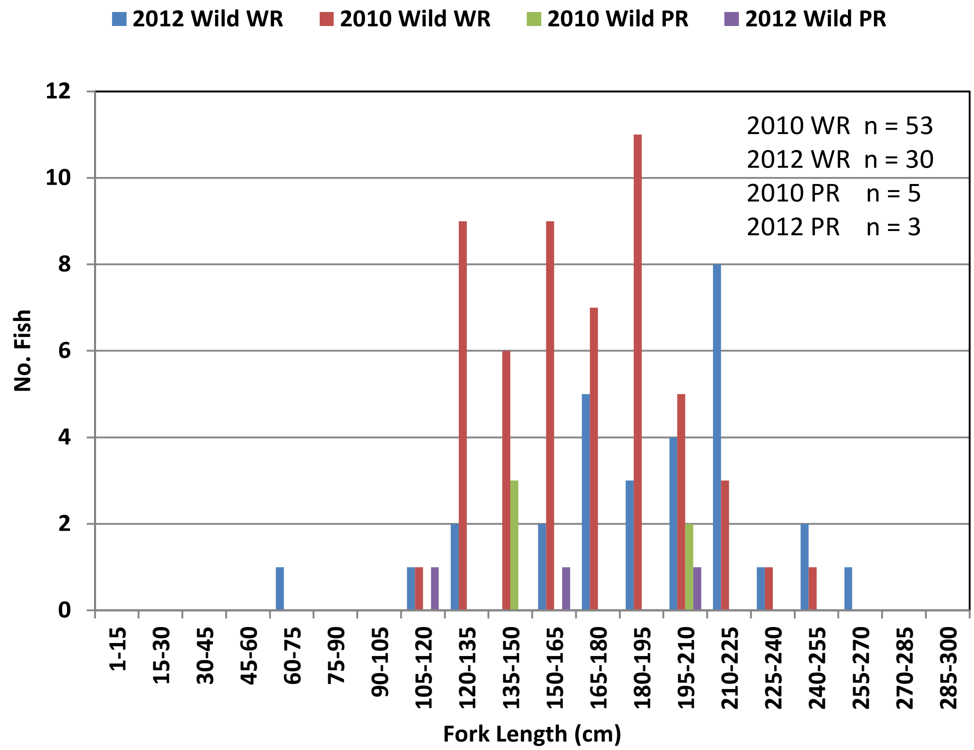


Figure 14 **Length-frequency distributions of wild white sturgeon captured in Wanapum Reservoir (WR) and Priest Rapids (PR) reservoirs during the 2010 and 2012 adult indexing programs.**

During the 2012 adult population indexing program, the average length of CRITFC hatchery white sturgeon captured in Wanapum Reservoir (n = 193) was 115.0 cm (range = 57.5 cm to 144.0 cm FL; Figure 15). Similarly, the average length of CRITFC hatchery white sturgeon captured in Priest Rapids Reservoir (n = 87) was 113.0 cm (range = 56.5 cm to 141.0 cm FL; Figure 15). For comparison, during the 2010 adult population indexing program, the average length of CRITFC hatchery white sturgeon in Wanapum Reservoir (n = 311) was 104.0 cm (range = 58.0 cm to 132.5 cm FL) and the average length of CRITFC hatchery white sturgeon captured in Priest Rapids Reservoir (n = 147) was 101.0 cm (range = 64.5 cm to 132.5 cm FL). The shift to the right of the length-frequency distributions of CRITFC hatchery white sturgeon from 2010 to 2012 clearly indicates that the hatchery fish have continued to growth and apparently thrive. In both reservoirs, the increase in mean FL of CRITFC hatchery fish from 2010 to 2012 was similar (i.e., 11.0 cm FL in Wanapum and 12.0 cm FL in Priest Rapids).

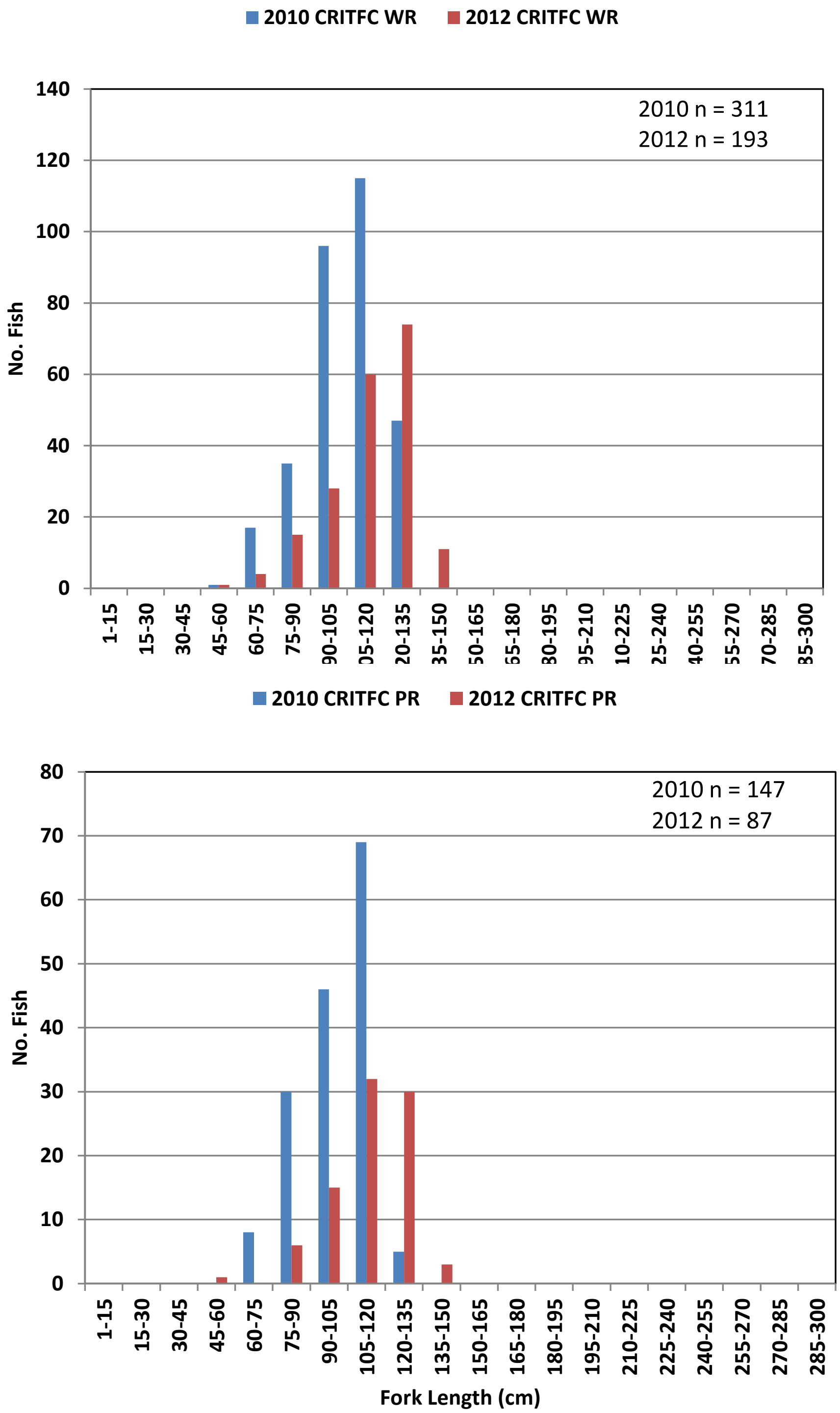


Figure 15 **Length-frequency distribution of CRITFC hatchery white sturgeon captured in Wanapum Reservoir (WR; top) and Priest Rapids Reservoir (PR; bottom) during the 2010 and 2012 adult index programs.**

Two 2010BY were captured during adult indexing; one in Wanapum Reservoir and the other in Priest Rapids Reservoir. Both fish were from the LCC release group. The Wanapum Reservoir fish was at large for 507 days and increased in fork length by 20.5 cm from 37.0 cm FL to 57.5 cm FL. The weight of the fish increased 1,072 g (i.e., from 327 g 1,400 g). Similarly, the Priest Rapids Reservoir fish was at large for 523 days and increased in fork length by 21.4 cm from 35.1 cm FL to 56.5 cm FL. The weight of this fish increased 1,114 g (i.e., from 286 g to approximately 1,400 g). Both fish were recaptured at locations downstream of their release site. The Wanapum fish was recaptured near RM 423.2, 27.4 miles downstream of the Columbia Siding release site at RM 450.6. The Priest Rapids fish was recaptured near RM 402.5, 13.1 miles downstream of the Wanapum tailrace release site at RM 415.6.

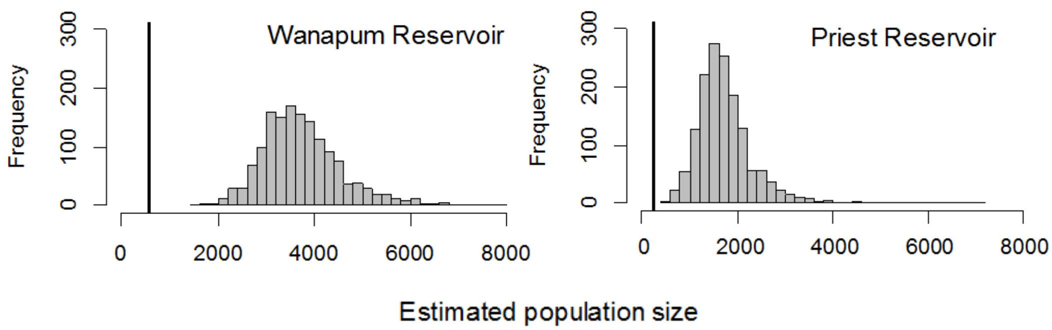
3.15 Adult White Sturgeon Population Estimate

Due to the low catch of wild White Sturgeon during adult population indexing in 2012 (i.e., 33 wild fish total), population estimates were based on mark-recapture data for CRITFC hatchery white sturgeon and then extrapolated to the wild population. The combined CRITFC white sturgeon catch for the mark and recapture sessions in Wanapum Reservoir was 193 individuals, of which 3 were intersession recaptures. About half that number of fish was captured in Priest Rapids Reservoir, with a combined mark and recapture session catch of 87 individuals, of which two were intersession recaptures. Due to the low numbers of wild fish captured, the 2012 population abundance estimates had broad confidence intervals. For the 2012 Bayesian analysis of Petersen mark-recapture estimates, only uninformative priors were used (i.e., a mean of 8,000 fish for both reservoirs) and were selected to be substantially higher than the expected mean of the population. In comparison, for the previous 2010 SBA population estimates, the total number of individual fish captured was used as the lower prior. Based on the 2012 mark-recapture data, the mean CRITFC White Sturgeon population estimate in Wanapum Reservoir was 3,550 fish (95% CI = 875 to 10,768). In Priest Rapids Reservoir, the mean CRITFC white sturgeon population estimate was 1,565 fish (95% CI = 289 to 6,284).

As a substantial number of fish had been marked during the 2010 indexing study, mean population estimates were also calculated based on fish marked in 2010 that were recaptured during the 2012 adult indexing program. In 2010, a total of 377 and 155 CRITFC white sturgeon were captured and tagged in Wanapum and Priest Rapids, respectively. Out of the fish marked in 2010, a total of 20 were recaptured in 2012 in Wanapum Reservoir and 8 in Priest Rapids Reservoir. Bayesian estimates of capture efficiency were similar across both reservoirs, with a mean of 0.052 (95% CI = 0.025 to 0.088) in Wanapum Reservoir, and a mean of 0.053 (95% CI = 0.034 to 0.076) in Priest Rapids Reservoir. Abundance estimates from the 2010-2012 Bayesian analysis indicated that the abundance of white sturgeon in Wanapum Reservoir was almost double that of the Priest Rapids Reservoir, with mean population estimates of 3,740 individuals (95% CI = 2,340 to 5,830) in Wanapum Reservoir and 1,729 individuals (95% CI = 889 and 3,181) in Priest Rapids Reservoir.

Using the 2010-2012 Bayesian mean population estimate of CRITFC hatchery fish in Wanapum Reservoir, the wild white sturgeon population was estimated to be 13.5% of the hatchery population, based on the ratio of wild to hatchery catch in the 2012 adult indexing program. This equates to approximately 505 wild white sturgeon. Previous SBA estimates of wild white sturgeon abundance in Wanapum Reservoir was approximately 872 fish based on 2010 catch results and 817 fish based on results from the 1999-2002 study.

Based on the 2010-2012 Bayesian analysis for Priest Rapids Reservoir, the wild white sturgeon population was estimated to be 3.3% of the hatchery population (ratio of wild to hatchery catch in the 2012 adult indexing program) or approximately 57 wild white sturgeon. Previous population estimates of wild white sturgeon in Priest Rapids Reservoir based on 2010 catch results was 99 fish. The 1999-2002 study wild white sturgeon population estimate was not considered reliable.



4.0 SUMMARY AND RECOMMENDATIONS

In 2012, the majority of the M&E study components were either conducted for the first time as a pilot study (i.e., juvenile indexing), or had been conducted only one or twice previously since 2010. Although the empirical data has been recorded during each study component, many of the findings during the first or second years of the M&E program have led to further refinements in the methodology and how data were collected in subsequent years. As such, detailed inter-year comparison of the data collected over 2 or 3 years as the methodology developed and was refined was considered of limited value. Therefore, the following provides a brief discussion and interpretation that focusses on the 2012 M&E study results; a more detail analysis and interpretation of results from all study years will be provided as part of the 2014 final report.

In 2012, flows in the Columbia River were high and sustained over the freshet period. The peak mean daily discharge from Rock Island Dam was 9,149 m³/s on June 26, 2012 and high flows and spill conditions persisted into mid-summer. The lowest mean daily discharge from Rock Island Dam was 292 m³/s on October 12. Water temperatures in the Project area during the white sturgeon spawning period where within the optimal 14°C to 16°C window from July 7 to July 24, 2012.

4.1 Juvenile Marking and Release

Due to the limited number of candidate broodstock captured in 2011, the 2011BY progeny were produced from a 1x1 cross as opposed to a 3x3 partial factorial cross, which would have produced nine unique families. In 2011, the PRFF decided to release 722 BY2011 juvenile white sturgeon (1/9 of the annual release target of 6,500 juveniles) from the into the Project area. This decision was made in accordance with stocking guidelines in the WSMP to reduce the risks of future genetic swamping by not releasing large numbers of fish into the Project area with the same or similar genetic make-up. The 722 juveniles were to be distributed between Wanapum and Priest Rapids reservoirs at approximately a 3:1 ratio distributed between Wanapum (77% or 556 fish) and Priest Rapids reservoirs (23% or 166 fish).

During rearing of the 2011BY at MDH, hatchery staff noted the fish exhibited below average growth rates and were undersized (i.e., 22.8 g/fish as of February 29, 2012; personal communication, Donella Miller, Marion Drain Hatchery, April 4, 2012). Consequently, the 2011BY fish were still too small to tag in April 2012, when the fish were scheduled to be tagged and released. Attempts were made to increase the size of the fish by rearing them in warmer temperatures, reducing density of fish per rearing tank, and providing extra feed. These attempts only resulted in limited success, as the fish were approximately 100 g/fish by the end of June 2012. For comparison, the average fish weight of the 2010BY at tagging was 177g/fish. Pathology testing of the 2011BY identified the presence of disease indicators and suggested that the fish had been exposed to white sturgeon Iridovirus. In consultation with WDFW and USFWS Idaho Fish Health Center fish culture and pathology experts, members of the PRFF agreed by consensus that the 2011BY would not be released.

For consideration, if the PRFF had agreed that the 722 2011BY should be released as planned, the contribution of the 2011BY in terms of supplementation and restoration of the white sturgeon populations within the Project area would have been limited due to the small number released and the high mortality rate of juvenile white sturgeon in their first year after release (i.e., approximately 70%; Irvine et al. 2007). Future juvenile population indexing studies would not likely capture sufficient numbers of the 2011BY to estimate population and life history metrics for this year-class. The ability of future juvenile indexing programs to accurately assess the success and survival of annual juvenile supplementation efforts will depend on the number and health of the juveniles released. Factors that negatively affect the health and survival of the juveniles during production, processing, and release should be identified and minimized. The following are examples of factors that should ideally remain consistent during the production and release of each year-class:

- The number released each year should be sufficient to ensure that adequate numbers survive to adulthood and potentially contribute to a naturally reproducing population. The WSMP calls for a minimum of 6,500 juveniles to be released each year dependent on their genetic make-up. A larger annual release may be required if survival rates are lower than expected.
- Ideally, the length and weight distribution should be similar for each annual release. Broodyears of smaller or unhealthy fish will have lower survival compared to broodyears with larger fish. Similarly, cohorts that were stressed and less healthy at release will have a lower survival than broodyears with healthy fish.
- Handling and treatment of brood during rearing, marking and tagging, transport, and release procedures should be standardized. This includes allowance of a sufficient amount of recovery time after tagging and prior to release.
- Consistency of release schedule and release location is recommended to ensure each broodyear is released into a similar environment from year to year. If possible, each annual release should occur within the same calendar window (e.g., in the last two week of April of each year).

Proper documentation and regular monitoring during all phases of the brood development, processing, and eventual release will be necessary to allow identification of factors that may result in differential survival among brood years. Compilation of these data directly into a custom designed database directly in the field would greatly facilitate date management and subsequent analysis. Adaptation of an existing monitoring program and data collection platform would likely be the most efficient approach, benefiting from the experience of other similar programs; however, as with any long-term program over multiple years, development of a refined and efficient program occurs in part from lessons learned by trial and error over time.

4.2 Broodstock Capture

The 2012 broodstock capture program was the most successful to date, with four males and one female transported to MDH and successful mated to produce a 1Fx4M cross and four 2012BY families. Although statistically not defendable, the following factors were assumed to improve the 2012 broodstock capture results relative to previous broodstock efforts in 2010 and 2011:

1) Greater angling effort by a skilled local fishing guide who specifically fishes for white sturgeon. The guide was very knowledgeable of the seasonal movements and the location where white sturgeon can be found and caught. Angling was effective in sampling areas where set lines could not be deployed (i.e., fast flowing and entrenched portions of the river).

2) Use of salmon and specialty brined squid on set lines and angling gear likely increased catch. Wild white sturgeon likely are familiar with salmon and may prefer it to other bait types. The specialty bait was also larger and produced a more intense and sustained scent compared to the smaller (and often putrid) commercial pickled squid used during previous broodstock programs. As a result, fish maybe have been attracted to the sample gear from a larger distance. However, catch results and general field observations suggested there is an optimum bait size that if exceeded, resulted in reduced catches. For example, large Spring Salmon heads did not catch sturgeon, and if they did, the size of the sturgeon that would be able to ingest a bait of that size would likely have been too large to be a suitable broodstock candidate.

3) Use of mobile acoustic telemetry to located acoustic-tagged white sturgeon assisted in the identification of more effective set line deployment sites. Even if the fish identified was not classified as a pre-spawner based on historical capture data, some non-spawning fish and second year post-spawners tend to aggregate on the spawning grounds along with pre-spawning fish. Typically, the acoustic-tagged fish were located in high flow locations not suitable for direct deployment of set lines or even angling gear. In this situation, set lines with specialty bait were either set in lower velocity habitat upstream or adjacent to where the fish were located, under the assumption the fish may move into the lower velocity habitat to rest or feed.

4) The size 20 circle hooks used on the set lines were very robust and unlikely to be straightened, even by a very large fish. Although the hooks were de-barbed according to the methodology outlined in the WSMP, some hooks retained a remnant of the barb that could not be removed. Based on general observations during the broodstock program, hooks with barb remnants seem to hold bait better and catch more fish, possibly because the barb remnant prevented the hook from backing out in situations where tension was removed from gangion leader.

During the 2012 broodstock capture program, use of the Columbia Siding launch was found to be a substantial logistical improvement over transporting fish out of Crescent Bar. Barring further degradation of the compact dirt and gravel launch surface to the point it is not usable, it is anticipated that all future broodstock transfer will occur at the Columbia Siding launch.

Male broodstock captured in June 2012 were flowing and readily identifiable as suitable broodstock candidates. However, as these fish were processed, milt would typically continue to flow from the fish. As a consequence, upon arrival at MDH, the fish had ceased flowing and hatchery staff were unable to extract a sufficient quantity of milt for breeding purposes. As a result, the fish had to be cooled, rewarmed, and then injected with hormones to stimulate milt production, a procedure that can take as long as five days to reinitiate milt production (personal communication, Donella Miller, Marion Drain Hatchery, January 29,2013). Potentially, this delay could affect the success the breeding program if the males cannot be brought on at the correct time to coincide with egg extraction from the female. As a contingency, future processing of male broodstock will also entail milt extraction in the field according to procedures provided by fish culture experts. Milt is extracted with a syringe and a length of 4 mm diameter tygon tubing. Care must be taken to ensure that the milt does not mix with water during extraction. Once extracted, the milt is transfer to a plastic bag, filled with pure oxygen, then sealed. Stored on ice, the milt will remain viable for up to three days. Once the milt is extracted, both the fish and the extracted milt will be transported to the hatchery.

Consideration will be given to conduct future brood collection efforts earlier in June to ideally increase catch rate and coordinate better with other broodstock collection efforts to increase the number of brood available for MDH staff. The timing of the 2012 broodstock capture program was scheduled for mid to late June based on an expected high flow year and lower water temperatures that were assumed to likely delay spawning until later in the summer. Previous studies have identified that white sturgeon spawning in the Middle and Upper Columbia Rivers usually start at the end of June, typically on the descending limb of the spring freshet at water temperatures between 14°C and 16°C (Golder 2011a). In 2012, a substantial reduction in the wild white sturgeon catch was evident during the last week of the broodstock capture program. The reasons for this decrease are unclear but based on the capture of a recently spawned female (F6; see Table 2) on the final day of the broodstock program, may have been due to the start of spawning activity that may have commenced during the last week of sampling, even though peak freshet had not been reached and water temperature was below 13°C. Starting the Grant PUD broodstock collection effort in early June may avoid the late season reduction in CPUE experienced in 2012, and result in the capture of more fish. Furthermore, in late May 2012, Chelan PUD also conducted one week broodstock capture in a lower reach of the Columbia River. This effort resulted in the capture of five females and four male broodstock candidates, of which three females were successfully spawned with one male. Due to the earlier start date of the Chelan program, confirmation of viable male broodstock was more difficult to determine in the field. However, had the Grant PUD and Chelan PUD efforts been conducted during the same time frame, potentially both Grant and Chelan fish could have been bred to produce a four female by five male cross. Increased coordination among mid-Columbia sturgeon recovery programs is planned for the 2013 broodstock collection effort.

4.3 Juvenile Movement and Habitat Assessment

The 2010BY, 91 of which were implanted with acoustic telemetry tags, were released in Project area in April 2011. Telemetry data from the acoustic-tagged fish up to October 2012 confirmed the initial findings presented in the 2011 report (Golder 2012) that the three release groups (i.e., UCW, MCW, and LCC) exhibited substantial differences in post-release movement and dispersal within the Project area. In both reservoirs, the UCW and MCW fish tended to remain in the upper portion of each reservoir, while the LCC moved downstream into the lower portion of each reservoir.

Within the first few months after release, the LCC release groups in both Wanapum and Priest Rapids reservoir demonstrated primarily downstream movement. Five acoustic-tagged LCC fish were either entrained or volitionally moved from Wanapum Reservoir into Priest Rapids Reservoir and at least two fish went from Priest Rapids into McNary Reservoir. However, the LCC fish that remained in Wanapum Reservoir also moved substantial distances upstream. The LCC fish were also detected more frequently and more recently, with numerous detections throughout Wanapum Reservoir in 2012. As of October 2012, an estimated 11 of the 20 acoustic-tagged LCC fish released in Wanapum Reservoir were considered alive (i.e., had exhibited upstream movement at some point after release). In Priest Rapids Reservoir, two of the six acoustic-tagged LCC fish were considered alive.

Conversely, in Wanapum Reservoir, both the UCW and MCW exhibited upstream movement immediate after release, which was initially viewed as positive indicator of survival. However, subsequent telemetry data from these fish in 2012 was minimal, with the majority of fish either not detected or very few detections that did not indicate typical seasonal movement expected for juvenile white sturgeon (e.g., fall movements to known overwintering areas). As of October 2012, only three of the 20 acoustic-tagged UCW and two of the 30 acoustic-tagged MCW released in Wanapum Reservoir were considered alive (i.e., had exhibited upstream movement at some point after release). In Priest Rapids Reservoir, two of the six acoustic-tagged UCW and one of the nine acoustic-tagged MCW were considered alive. For all release groups, 21 of the 91 acoustic-tagged 2010BY were assumed alive and present in the Project area as of October 2012.

As all 2010BY were PIT-tagged, the MDH tag codes (i.e., MCW and LCC fish) were uploaded in the Columbia River PTAGIS database; however, the KTH tag codes (i.e., UCW fish) were not. PIT-tag detection arrays are present at dams throughout the Columbia Basins and are configured primarily for tracking salmon migration and monitoring fish passage. Tag detection probability of these array systems tends to be low; however, PTAGIS queries conducted in 2011 did return PIT-tag detections of 2010BY at dams downstream of the Project (personal communication, Josh Murauskas, Chelan PUD, November 18, 2011). The majority of these detections, 58 PIT-tags, were found during an avian predator survey at a known bird colony on an island in the Rock Island forebay. All tags detected at this site were from the MCW Wanapum 2010BY release group and one of the PIT-tags was from an acoustic-tagged MCW fish (ID 44537) with a fork length of 349 mm. Given that 58 PIT-tag represents 2% of the total MCW release in Wanapum Reservoir, combined with the low detection efficiency of method used to survey the bird colony (i.e., approximately 1%) and that other bird colonies are in the area, this evidence suggests that a substantial portion of the Wanapum MCW release may have been eaten by birds.

In comparison, the UCW fish were on average smaller (i.e., 247 mm FL) than the MCW fish (i.e., 288 mm FL), and that based on movements of acoustic-tagged fish, both groups showed similar dispersal after release. Therefore, the survival of the UCW fish should also have been impacted by avian predation. This could not be verified at the time of this writing because the UCW PIT-tag data had not yet been entered into the PTAGIS database. A search of the PTAGIS database for recovered UCW PIT-tag will be conducted in 2013 after the tag information is uploaded, to assess effects of avian predation on this release group.

Telemetry data as of October 2012 indicated that possibly only 5 out of the 50 acoustic-tag UCW and MCW fish are still alive. Telemetry data from Priest Rapids was limited, but assuming similar avian predator densities, the survival of the 2010BY released in Priest Rapids Reservoir were also likely influenced by avian predation.

The exact effect of avian predation on the survival of the 2010BY or possible differences in mortality rates for the different release groups is unknown. Some potential factors that could influence overall and group survival rates are discussed below.

Behavior

The tendency for the UCW and MCW fish to move upstream after release may have resulted in these fish moving into a location where they were exposed to increased levels of avian predation. Conversely, the tendency of the LCC fish to mainly move downstream after release a potential were not exposed to the same level of predation.

Release Size

The average release size of both the UCW and MCW fish (i.e., 247 mm FL and 288 mm FL, respectively) was smaller than the LCC fish (i.e., 350 mm FL). Based on the PIT-tag detection data from Rock Island bird colony, avian predators are capable of taking fish as large as 350 mm FL. Since a large average size-at-release would confer increased protection against predation, consideration should be given to raising future releases to an average length 350 mm FL or greater.

Release Location

In Wanapum Reservoir, two factors that likely affected the amount of avian predation on the 2010BY were 1) the proximity of the Columbia Siding release site to bird colonies in the vicinity of Rock Island Dam, and 2) the bathymetric and flow characteristics of the Columbia Siding release site. Flight time between the fish release site and nesting and roosting sites of avian predators likely was a factor that affected predation rate, in that the shorter the distance between the two locations, the higher the potential predation rate on the release fish. Feeding activity by avian predators also tends to attract other avian predators to the area, further increasing the predator pressure. Avian predation might have been further enhanced by the bathymetric and hydraulic attributes of the release site. Water velocity at the Columbia Siding release site typically is low and the river bottom consists of a shallow shelf with a maximum water depth of approximately 5 m to a point 150 m from shore until mid-channel, at which point depth and water velocity substantially increases (e.g., > 20 m depth and > 1.5 m/s). If fish released at this location remained in the shallows areas of the release site for an extended period of time, this would potentially result in higher levels of predation compared to a deeper release site. Pending further evidence of the effect of avian predation of brood survival, future brood release programs should consider a deeper release location located downstream of Rock Island Dam.

Summer mobile telemetry tracking identified several locations in Wanapum and Priest Rapids reservoir considered as juvenile white sturgeon rearing habitat. These locations were used by both adult and juvenile white sturgeon, that likely feed on shellfish populations present at these locations. Sand substrate was also commonly found, usually as an elevated sand lens evident in the bottom cross sectional profile in one or more of the ADCP transects. Mobile telemetry tracking was able to locate new aggregations of fish between the VR2W stations. However, due to the long interval between signals of the acoustic tags deployed (i.e., maximum of 5 minutes), detection of movement to indicate that the fish was alive could not be conclusively determined. When several other tags were also within the detection range of the receiver, determination of a fish location was even more difficult. The mobile telemetry data collected in 2012 can potentially be used to stratify the reservoirs when selecting GRTS random samples in future juvenile indexing studies.

4.5 Tag Detection Probability

Preliminary estimates of tag probability detection were calculated for VR2W receivers at RM 437.1, 442.0 and 446.9 based on putative white sturgeon spawning movements between the overwintering area at RM 426.5 and the spawning area near RM 452.4. The low tag detection probability estimate of the RM 437.1 receiver was an artifact of limited data, as the station had been recently deployed in 2012. With additional telemetry data, the accuracy of future detection probability estimates will improve. Given the small size of each reservoir, ongoing release of long-life telemetry tags in subsequent years may eventually reduce the effectiveness of the VR2W receivers situated near high-use holding and overwintering areas. As the number of tags in range of a receiver increases, the number of collisions increases as does the time to resolve an individual tag code. Eventually, relocation of these receivers to a location upstream or downstream of the overwintering and holding areas may be required to improve signal resolution. In this eventuality, although constant monitoring of acoustic-tagged fish within the overwintering area will not be possible, seasonal movements should still be detected and the overall quantity of redundant data reduced.

4.6 Juvenile Indexing

Gill net sampling failed to capture any of the 2010BY hatchery sturgeon released into the Project area in April 2011. The magnitude of the by-catch observed during the survey indicates that the nets were fished effectively, which suggests that 2010 BY juvenile sturgeon densities were lower than expected in the areas sampled in 2012.

Gill net sampling was confined to areas that were ≥ 10 m deep and where current velocities were low enough for gill nets to fish effectively. The effect of these constraints in Priest Rapids Reservoir was that sampling effort was almost exclusively limited to the downstream third of the reservoir with only one set deployed in characteristically riverine habitat (see Figure 11). While effort was more widely distributed throughout Wanapum Reservoir, riverine areas also received relatively little sampling effort (see Figure 11). The 2010 BY were released into riverine areas in close proximity to the tailraces of Rock Island and Wanapum dams and may have remained in aggregations close to their point of release. A general lack of downstream dispersal from release locations would obviously result in low densities in areas where the majority of gill net sampling occurred in 2012. Active and passive acoustic telemetry observations indicate that this may indeed be the case: while some downstream dispersal of telemetered sturgeon was documented, most fish apparently remained in the upper reaches of each reservoir where relatively little gill net sampling effort was applied. To compound matters, high levels of avian predation on hatchery releases and documented entrainment of telemetered fish out of the Project area may have reduced overall juvenile abundance to a level below that assumed during the planning stages of this pilot survey.

If juvenile hatchery sturgeon do exhibit a preference for riverine areas of the Project, then future surveys should ensure that sufficient sampling effort is applied in this habitat type. This could be achieved through a more careful stratification of sampling effort. There may also be a need to reconsider the type of gear employed in future surveys. While the small-mesh gill nets used during the 2012 pilot study are suitable for sampling small (<60 cm FL) sturgeon, they can only be fished in areas of the Project where water depth is ≥ 10 m to reduce the potential for interaction with ESA species. This restriction limits sampling opportunities in the upper reaches of both Priest Rapids and Wanapum reservoirs where the majority of juvenile hatchery sturgeon may be resident. This is particularly true for the upstream two-thirds of Priest Rapids Reservoir where habitats ≥ 10 m in depth are limited, and that which does exist, is mostly unsuitable for sampling with gill nets due to high water velocities. Consequently, it may be reasonable to consider switching to, or incorporating, alternative gears that do not require adherence to depth restrictions and which can be fished effectively in areas of appreciable water velocity. Baited set lines equipped with small circle hooks may represent a suitable alternative.

4.7 Adult Indexing

In 2012, the combined sample effort from both adult indexing sessions resulted in the capture of 313 white sturgeon (includes recaptured fish) composed of two 2010BY fish, 278 CRITFC hatchery fish, and 33 wild fish for an overall CPUE of 0.26 fish/100 hook-hours. In comparison, during the 2010 adult indexing program using systematic set line sampling, 130,640 hook-hours of effort captured 544 hatchery and 58 wild white sturgeon for an overall CPUE of 0.46 fish/100 hook-hours.

Due to the large number of 2010 marked fish recaptured in 2012, the mean white sturgeon population estimate for Wanapum Reservoir (i.e., 3,730 CRITFC fish and 505 wild fish) and Priest Rapids Reservoir (1,729 CRITFC fish and 57 wild fish) were consider better estimators than the within year estimates obtained in either 2010 or 2012. The lower overall CPUE during the 2012 adult indexing program (i.e., 0.26 fish/100 hook-hours) compared to the 2010 program CPUE (i.e., 0.46 fish/100 hook-hours) was attributed in part to a selective bias in gear placement of 2010 systematic sampling study design versus the unbiased and random GRTS study design used in 2012. In 2010, even though sample sites were selected based on mile marker locations, the exact location in the vicinity of the marker where the set line was deployed was subjective. Crews purposefully avoid deploying gear near shore in shallow water locations and typically selected locations more mid-channel and deeper, with the intention of maximizing catch at that sample location. In some locations with extensive areas of shallow water, milfoil, or high water velocity, gear was instead deployed upstream or downstream of the mile marker at the nearest ½ mile location. During the recapture session, because sampling gear was deployed roughly at the same location as the previous session, the probability of recapture a fish previously caught in the first session was also potentially biased. In 2012, randomization of sample sites using the GRTS approach in both mark and recapture sessions removed known and unknown sample bias associated with the collection effort. However, the number of inter-session recaptures was too low to calculate in-year population estimates, which suggests that additional sample effort, possibly calculated by a power estimate, should be considered when conducting future GRTS sampling.

Differences in set line orientation between the 2010 and 2012 studies may have affected CPUE. In 2010, set lines were deployed perpendicular to flow. A perpendicular orientation allowed deployment of hooks over a greater depth range between mid-channel and the adjacent bank, which increased the chance that more hooks would be deployed in deeper water near mid-channel. The scent trail of the baited hooks also was distributed over a wide section of the river, increasing the chance a fish downstream may detect the bait and swim upstream to investigate. However, perpendicular sets were only possible in lower velocity locations; most set lines deployed in higher velocity locations tended to end up parallel with the direction of flow. The difference in set line orientation in 2010 may have affected catch efficiency and the resultant CPUE. In 2012, all set lines were set parallel with flow to ensure all set lines had similar catch efficiencies. The consequence was that if the site started in shallow water, all the hooks were usually set shallow. The scent trail of the baited hooks was also confined to a narrow portion of the river, potentially only readily detectable by fish directly downstream of the set line.

Use of barbless circle hooks during the 2012 and all previous index studies likely has resulted in lower CPUE. General observations during set line sampling documented that more white sturgeon were captured on hooks positioned closer to either anchors than hooks on the middle of the set line. Although not quantified (e.g., by recording hook position on the set line when a fish was caught), the apparent difference in catch rate among hooks may have been due to differences in tension applied to the hook depending how close to either anchor the hook was located. Hooks near the anchors may set better when taken by a fish. The anchor also likely creates resistance and keeps tension on the hook and is retained by the fish. However, when a fish take a barbless hook in the center of the set line, some distance from the anchor, the amount of tension on the hook maybe less, with the result that the barbless hook may rotate and fall out when not under tension. Although the ease of which barbless hooks are removed is a benefit during fish processing, use of barbed hooks during future adult indexing programs should considered in an effort to increase CPUE.

5.0 BIOLOGICAL OBJECTIVES STATUS REPORT

Included in Water Quality Certification for operation of the Project, Grant PUD was required, in consultation with the PRFF, to develop and implement a white sturgeon Management Plan (WSMP) within one year after the issuance of the FERC license for the Project. The WSMP was developed in 2009 (Grant PUD 2009); Specific Biological Objectives of the WSMP are as follows:

1) Spawning and rearing in Project area: Natural reproduction potential reached via natural recruitment.
2) Spawning, rearing, and harvest in Project reservoirs: Increase the white sturgeon population in the Project reservoirs to a level commensurate with available habitat.
3) Adult and juvenile upstream and downstream migration: Provide safe, effective, and timely volitional passage, if reasonable and feasible passage means are developed.
4) Until reasonable and feasible means for re-establishing natural production and providing support for migration are available, and recognizing that those means appear unlikely in the foreseeable future, the Biological Objective is to sustain a population at a level commensurate with available habitat through implementation of a white sturgeon supplementation program in the Project reservoirs. The supplementation program will

provide an initial foundation for the Monitoring and Evaluation (M&E) Program, which is designed to a) identify existing impediments to achieving the Biological Objectives, b) sustain the populations until the existing impediments can be corrected, and c) mitigate for population losses due to Project impacts.

5) The goal of the WSMP is to: (1) identify and address Project effects on white sturgeon and, (2) develop and implement "Implementation Measures" designed to avoid and mitigate for Project effects of white sturgeon. Adaptive management shall be applied to resolve critical uncertainties. In addition, the following tasks consistent with achieving the Biological Objectives incorporated into the WSMP are:

    Task 1: Determine the effectiveness of the supplementation program in creating a sustainable white sturgeon population in the Project reservoirs based on natural production potential and adjust the supplementation program accordingly.

    Task 2: Determine the carrying capacity of available white sturgeon habitat in each reservoir.

    Task 3: Participate and cooperate in the development of any regional white sturgeon management effort initiated for the purpose of addressing flow fluctuation effects on the Hanford Reach white sturgeon population as a result of Project operations. If questions arise as to the appropriate level of participation and cooperation, Grant PUD shall request clarification from the Washington Department of Ecology.

    Task 4: Determine juvenile downstream passage rates and survival.

The WSMP identified six Protection, Mitigation, and Enhancement measures (PMEs) to be implemented by Grant PUD to achieve the Biological Objectives of the WSMP. The following section lists these PMEs, describes progress-to-date in their implementation, and identifies where modifications from the proposed WSMP study program and schedule have occurred. These modifications were made in consultation with the PRFF as part of the adaptive management approach described in the WSMP.

1) **Prepare a brood stock collection and breeding plan within year one of the effective date of the New License and, if feasible, begin brood stock collection in year two of the New License.**

An aquaculture plan that included program goals, population models, genetic considerations and hatchery practices was developed in 2009) and was included in the WSMP (Grant PUD 2009). Since that time, the PRFF has met several times annually to plan breeding and broodstock collection, including modifications to the program, and coordinate broodstock collection and juvenile release efforts. Broodstock collection began in 2010 and was continued in 2011 and 2012 to assess the feasibility of collecting brood stock from within the Project area. Results from brood stock collection are described in WSMP annual reports prepared since 2010.

Broodstock collection efforts in 2010, 2011, and 2012 have involved several different capture methods and locations within and outside the Project area, by several different groups including consultants, tribes, fishing guides, Chelan PUD and Grant PUD. Despite these considerable efforts, the number of broodstock captured and available for hatchery spawning has not yet met breeding design goals described in the WSMP in all years and this has impacted the ability to achieve the desired genetic diversity and stocking level targets (see Section 5.2 of WSMP). For this reason, alternative and additional methods of aquaculture supplementation are being considered and the PRFF is investigating the feasibility of collecting wild white sturgeon larvae using D-ring drift nets and raising these larvae at a hatchery facility until large enough to release in the Project area (Appendix D, WSMP Study Plan and Schedule). Previous PRFF discussions related to alternative or additional methods of supplementation can be reviewed at www.grantpud2.org/rc/PRFF.htm. A pilot larval collection program to assess the feasibility of this program as a means to supplement the broodstock collection program is scheduled for initiation in 2013 below the known white sturgeon spawning area downstream from Rock Island Dam. This additional method for aquaculture supplementation is discussed further in the recommendations section (Section 4.1) and would be discussed with and approved by the PRFF and relevant regulatory agencies before implementing a pilot study.

2) **Implement a white sturgeon supplementation program by releasing up to 5,000 yearling white sturgeon into the Wanapum Reservoir each year and 1,500 yearling white sturgeon into the Priest Rapids Reservoir annually for Years 3 through 7 of the M&E program, with subsequent annual release levels to be determined by the PRFF, based on monitoring results.**

Yearling hatchery-raised white sturgeon were first released into the Project area reservoirs in 2011. Based on the results of broodstock collection in 2010 to 2012, the PRFF have implemented changes in the breeding design and numbers of hatchery juveniles released compared to what was proposed in the WSMP (Grant PUD 2009). The hatchery breeding plan in the WSMP targets two 3x3 full factorial crosses, which would require 12 adult broodstock. In the first year of broodstock collection in 2010, only one female and two male broodstock were captured and spawned, despite a considerable amount of sampling effort by staff from Golder, Grant PUD, and the Yakama Nation. In 2011, only one female and one male were captured and successfully spawned. Based on these results the PRFF reconsidered the likelihood of capturing 12 brood stock from the Project area or adjacent reservoirs and amended the breeding plan in the hopes of achieving one 3x3 partial factorial mating design (PRFF 2011). In 2012, one female and four males were captured in the Project area and successfully spawned, which produced a 4x1 cross. In addition, three females and one male were captured downstream of the Project area in John Day Reservoir and spawned at the Marion Drain Hatchery to produce a 3x1 cross. This has resulted in a total of seven half-sib families that are presently being raised at MDH and CBH for release into the Project area in 2013.

Due to difficulties in obtaining sufficient numbers of broodstock, the actual number of hatchery white sturgeon released in 2011 and 2012 also has required modification from the 6,500 fish target identified in the WSMP. These changes have been made by the PRFF based on recommendations from specialists in white sturgeon hatchery management and genetics. In 2011, only two families were produced from wild broodstock caught in the Project area in 2010. To supplement the numbers released from the local wild stock, additional hatchery juveniles were sourced from the Upper Columbia River in Canada and from captive broodstock at the MDH for release in the Project area. In total, 9,117 juveniles were released into the Project area in 2010, of which 2,627 were from Upper Columbia River broodstock raised at Kootenay Trout and Sturgeon Hatchery in British Columbia, 2600 were from 2nd generation hatchery cultured broodstock originating from the Lower Columbia River (below Bonneville Dam), and 3,896 were from the two crosses of mid-Columbia broodstock caught in the Project area. The change in the number and origin of juveniles released in 2011 compared to what was proposed in the

WSMP was agreed on by PRFF and is consistent with an adaptive management approach. This release was designed as an experimental program to assess potential movement patterns and retention rates among the three release groups as a means to determine if any differences observed could be used as a future guide to selection of broodstock or progeny. The initial results of the experimental program indicated there were observable differences in post-stocking movements among the three groups. The LCC group exhibited the greatest tendency to move downstream and out of the study area which suggests that in the future, use of progeny from broodstock in the lower Columbia River should not be used (or only used as a last resort) for supplementation in the Project area.

The results from the 2011 experimental stocking program also identified the potential for significant levels of juvenile sturgeon post-release mortality due to avian predation. This finding has resulted in modification of the 2013 release plan to incorporate an experimental release design that will compare juvenile survival of fish released in Wanapum Reservoir at the 2010 release location (i.e., released from the shore in a relatively shallow area) with fish released further downstream (i.e., released in the thalweg in a much deeper area).

In 2011, only one, half-sibling family was produced compared to the target of nine families that would be produced by a 3x3 factorial cross. Therefore, the number of 201BY selected for release in 2012 was 722 fish (i.e., one-ninth of the 6,500 fish target). The smaller release number was intended to allow genetic representation by this family while avoiding genetic swamping that could occur by releasing larger numbers of fish from the same family. However, due to slow growth of the fish and histological tests that indicated the presence of disease (see Section 3.2), the PRFF and regulatory agencies decided not to release the 2011BY in 2012.

In the spring of 2013, 2012BY juveniles from seven half-sib families will potentially be available for release into the Project area. The numbers of fish released from each family group have yet to be determined by the PRFF and will depend on the size and health of the fish in April 2013. All juveniles released in 2013 will be wild stock, either from the Project area or from the mid-Columbia downstream of the Project area, which meets the preferred options for broodstock according to the WSMP.

3) Design and implement a long-term juvenile index monitoring program over the term of the New License to monitor age-class structure, survival rates, growth rates, distribution, and habitat selection of juvenile sturgeon.

The first year of the juvenile indexing program was conducted in 2012 as a pilot study to 1) assess the effectiveness of gill nets as a capture method and 2) provide a preliminary population estimate of the 2010BY hatchery juveniles. The juvenile indexing pilot study was initially scheduled in the WSMP for 2011 but was re-scheduled by the PRFF for 2012 due to the limited juvenile supplementation which was expected to have occurred prior to the initial indexing pilot program.

Results of the 2012 pilot study were disappointing in terms of the number of juveniles captured (1 fish) but factors such as high avian predation rates, potential habitat selection by juveniles in higher velocity habitats not suited to sampling by gill net, or documented juvenile emigration out of the Project area likely reduced the number of juveniles available for capture. Additional details of the program are provided in the present report (Section 4.6). Juvenile indexing is not planned in 2013 (see proposed 2013 Study Plan in Appendix D) but may be conducted again in 2014 if considered warranted by the PRFF.

In addition to the juvenile population indexing component of the WSMP, information regarding the distribution and habitat selection of juvenile white sturgeon has been and is continuing to be collected as part of the telemetry study program that uses a combination of mobile tracking and stationary receivers to identify movements to and locations of juvenile feeding and overwintering habitats. Once these habitats are identified, assessments using underwater videography and ADCP (see Section 3.9) will be used to quantify important habitat characteristics. Juvenile movement (telemetry) and habitat assessment studies were conducted in 2011 and 2012 and are scheduled to continue in 2013 and 2014.

4) **As part of the supplementation program, conduct tracking surveys of juvenile white sturgeon released with active tags to determine emigration rates and passage survival from the Priest Rapids Project area.**

Tracking of juvenile white sturgeon movements and emigration rates using mobile and stationary telemetry receivers was conducted in 2011 and 2012 and is proposed again in 2013. These studies assessed the movements of 201BY hatchery releases and also assessed differences in the three release groups of different broodstock origin. Results to date indicate that a portion of acoustic-tagged fish (7 of 91 tags or 7.7%) did emigrate out of the reservoir where they were stocked (either by entrainment or volitional movement). This program is scheduled to continue for the foreseeable future and the data obtained will be used to adjust future stocking levels in the Project area.

5) **Compile information on other white sturgeon supplementation programs in the region.**

Information regarding white sturgeon supplementation from other parts of the Columbia River watershed was reviewed extensively and used in developing the WSMP for the Project area (Grant PUD 2009). This included information from white sturgeon recovery programs in the upper Columbia River, the Kootenai River, and Nechako River as well as the mid-Columbia River sturgeon recovery programs being conducted by Chelan and Douglas County PUDs. Further, the PRFF meets monthly to share information and plan white sturgeon monitoring program, and consults specialists and experts outside the group when necessary. Compiled white sturgeon supplementation data is included in the WSMP and is also discussed as needed in the annual data reports.

6) **Use the information collected above to direct and modify the supplementation program strategy.**

As discussed above, several modifications to the original objectives of the WSMP and the proposed M&E programs have been required based on results of the first few years of the recovery program and information learned from other white sturgeon supplementation programs. These modifications have been approved by the PRFF and reflect the adaptive management approach that is a vital part of the WSMP. Information from the M&E programs and other recovery programs will continue to be incorporated into the overall management framework of the WSMP.

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Appendix A
Additional data from white sturgeon broodstock collection in Priest Rapids and Wanapum reservoirs, 2012

Table A1. Summary of capture, life-history and tagging information for all white sturgeon caught by set line during broodstock capture in 2012. Origin was wild (W) or hatchery (H). See Table 2 for definitions of Sex / Maturity codes.

Reservoir	Site	Date	Origin	Fork Length (cm)	Weight (kg)	Sex / Maturity	PIT-tag#
Wanapum	BS452.7R	19-Jun-12	W	199.5	74.8	30	985120017142964
Wanapum	BS451.7R	23-Jun-12	W	199.0	84.4	F3	985120017148889
Wanapum	BS452.6R	17-Jun-12	W	155.0	35.8	98	985120017169283
Wanapum	BS451.7R	23-Jun-12	W	134.0	16.5	98	985120017184741
Wanapum	BS451.8R	16-Jun-12	W	241.5	132.0	F3	985120017812453
Wanapum	BS451.7R	26-Jun-12	W	160.5	36.7	M1	985120017822058
Wanapum	BS443.1L	16-Jun-12	H	114.0		98	985120018347661
Wanapum	BS451.0R	24-Jun-12	W	175.5	46.7	M1	985120018650093
Wanapum	BS442.9L	16-Jun-12	W	156.0	33.1	98	985120018654580
Wanapum	BS442.9L	16-Jun-12	H	109.0		98	985120019335390
Wanapum	BS451.8R	22-Jun-12	H	115.0	11.8	98	985120019348911
Wanapum	BS442.9L	16-Jun-12	H	124.5		98	985120019368987
Wanapum	BS452.6R	16-Jun-12	H	127.5		98	985120019385394
Wanapum	BS451.0R	24-Jun-12	H	82.0	3.6	98	985120019391246
Wanapum	BS450.0L	24-Jun-12	H	110.0	12.0	98	985120019394944
Wanapum	BS451.8R	25-Jun-12	H	115.0	11.8	98	985120019410844
Wanapum	BS450.0L	24-Jun-12	H	121.5	15.4	98	985120019411063
Wanapum	BS452.7R	25-Jun-12	H	119.0	17.2	98	985120019414264
Wanapum	BS443.1L	16-Jun-12	H	131.5		98	985120019432338
Wanapum	BS452.6R	16-Jun-12	H	131.0		98	985120019435155
Wanapum	BS443.1L	16-Jun-12	H	122.5		98	985120019437741
Wanapum	BS451.8R	16-Jun-12	H	106.0		98	985120019460680
Wanapum	BS451.7R	28-Jun-12	H	134.0	0.0	98	985120019462990
Wanapum	BS452.7R	27-Jun-12	H	120.6	15.8	98	985120019463906

Wanapum	BS443.1L	16-Jun-12	H	106.0		98	985120019472231
Wanapum	BS451.8R	22-Jun-12	H	134.5	20.9	98	985120019472826
Wanapum	BS451.0R	16-Jun-12	H	133.5		98	985120019508122
Wanapum	BS452.7R	24-Jun-12	H	93.0		98	985120019528357
Wanapum	BS452.7R	25-Jun-12	W	186.0	61.7	M1	985120020900896
Wanapum	BS452.6R	16-Jun-12	W	174.5	48.5	M1	985120020920649
Wanapum	BS451.8R	21-Jun-12	W	120.0	13.5	98	985120021441242
Wanapum	BS451.0R	25-Jun-12	H	68.5	2.2	98	985120021599940
Wanapum	BS452.7R	28-Jun-12	W	236.5	136.1	F6	985120021740441
Wanapum	BS443.1L	16-Jun-12	H	103.0		98	985120021745806
Wanapum	BS452.7R	25-Jun-12	W	149.0	27.7	30	985120021761892
Wanapum	BS451.2M	19-Jun-12	W	199.5	69.4	M2	985120021770455
Wanapum	BS452.7R	21-Jun-12	W	234.5	145.0	F5	985120021771735
Wanapum	BS452.7R	21-Jun-12	W	163.0	37.6	M1	985120021778097
Wanapum	BS451.2M	19-Jun-12	W	184.0	48.1	M2	985120021791545
Wanapum	BS452.6R	17-Jun-12	W	175.0	53.1	M1	985120021807388
Wanapum	BS442.0L	16-Jun-12	H	80.0		98	985120021813775
Wanapum	BS452.6R	16-Jun-12	H	131.0		98	985120025263721
Wanapum	BS443.1L	16-Jun-12	H	96.5		98	985120025274477
Wanapum	BS442.9L	16-Jun-12	H	97.5		98	985120025314728
Wanapum	BS443.1L	16-Jun-12	H	130.0		98	985121021160788
Wanapum	BS452.7R	24-Jun-12	W	205.0	81.2	M2	42033F7126
Wanapum	BS451.8R	19-Jun-12	W	175.5	43.0	M1	420401477D

Appendix B
2011 Hatchery 2010BY Juvenile Release Data

Table B1 Yakima Hation Marion Drain Hatchery (MDH) and the FFSBC Kootenay Trout Hatchery (KTH) juvenile White Sturgeon 2010BY Release Numbers.

MDH Release	**Project Area**	**Priest Rapids Reservoir**	**Wanapum Reservoir**
PIT Only			
Lower Columbia Cultured (LCC)	2574	594	1980
Middle Columbia Wild (MCW)	3857	891	2966
Total PIT	6431	1485	4946
PIT/Acoustic Tagged fish			
Lower Columbia Cultured (LCC)	26	6	20
Middle Columbia Wild (MCW)	39	9	30
Total PIT/Acoustic Tagged fish	65	15	50
Total Release	6496	1500	4996
KTH Release	**Project Area**	**Priest Rapids Reservoir**	**Wanapum Reservoir**
Upper Columbia Wild (UCW) PIT-tagged Only	2595	595	2000
UCW Total PIT/Acoustic Tagged fish	26	6	20
Total Release	2621	601	2020
Total 2010BY Release	**Project Area**	**Priest Rapids Reservoir**	**Wanapum Reservoir**
Total PIT tagged Only	9026	2080	6946
Total PIT/Acoustic Tagged fish	91	21	70
Total Release	9117[a]	2101	7016

[a] Original 2011 total was 9123. This value was too high by 6 PIT-tagged fish; 3 extra KTH fish in Priest Rapids Reservoir, 3 extra fish in Wanapum Reservoir

Appendix C
Juvenile white sturgeon ADCP Habitat Assessment July-August 2012

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LEGEND

— ADCP TRANSECT

☐ FIGURE EXTENTS

0 5 10 15

SCALE 1:400,000 KILOMETRES

REFERENCE

1) Base image from Bing Maps for ArcGIS published by Microsoft Corporation (2009).

Datum: NAD83 Projection: UTM Zone 10

PROJECT

WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE

ADCP TRANSECTS AND PROFILES OVERVIEW

Golder Associates

PROJECT		12-3930-0302	FILE No.	
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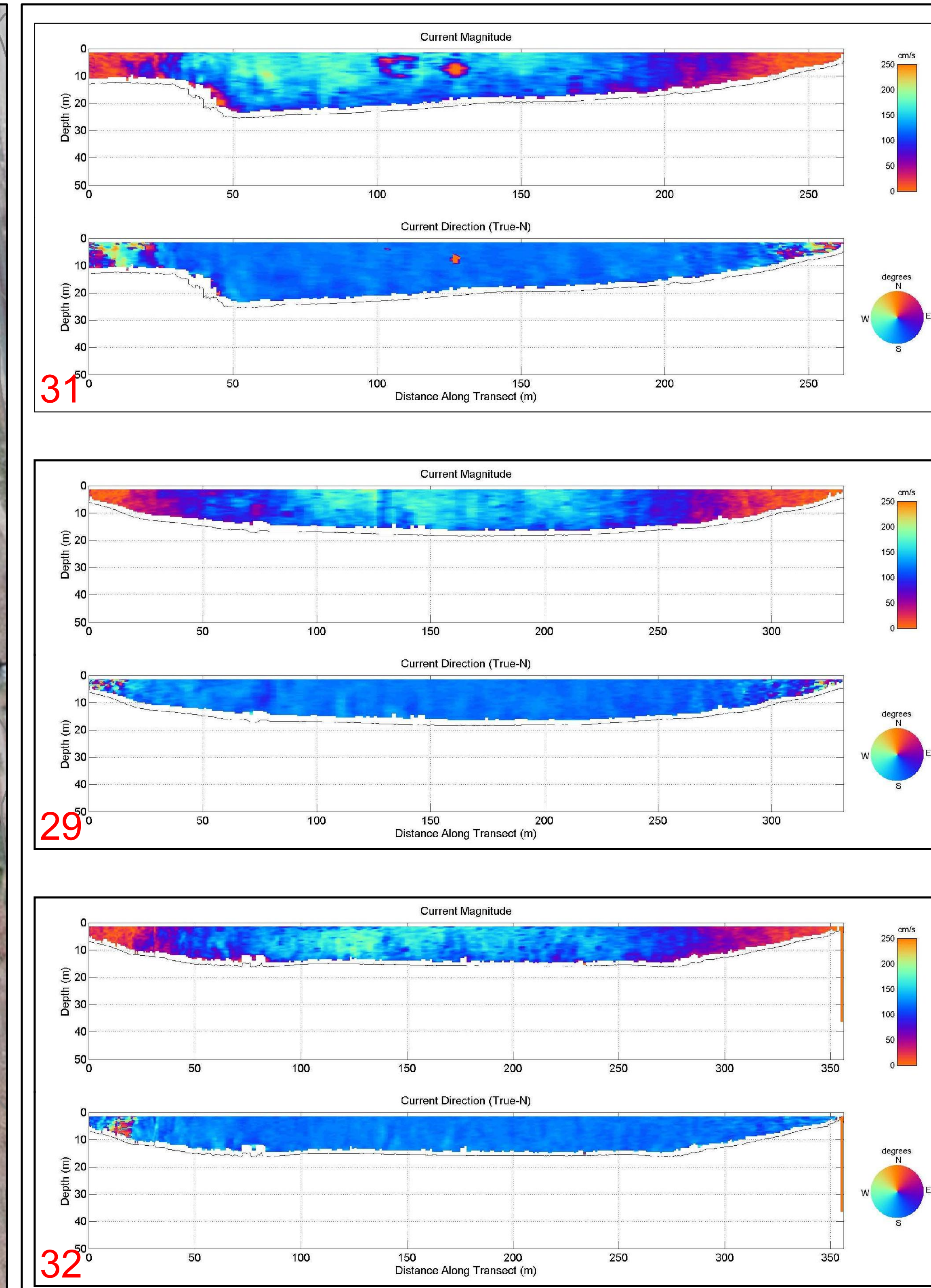

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ADCP Transect

5m Contour

REFERENCE

Baselayer: Image courtesy of USGS © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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PROJECT
WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER
WASHINGTON, U.S.A.

TITLE
ADCP TRANSECTS AND PROFILES
AUGUST 3, 2012

Golder Associates
Castlegar, BC

PROJECT No. 12-3930-0302			SCALE AS SHOWN	REV. 0
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GIS	CD	24 JAN. 2013		
CHECK	PG	15 MAR. 2013	FIGURE 2	
REVIEW	LH	15 MAR. 2013		

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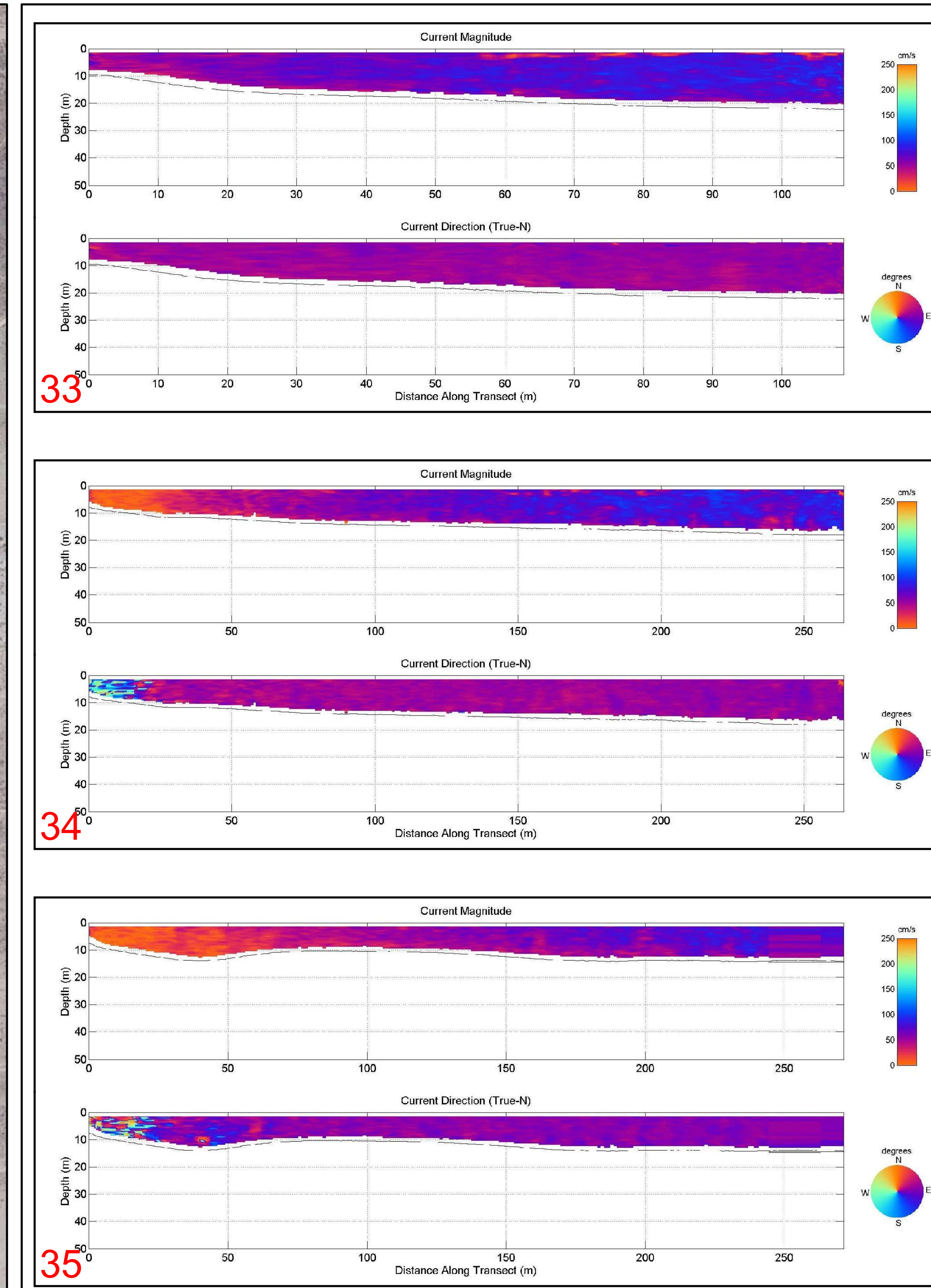

LEGEND

- ADCP Transect
- 5m Contour

REFERENCE

Baselayer: Image courtesy of USGS © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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PROJECT

WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE

ADCP TRANSECTS AND PROFILES AUGUST 3, 2012

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GIS	CD	24 JAN. 2013		
CHECK	PG	15 MAR. 2013		
REVIEW	LH	15 MAR. 2013		

FIGURE 3

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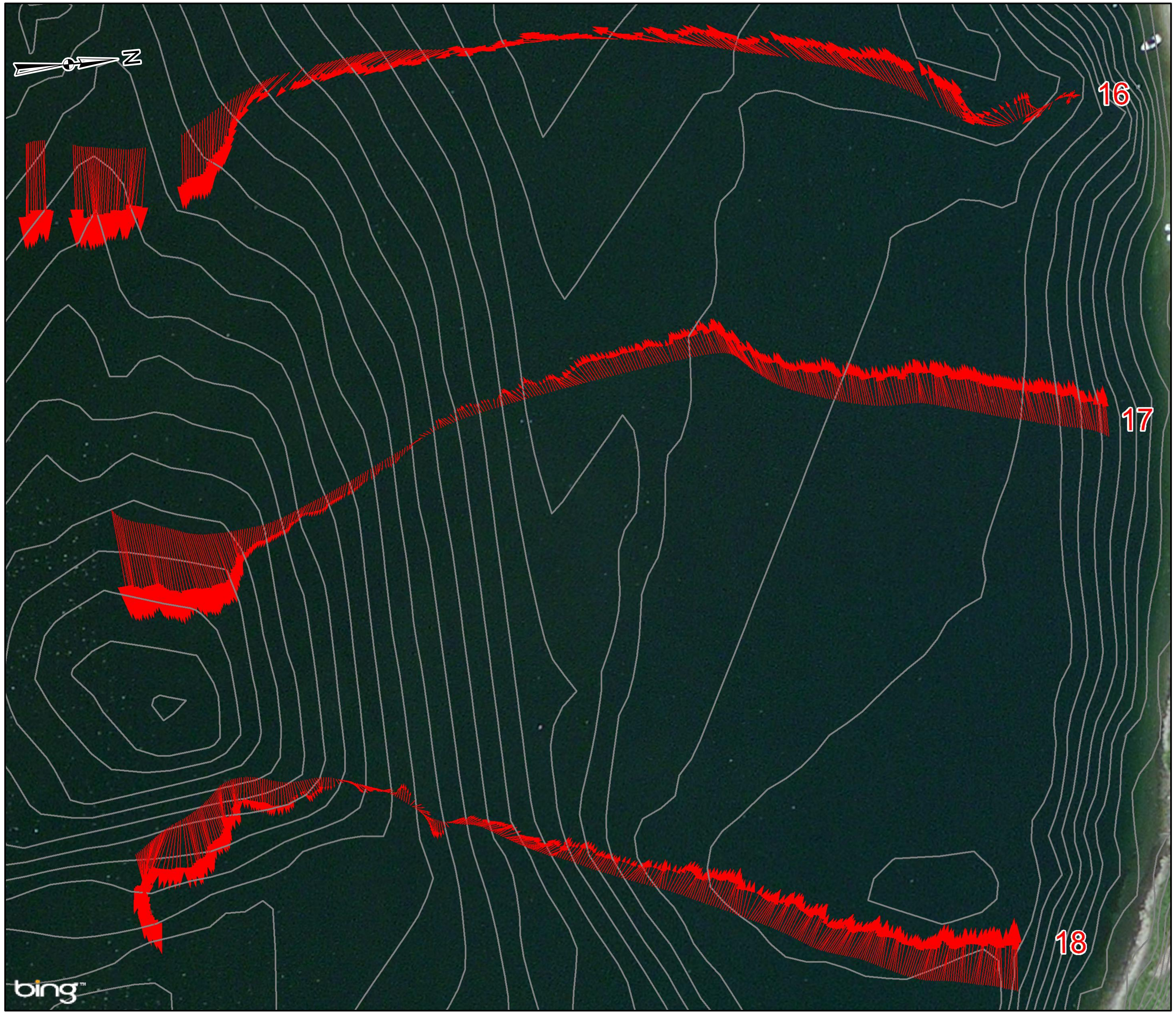

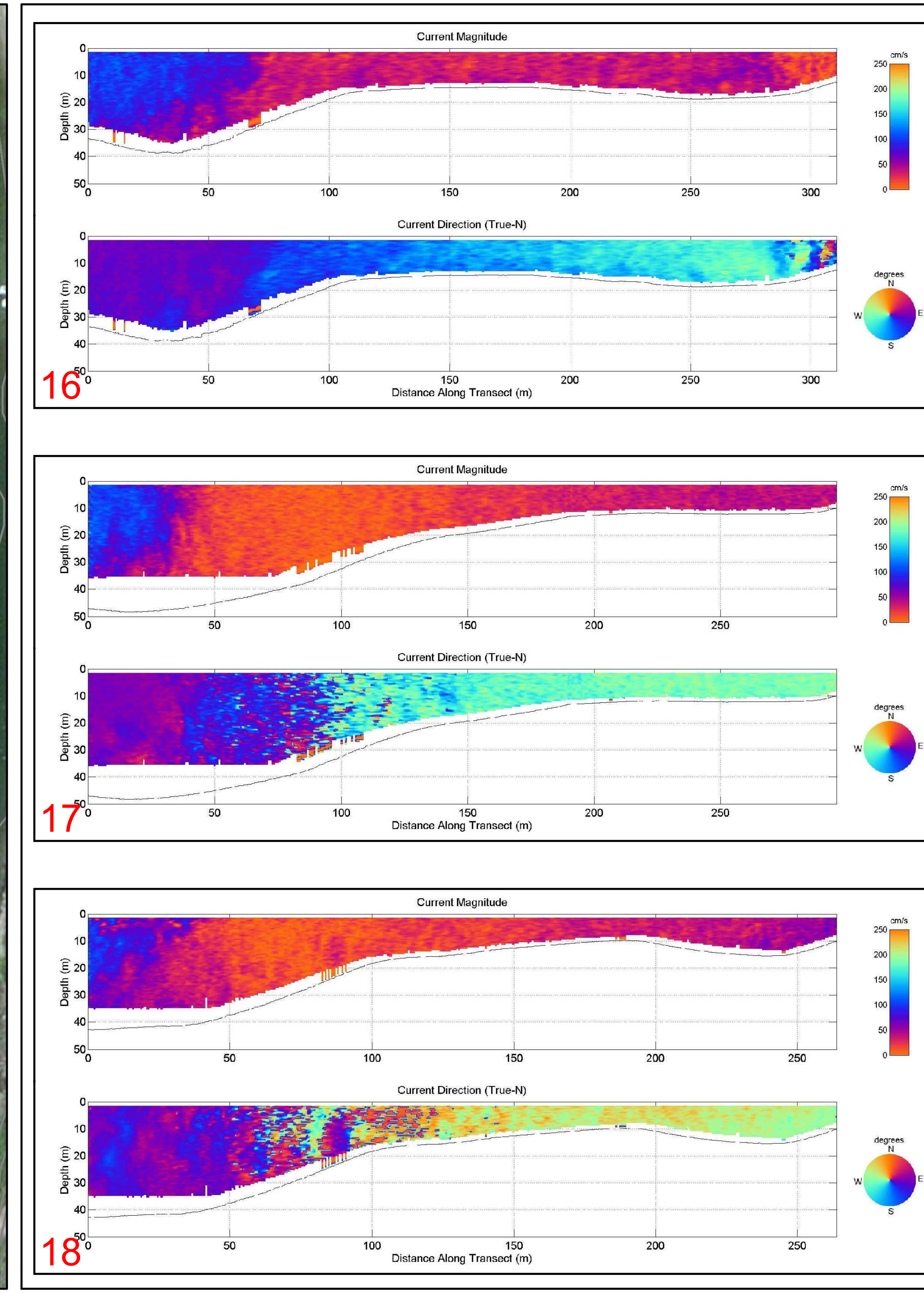

LEGEND

ADCP Transect

5m Contour

REFERENCE

Baselayer: © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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PROJECT

WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

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ADCP TRANSECTS AND PROFILES AUGUST 3, 2012

Golder Associates
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PROJECT No. 12-3930-0302			SCALE AS SHOWN	REV. 0
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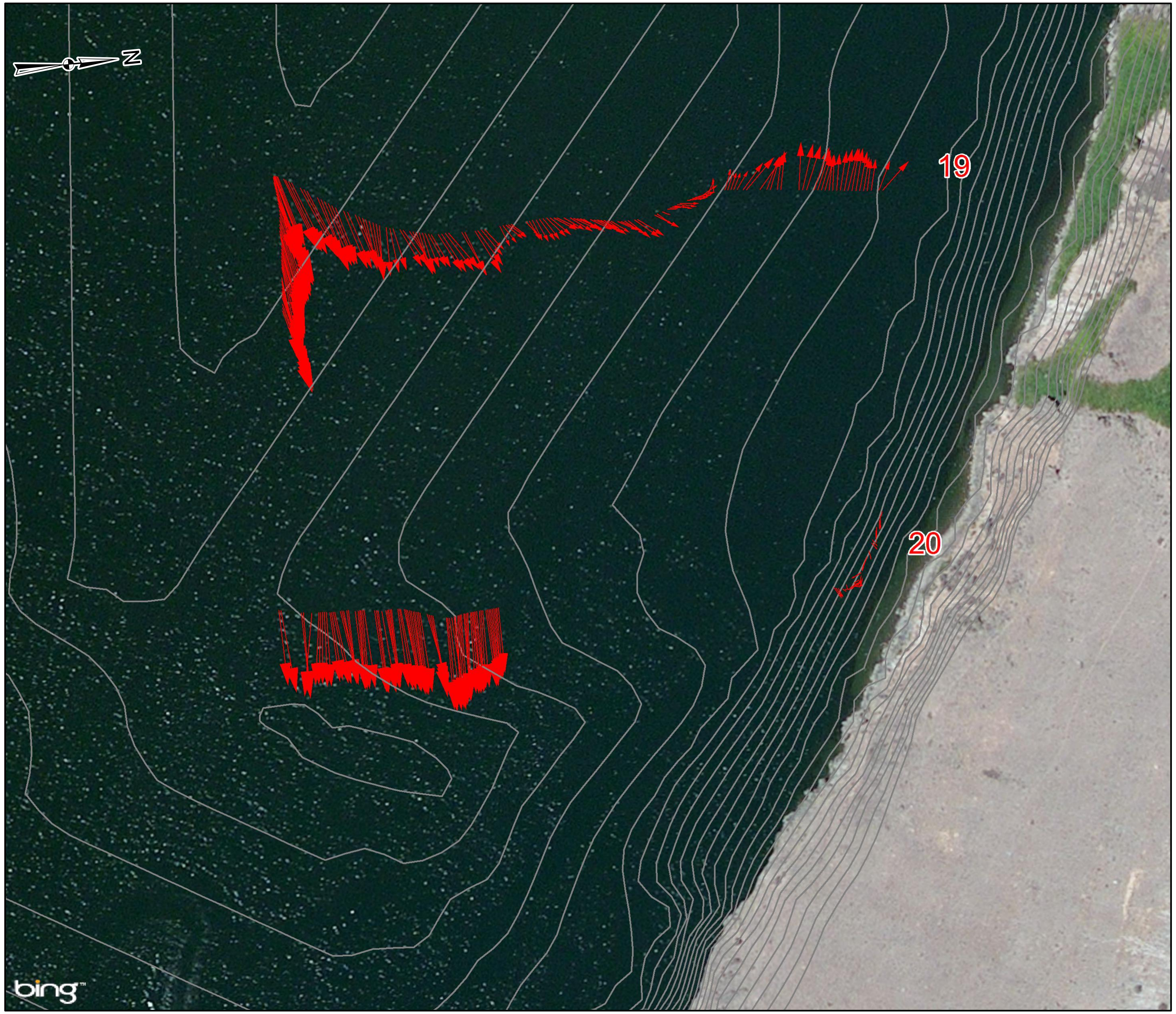

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ADCP Transect

5m Contour

REFERENCE

Baselayer: © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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PROJECT
WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE
ADCP TRANSECTS AND PROFILES AUGUST 3, 2012

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Castlegar, BC

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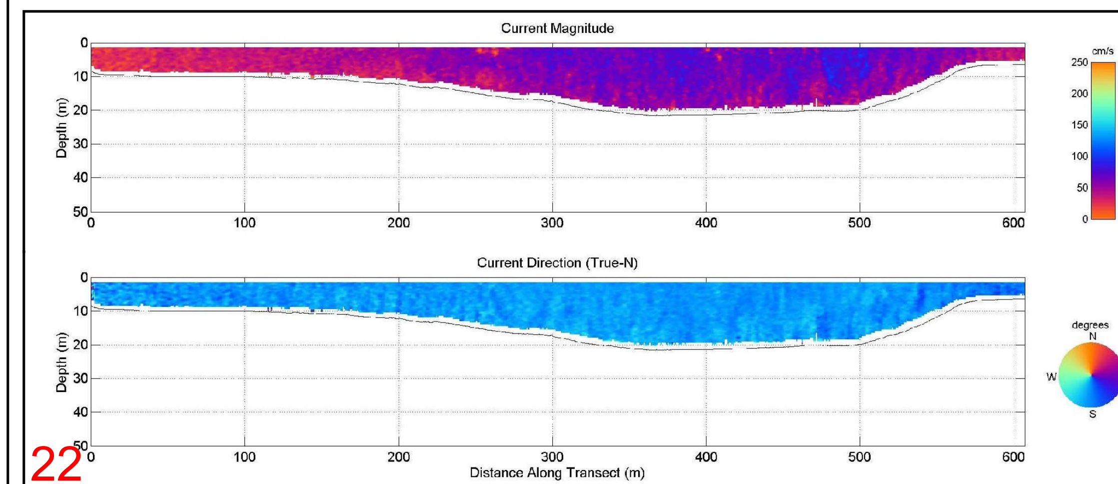

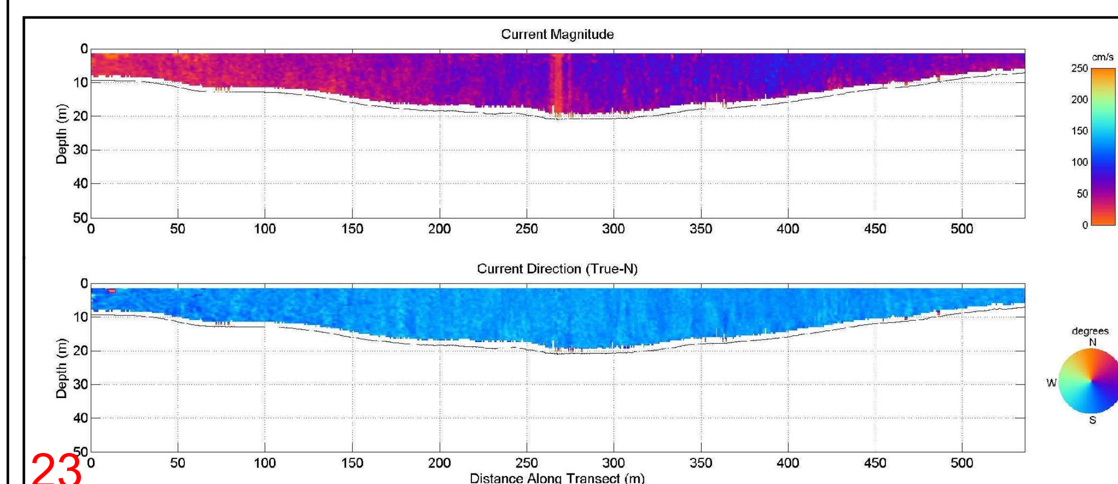

LEGEND

- ADCP Transect
- 5m Contour

REFERENCE

Baselayer: Image courtesy of USGS © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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SCALE 1:3,000 METRES

PROJECT

WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE

ADCP TRANSECTS AND PROFILES AUGUST 3, 2012

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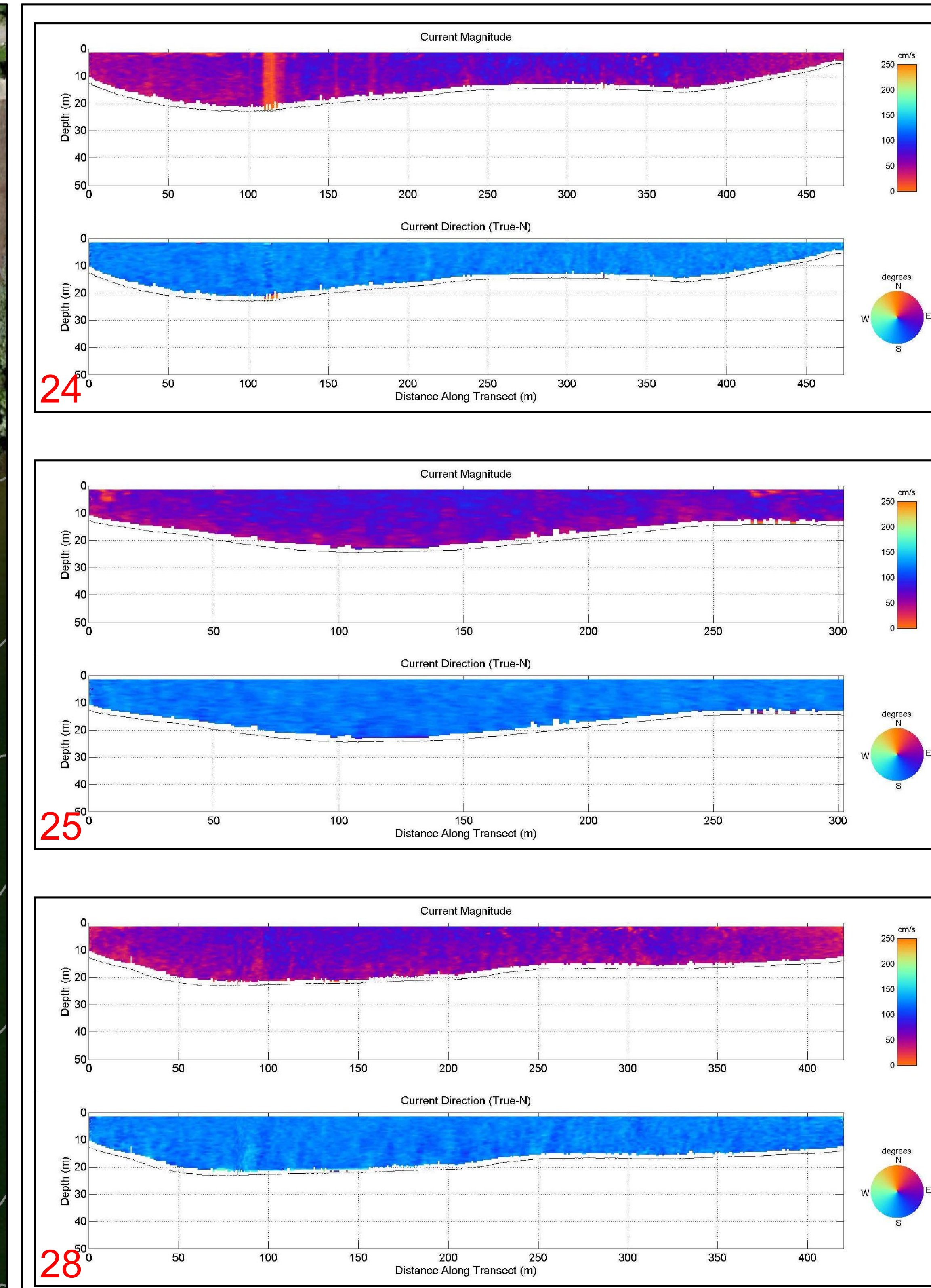

LEGEND

- ADCP Transect
- 5m Contour

REFERENCE

Baselayer: Image courtesy of USGS © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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SCALE 1:4,000 METRES

PROJECT
WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE
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PROJECT No. 12-3930-0302			SCALE AS SHOWN	REV. 0
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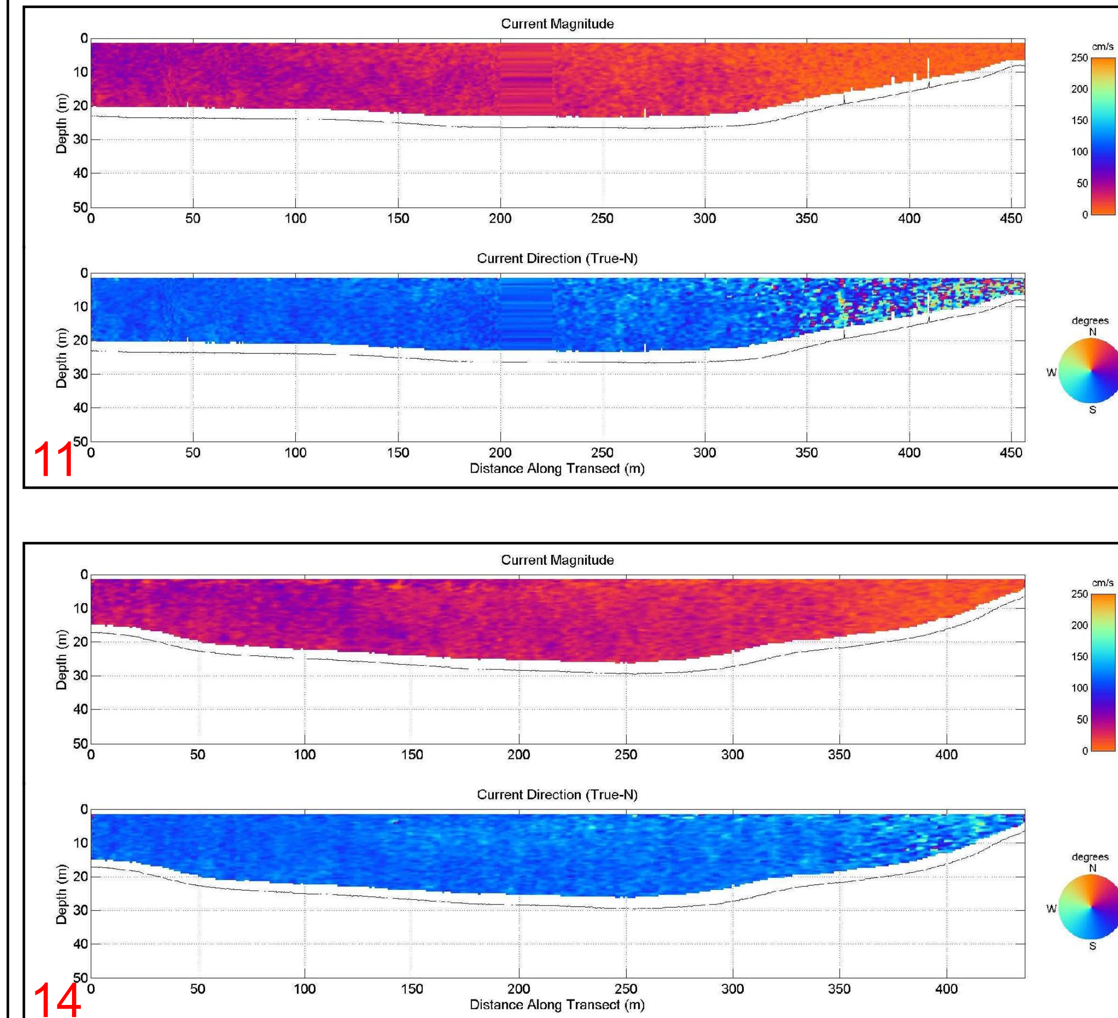

LEGEND

- ADCP Transect
- 5m Contour

REFERENCE

Baselayer: Image courtesy of USGS © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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SCALE 1:2,500 METRES

PROJECT
WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER
WASHINGTON, U.S.A.

TITLE
ADCP TRANSECTS AND PROFILES
AUGUST 2, 2012

Golder Associates
Castlegar, BC

PROJECT No. 12-3930-0302			SCALE AS SHOWN	REV. 0
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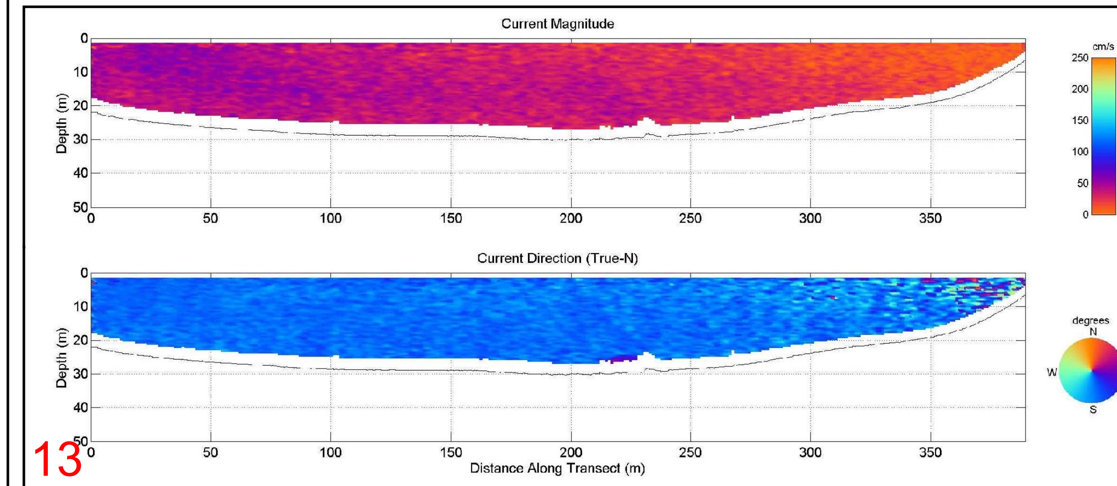

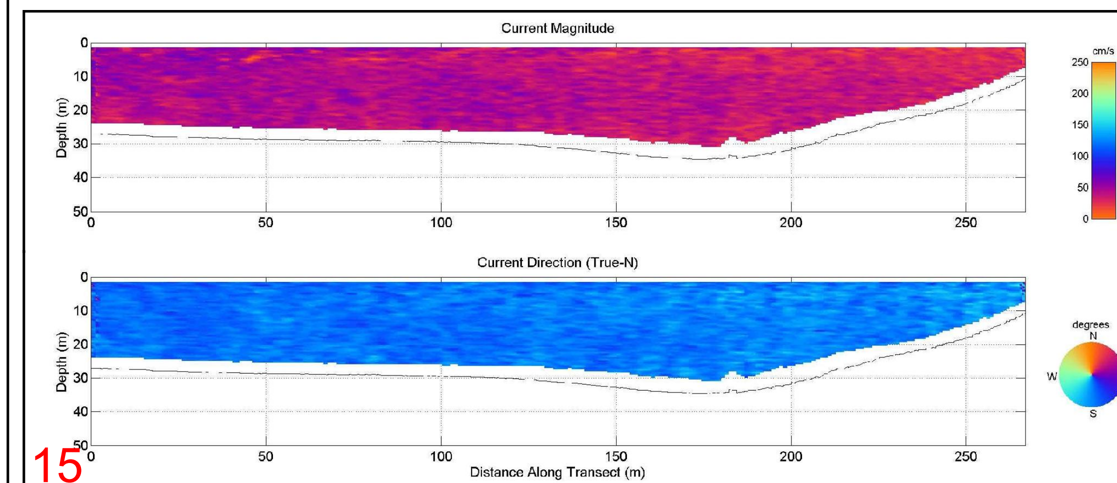

LEGEND

- ADCP Transect
- 5m Contour

REFERENCE

Baselayer: © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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SCALE 1:2,000 METRES

PROJECT
WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE
ADCP TRANSECTS AND PROFILES AUGUST 2, 2012

Golder Associates
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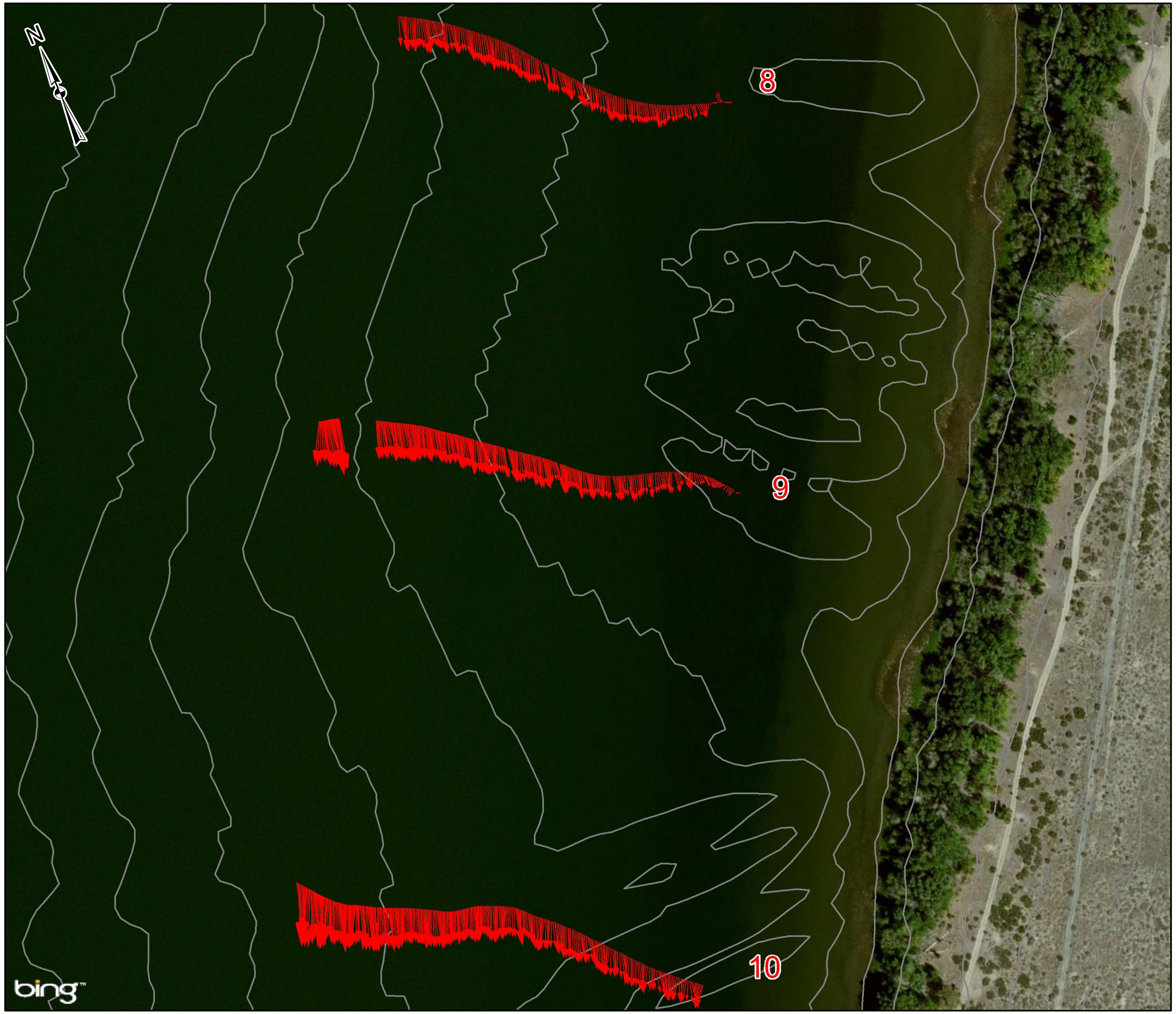

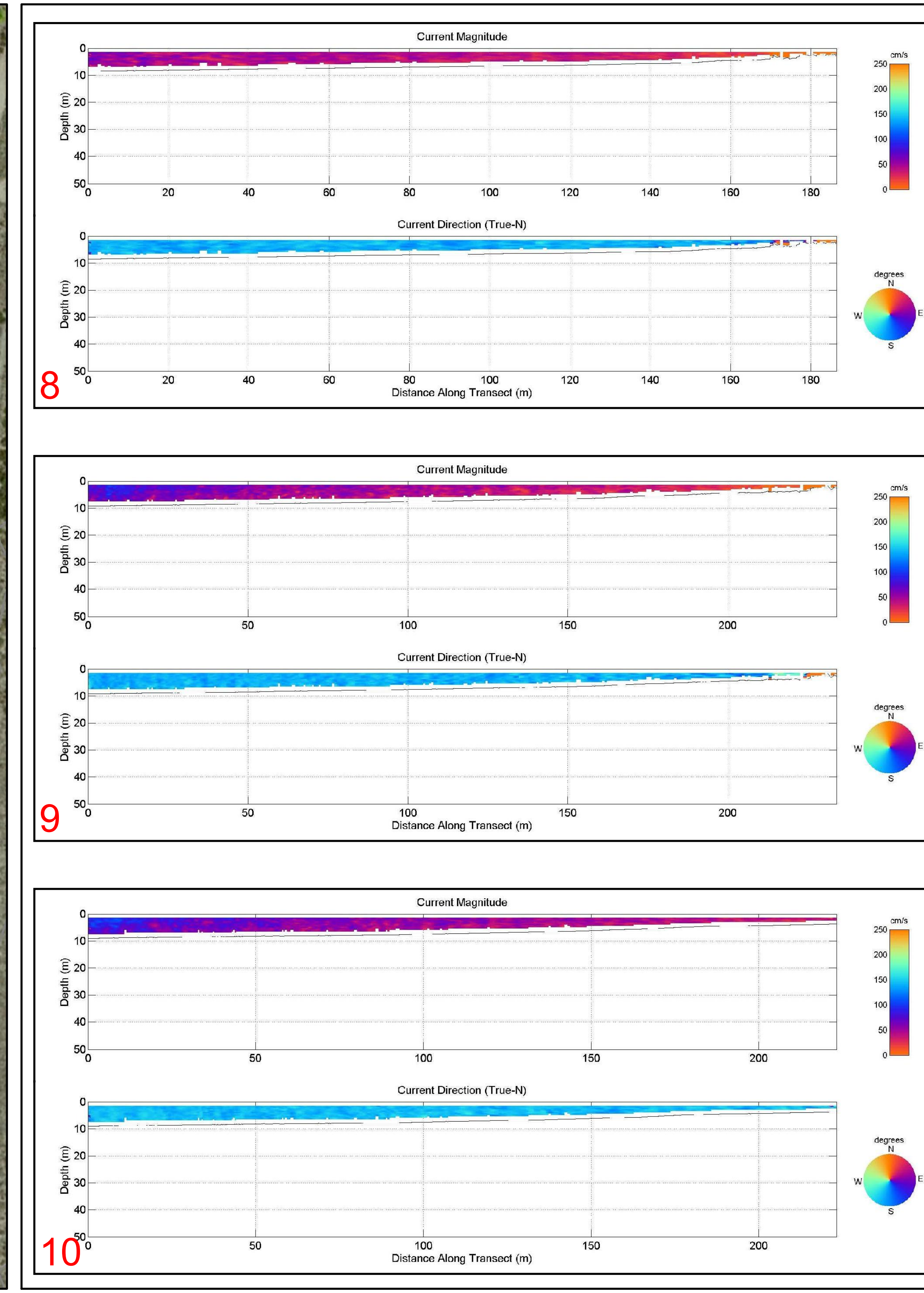

LEGEND

- ADCP Transect
- 5m Contour

REFERENCE

Baselayer: Image courtesy of USGS © 2013 Microsoft Corporation

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WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE
ADCP TRANSECTS AND PROFILES AUGUST 2, 2012

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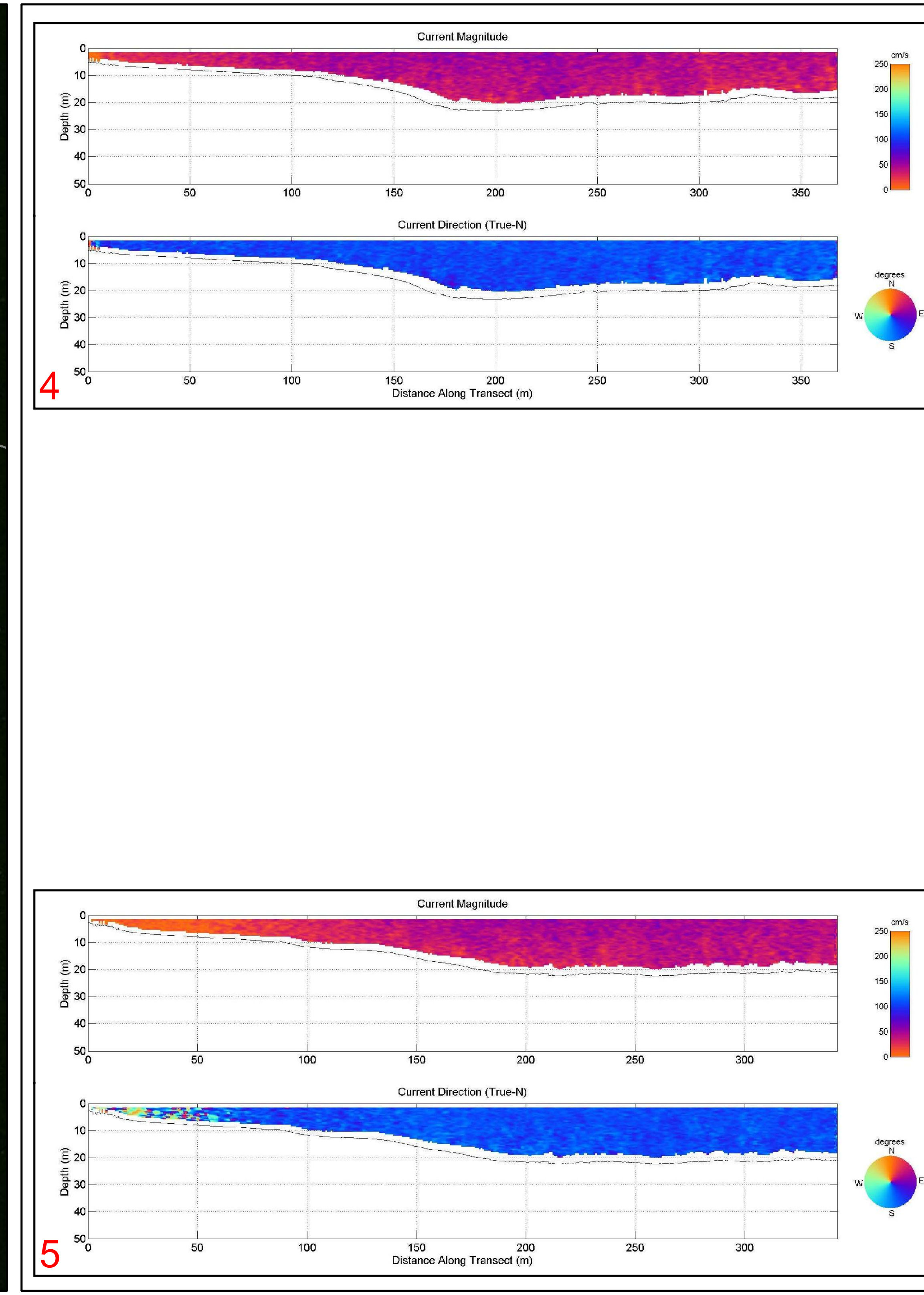

LEGEND

ADCP Transect

5m Contour

REFERENCE

Baselayer: © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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SCALE 1:2,000 METRES

PROJECT

WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE

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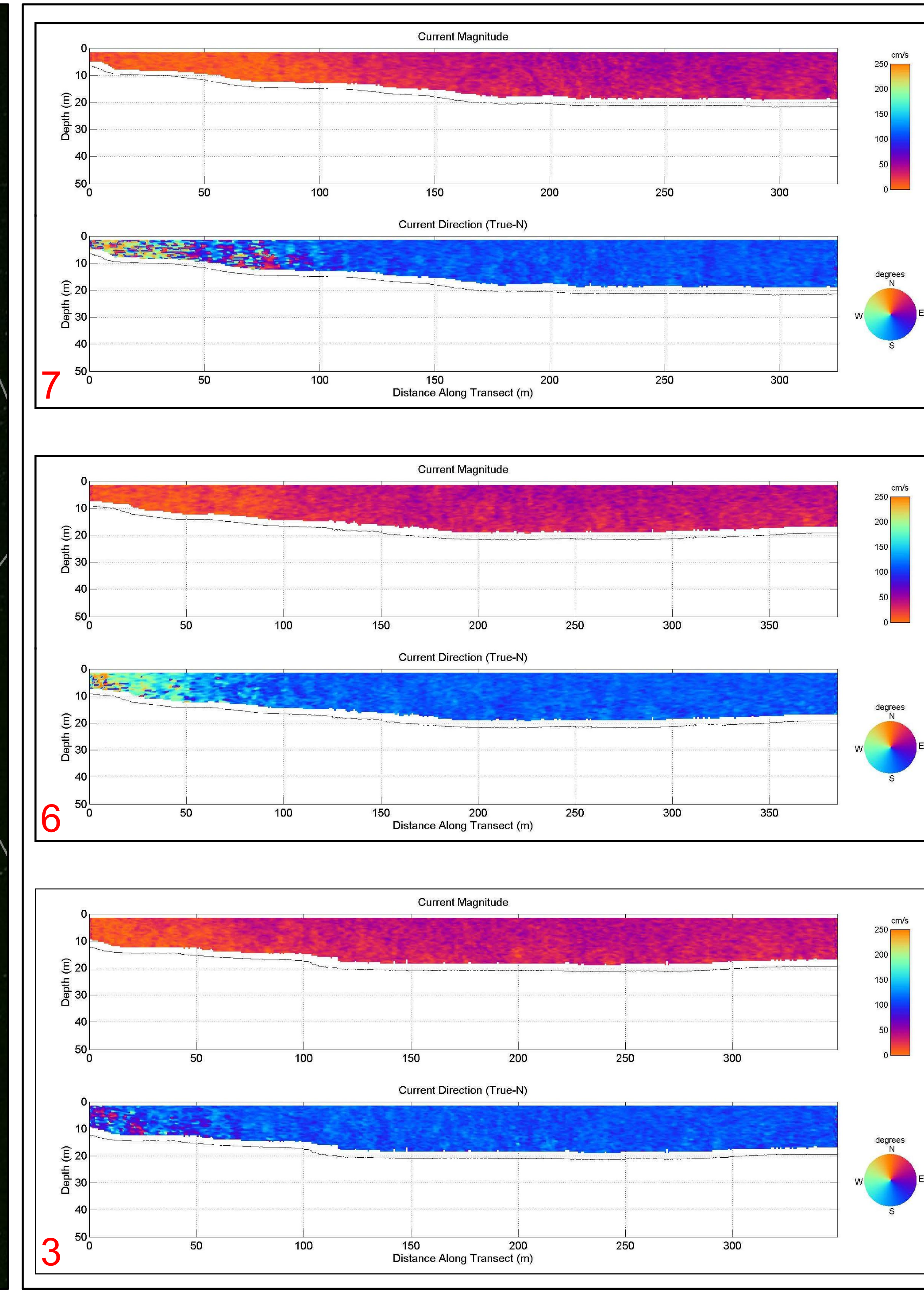

LEGEND

- ADCP Transect
- 5m Contour

REFERENCE

Baselayer: © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

50 0 50

SCALE 1:2,000 METRES

PROJECT
WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER
WASHINGTON, U.S.A.

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FIGURE 12

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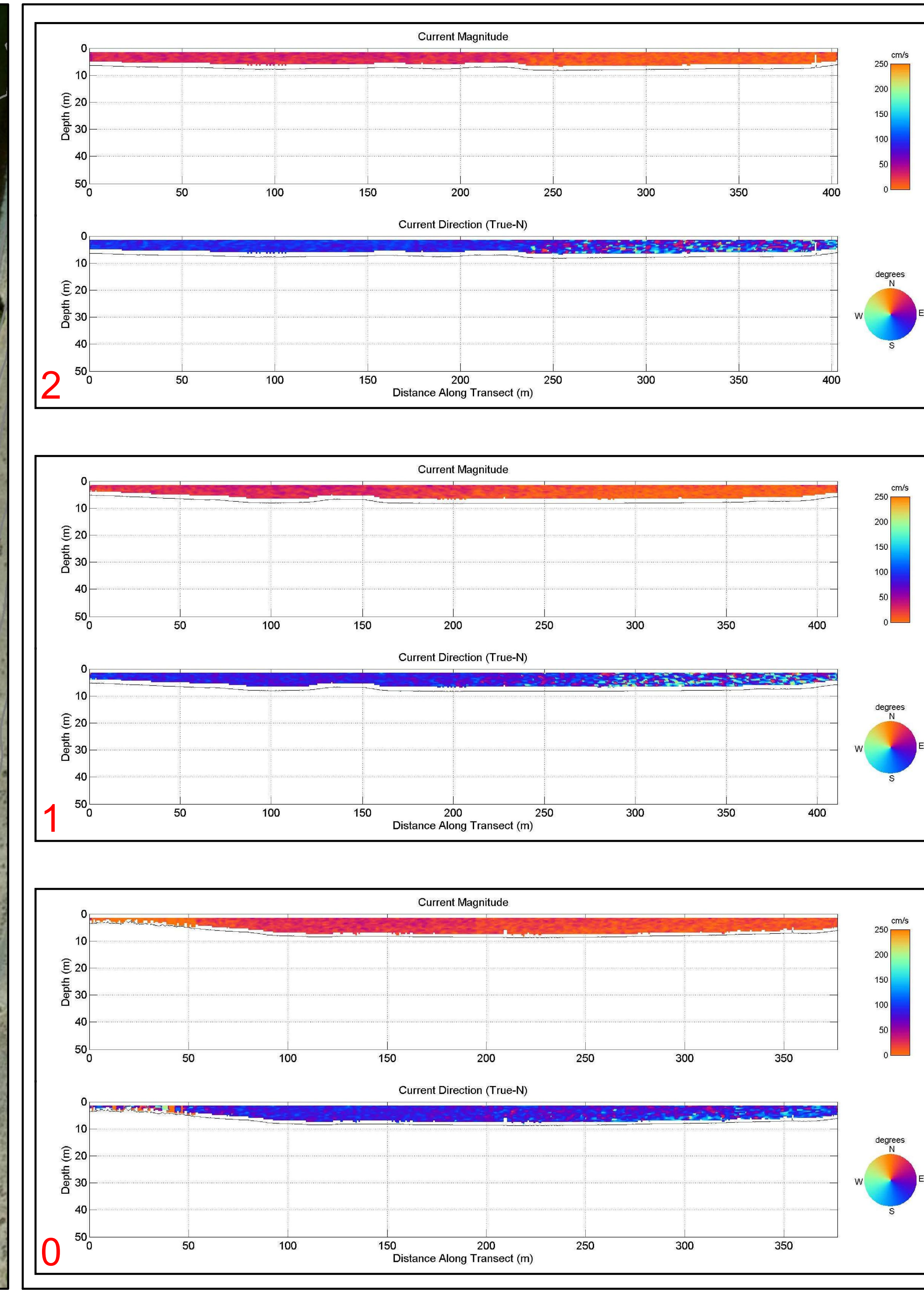

LEGEND

— ADCP Transect

— 5m Contour

REFERENCE

Baselayer: Image courtesy of USGS © 2013 Microsoft Corporation

Projection: UTM10 Datum: NAD83

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SCALE 1:2,500 METRES

PROJECT

WHITE STURGEON INVESTIGATIONS IN PRIEST RAPIDS AND WANAPUM RESERVOIRS ON THE COLUMBIA RIVER WASHINGTON, U.S.A.

TITLE

ADCP TRANSECTS AND PROFILES AUGUST 2, 2012

Golder Associates
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PROJECT No. 12-3930-0302			SCALE AS SHOWN	REV. 0
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Appendix D
2013 WSMP Study Plan and Schedule

INTRODUCTION

Golder proposes the following study plan and schedule for the 2013 component of the White Sturgeon Management Plan (WSMP). The specific objectives and tasks that were developed for the three years of the current study (2012 to 2014) to meet the overall study objectives of the WSMP and address the specific Monitoring and Evaluation (M&E) tasks described in the Grant PUD RFP No. 11-31, are provided in Table 1.

Study components associated with: 1) adult broodstock collection; 2) production, marking, and release of juvenile white sturgeon; 3) assessment of adult and juvenile seasonal movements; 4) database management; and, 5) reporting, will be conducted each study year.

Table 1: 2013 to 2014 WSMP M&E program task objectives by study year.

Objective	Task No.	Task	Year	
			2013	2014
1	1	Broodstock Collection	x	x
1	2	PRFF Support	x	x
1	3.1	Juvenile Marking	x	x
1	3.2	Juvenile Transport	x	x
2	1	Juvenile Movement Assessment	x	x
2	2.1	Juvenile Indexing		x
2	2.2	Habitat Assessment (Juvenile)		
2	3	Adult Indexing		
4	1	Evaluation of Existing Spawning Use	P[1]	
4	3	Conservation Aquaculture Database Requirements	x	x
4	4	Annual WSMP Report [2]	x	x

[1] Pilot study (P).

[2] Includes Objective 4 Task 2 to assess reproduction and stocking rates.

The following sections provide details on the timing and methods that will be used in the 2013 study program to achieve the M&E objectives shown in Table 1. In addition to the tasks identified in the WSMP and FERC permit obligations for 2013, a pilot study assessing the feasibility of capturing white sturgeon larvae using D-ring sampling will be conducted in 2013.

Objective 1 Task 1 - Broodstock Collection

Broodstock collection will be conducted in early June 2013 (tentatively scheduled from June 4 to June 17), immediately prior to the peak of white sturgeon spawning activity. Previous studies found that White Sturgeon spawning coincides with water temperatures between 14 and 16 °C and usually occurs during the descending limb of the spring freshet (Golder 2003, 2011). Due to high flows in 2012, and a predicted prolonged freshet with cooler than normal water temperatures, we assumed the onset of spawning would be delayed until July, and on this assumption, the 2012 broodstock capture efforts were scheduled for late June. However, the actual onset of

White Sturgeon spawning occurred the last week of June and prior to the start of the descending limb of freshet, when mean daily water temperatures were between 12°C and 13°C (Golder 2013). With the onset of spawning, catch-per-unit-effort (CPUE) of white sturgeon decreased during the final week of sampling in late June. Timing of the Chelan PUD broodstock program (i.e., late May) and the Grant PUD program (mid-June to late June) also prevented crossbreeding of fish captured by both programs, which could have potentially produced up to 20 male:female crosses compared to the seven crosses actually produced.

A key objective in 2013 is the coordination of both Chelan and Grant PUD capture programs so that fish captured during both programs arrive at Marion Drain Hatchery (MDH) within a similar time frame to increase the possibility of crossbreeding between fish captured by both broodstock collection programs. The 2013 broodstock capture program methodology will be similar to the 2012 approach. Set line sampling will be conducted by a 3-person boat-based crew. The first crew will consist of a Golder sturgeon research boat that will deploy set lines in eddy habitat (minimum of 90 hooks per day), single hook jug sets in thalweg areas, and angling when time from other activities allows. This crew will also process and transport captured candidate broodstock by boat to the Grant PUD white sturgeon transport trailer. Passive sampling methods, like set lines, will use large circle hooks (size 20/0, barbed) to specifically target adult fish and reduce catches of smaller juvenile fish. Up to 30 hooks per day (the number of hooks per set line will be dependent upon the characteristics of the sample area) will be baited with large pieces of salmon. A second set line will be set with 30 hooks baited with specially-brined large squid. The use of larger hooks and larger pieces of specialty bait will ideally target larger adult fish and further limit the catch of juveniles.

The second crew will consist of a fishing guide (Stuart Hurd) with two to three other anglers operating from the guide's boat. When possible, one or two of the anglers on the guide boat will be Golder technicians or Grant PUD staff. The guide's crew will angle at locations where the guide has had previous success catching adult fish in late spring. Angling will be conducted primarily with salmon bait and specially-brined large squid.

The majority of broodstock capture effort will be conducted in the three to five kilometre section of river/reservoir habitat below Rock Island Dam in Wanapum Reservoir. Wanapum Reservoir has the highest known number of potential candidate broodstock and therefore, represents the sample area with the highest probability of capture success. Acoustic telemetry tracking with a VR100 receiver will be conducted prior to and during the sample program to locate previously captured and tagged adult fish, which based on gonad maturity at capture, could potentially spawn in 2013. Regardless of reproductive status, large white sturgeon also tend to aggregate in groups prior to spawning and the location of tagged large fish can be used to identify and target aggregations that may contain candidate broodstock. Processing and transport of captured white sturgeon will be conducted by the Golder crew. Fish caught by the guide crew during this time will be transferred to the Golder boat for processing. If other candidate broodstock are captured late in the day and cannot be processed in a timely manner, these fish will be held overnight in a portable fish transfer bag for processing by Golder the following day.

Each fish captured will be processed following methods outlined in the WSMP. PIT-tags will be applied during the broodstock assessment to increase the total number of marked individuals at-large in the white sturgeon populations within the Project area. After the sex and maturity of fish have been determined, selected fish will be implanted with a 10-year Vemco V16-6H 69 kHz coded acoustic tag. Up to 10 acoustic tags will be deployed during the 2013 broodstock collection study. All candidate broodstock transported to the hatchery will have a

V16 tagged applied during processing. When possible, milt will be extracted from flowing male White Sturgeon following methodologies provided by MDH and Kootenay Trout Hatchery (KTH) hatchery staff.

In the event of very low broodstock capture success in Wanapum Reservoir in 2013, a portion of the capture effort may be applied in the tailwater areas of Wanapum and/or Priest Rapids dams. This decision would be made in conjunction with the Grant PUD contract manager. Sampling below Wanapum and Priest Rapids dams would be conducted by the Golder crew, while the guide crew would continue to fish below Rock Island Dam.

Candidate broodstock will be transported by two technicians using the Grant PUD fish transport trailer. A DOT-registered Golder truck, capable of pulling the fully loaded trailer, will be used to transport the fish to the hatchery. A fish transport data form will be used to document pertinent aspects and the chronology of the transfer process, such as the date and time of capture, fish transfer stages, travel time and water quality checks, and fish disposition upon receipt by the hatchery. Golder will notify the hatchery staff upon capturing a candidate broodstock to allow hatchery staff preparation time to receive the fish.

Given that the amount of time broodstock will remain at MDH cannot be accurately determined, return of the fish to their reservoir of origin will be conducted by MDH hatchery staff, with assistance from Golder personnel if required. With the addition of a fish-lifting system and hydraulic boom arm to the MDH fish transport trailer, MDH staff can efficiently and safely transport fish. Wanapum Reservoir broodstock will be released at either the Vantage or Sunland Estates public launch. Broodstock from Priest Rapids Reservoir will be released in the Wanapum Dam tailrace

Assumptions: Objective 1 Task 1 White Sturgeon Broodstock Collection

Key assumptions of our proposed approach are:

1) Sample effort will concentrate in the Rock Island tailwater area in upper Wanapum Reservoir. Additional sampling may be conducted in the Wanapum Dam and/or Priests Rapids Dam tailwater if catch below Rock Island Dam is poor.

2) Fish will be transported using Grant PUD’s fish transport trailer equipped with a water pump and hoses, an oxygen regulation system, a portable YSI oxygen and temperature meter, and maintenance equipment.

3) Golder and its subconsultants will operate under Grant PUD’s 2013 state and federal fish transport and collection permits

4) Golder will deliver broodstock to Marion Drain Hatchery (MDH) during the broodstock collection program. If required, Golder will assist MDH staff with the return of broodstock from the hatchery to the Project Area.

Objective 1 Task 1 Broodstock Collection Schedule

Date	Task
May 31	Travel
June 1 to June 14	Broodstock capture
June 15	Travel

Objective 1 Task 2 – PRFF Support

Senior biologists from Golder, Colville Confederated Tribes (CCT) and the Freshwater Fisheries Society of British Columbia (FFSBC) will assist Grant PUD Resource Managers and members of the PRFF in the development and implementation of cost effective strategies to fulfill Grant PUD FERC license obligations in 2013. They will also participate in an advisory role as requested by the Grant PUD to provide input and expertise into the white sturgeon aquaculture component of the WSMP through participation at regional workgroups, the PRFF, and in support of aquaculture activities undertaken at the Yakama Nation, Marion Drain Hatchery facility in Toppenish, WA. The majority of involvement will entail attendance at PRFF meetings (via teleconference), review of documents, and technical and professional communications.

Assumptions: Objective 1 Task 2 Conservation Aquaculture

Key assumptions of our proposed approach are:

1) Senior or intermediate staff will participate in the majority of monthly PRFF meetings primarily via teleconferencing.

2) Physically attendance at PRFF meetings will be limited to once per year for senior staff (Larry Hildebrand, Paul Grutter, Jason McLellan, Matt Howell, and/or Dr. Jim Powell).

Objective 1 Task 3.1 – 2012BY Marking and Tagging

Broodstock captured in 2012 in the Project area consisted of 1 female and 4 males, all of which were captured in Wanapum Reservoir below Rock Island Dam. Broodstock captured by Chelan PUD in John Day Reservoir resulted in the capture of 3 female and 1 male. The fish within each capture group were successfully mated at Marion Drain Hatchery (MDH) to produce one family group of four half-sib crosses and one family group of three half-sib crosses, all 2012 White Sturgeon juveniles hereafter are referred to as the 2012 broodyear (2012BY).

As a contingency against brood failure, half the 2012BY were reared at MDH, with the remainder transferred to the Columbia Basin Hatchery (CBH). Pathology testing of the MDH 2012BY determined the fish to be healthy (personal communication, Marilyn Blair DVM, Idaho Fish Health Center, January 29, 2013) and growing at an acceptable rate (personal communication, Steven Mansfeld, WDFW, February 1, 2013).

The WSMP states that a 6x6 factorial cross is the breeding goal for the two reservoirs combined, but due to logistical constraints and low broodstock capture rates, a 3x3 factorial cross was also considered acceptable to provide sufficient genetic diversity for the proposed annual release size of 6500 fish (PRFF Statement of Agreement, August 2011). Because there were four genetic crosses from the Project area instead of the targeted nine that would result from a 3x3 design, the proposed number of 2012BY juveniles to be released will be 4/9 of the annual release target or 2888 fish. Tagging of the 2012BY will depend on growth rate of the 2012BY. Out of the 2888 juveniles planned for release in the Project area, 77% (2224 fish) will be provided by MDH for release in Wanapum Reservoir, with the remaining 23% (664 fish) provided by CBH for release in Priest Rapids Reservoir.

A portion of the John Day progeny became available, and based on review of the overall 2013 stocking plan by WDFW, the inclusion of the John Day progeny as a proportion of the 2012BY release was advised. As the acoustic tags (22 tags for Wanapum Reservoir, 6 for Priest Rapids Reservoir) were purchased based on the original release number, the decision was made by Grant PUD to release the original release number of fish (i.e., 2888 total), but to use fish from all 7 half-sib crosses. In discussions with Grant PUD, a greater proportion of progeny from the Wanapum half-sib crosses will be released, as these fish are from the genetic stock resident in the Project.

The specific release plan for fish from each hatchery (i.e., MDH and CBH) is provided below.

Marion Drain Hatchery

LGL biologists will supervise the marking and tagging of hatchery White Sturgeon progeny raised at MDH. LGL's responsibilities will include coordinating the tagging effort with MDH staff, organizing tagging and data recording equipment, assisting with the tagging and marking process, and surgically implanting acoustic tags.

During rearing, the seven half-sib cross were partially mixed and held in eight rearing pens at MDH. The pens were assigned the specific identification numbers by the MDH hatchery staff based on pen number and the genetic origin of the fish (Table 2).

Table 2: MDH rearing pen and genetic stock identification of 2012BY juvenile White Sturgeon

Rearing Pen/Genetic Stock ID
1- WF4xM1
2- WF2xM1
3-WF2xM1
4-WF1xM1
5-WF1xM1
6-WF6 x M1&2
7-WF6 x M3&4
8-WF6 x M1-4

In total, 2224 2012BY fish will be released in Wanapum Reservoir. All 2224 fish will receive a 12.5 mm 134 kHz ISO PIT tag. Three left lateral scutes below the dorsal fin will also be removed to mark all fish. Two types of acoustic tags will be implanted in a total of 22 of the 2224 fish; 14 V9-2L code pinger and 8 V9P-2L depth sensor tags. Specifications of the tags are provided in Table 3.

Table 3: Vemco V9-2L coded pinger and V9P-2L depth sensor tag specifications.

Vemco V9 Tag Specifications	V9-2L	V9P-2L (depth to 50m)
Output (dB/m)	142	142
wt in air (g)	4.7	4.7
Tag length (mm)	30	30
Tag diameter (mm)	9	9
Tag life at 170-310s burst interval (days)	959	651

In 2013, the effect of release location on survival will be assessed. This will require that equal numbers of PIT-tagged fish and acoustic-tagged fish are sorted into two separate release pens as they are tagged. The two release pens will be designated RM450.6 and RM442.0, corresponding to the release location river mile. The release pen identification number will be recorded for each fish processed. The fish release will be conducted by staff from Golder and Colville Confederate Tribes two weeks after tagging.

The tagging treatment, number of fish to tag in each of the eight rearing pens, and their corresponding release pen designation, are outlined in Table 4. Each release pen will contain 1112 fish comprised of 1101 fish with only PIT-tags, 7 fish with PIT-tags and V9-2L coded pingers, and 4 fish with PIT-tags and V9P-2L depth sensor tags.

Six additional fish from 8-WF6xM1-4 will also be processed and implanted with both PIT-tags and V9-2L coded pingers for release in Priest Rapids Reservoir; these six fish will be held in their own pen separate from the Wanapum Reservoir fish.

Table 4: 2012BY tagging numbers by pen/genetic stock, tagging treatment, and release pen designation.

		Number of Fish to Tag by Genetic Stock/Rearing Pen								
Treatment	Release Pen	1-WF4xM1	2-WF2xM1	3-WF2xM1	4-WF1xM1	5-WF1xM1	6-WF6xM1&2	7-WF6xM3&4	8-WF6xM1-4	Total
PIT-tag only	RM450.6	158	39	40	38	39	315	314	158	**1101**
	RM442.0	158	40	37	40	39	314	315	158	**1101**
PIT-tag V9-2L Pinger	RM450.6	1			1		2	2	1	**7**
	RM442.0	1		1			2	2	1	**7**
PIT-tag V9P-2L Depth Tag	RM450.6	1				1	1	1		**4**
	RM442.0			1			1	1	1	**4**
	Total	**319**	**79**	**79**	**79**	**79**	**635**	**635**	**319**	**2224**

LGL biologists will implant hatchery White Sturgeon progeny raised at MDH with PIT-tags, using an appropriate applicator, with the tag inserted on the left side at the base of the 4th dorsal scute, with the tag oriented in line with body axis towards the head of the fish. LGL biologists will assist MDH staff with PIT-tagging, scute-marking, and conduct the surgical implantation of acoustic tags using standard procedures first developed by Kootenay Trout Hatchery. A copy of these procedures will be provided to LGL by Golder for reference.

For each fish, LGL will record the data fields identified in Table 5. All fish processing data will be recorded in a manner similar to the methods LGL applied in 2011 during processing of the 2010BY release. Data will be recorded electronically into the P3 data processing program to limited errors associated with manual data entry. LGL biologist will be responsible for implementing appropriate quality control/quality assurance measures during fish processing and data recording.

Table 5: 2012BY release data to be recorded by LGL.

Data Field	Description
Rec #	Sequential record number
Hatchery (Rearing)	Marion Drain Hatchery (MDH)
Proponent	Grant PUD
Tagging Date &Time (mm/dd/yyyy hh:mm)	Date and time when each fish is tagged
PIT-Tag Code	in HEX or DEC,
Species	White Sturgeon
Fork Length (mm)*	Measure for all fish; tip of snout to tail fork (nearest 1 mm)
Weight (g)	Measure for all fish (nearest 1 g)
Acoustic ID code	Vemco V9 5 digit code
Acoustic Serial #	Vemco 7 digit serial number
Acoustic Tag Model	V9-2L or V9P-2L
Brood Year Cross	2012
Rearing Pen-Stock Id	See Table 2
Release Pen #	Release Pen RM450.6 or RM442.0
Scute removal	3 left lateral scute below dorsal, see work instructions provided
PIT-tag placement	left lateral, behind head
Notes	Record deformities and if fish are in poor health

Columbia Basin Hatchery

Columbia Basin Hatchery (CBH) staff will mark and tag of 664 2012BY White Sturgeon progeny in following the same marking and tagging procedures used at MDH as outlined above. At CBH, all half-sib crosses were assumed mixed and fish will be selected and tagged at random. All 664 CBH 2012BY will be released in Priest Rapid Reservoir in the Wanapum Dam tailrace. Six acoustic-tagged fish from the Wanapum half-sib crosses will be tagged in MDH and released in Priest Rapids Reservoir.

Assumptions: Objective 1 Task 3.1 Juvenile Marking

Key assumptions of the 2012BY Juvenile Marking program are:

1) Golder will provide LGL and CBH with written tagging procedures and 2013 tagging objectives.

2) Grant PUD will have a separate contract with the Marion Drain hatchery to provide hatchery staff to assist with fish handling and tagging.

Objective 1 Task 3.1 Juvenile Marking Schedule

Date	Activity
CBH tagging dates March 11, 2013	CBH staff to tag and mark 664 2012BY destined for Priest Rapids Reservoir
MDH tagging week of April 29, 2013	LGL to supervise MDH staff to tag and mark of 2224 2012BY destined for Wanapum Reservoir. Separate into two groups of 1112; implant 22 acoustic tags – 11 per release group.

Objective 1 Task 3.2 – Juvenile Transport and Release

Golder will assist Marion Drain hatchery staff in the release of the 2012BY juvenile white sturgeon. Golder will use the Grant PUD fish transport trailer and a DOT registered Golder truck to transport the 2012BY fish to Wanapum and Priest Rapids reservoirs. Transport of juvenile white sturgeon will require a minimum of three trips if one trailer is used. Written specific work instructions will be developed for filling and draining the trailer, monitoring and regulating water oxygen and temperature while in transit, highway transport safety, and fish release procedures. All aspects of each fish transport and release conducted by Golder will be documented using a fish transport and release data collection form.

The release of the 2012BY will be done in a manner that provides information on differential survival of released juveniles based on the release strategy employed. This information is needed in light of the apparent high level of avian predation that occurred following release of the 2010BY in Wanapum Reservoir. An Assessment of Avian Predation Risk in Relation to Release Site experiment will involve the following considerations and components:

The 2012 Juvenile population indexing and PIT-tag recovery data suggests moderate to high rates of avian predation on post-release 2010BY hatchery juveniles in Wanapum Reservoir; evidence of a similar risk of avian predation on fish released in Priest Rapids Reservoir was not found, possibly because the Priest Rapids Reservoir fish were released in a deep water location in the Wanapum Dam tailrace within the boundaries of the avian predator control area.

In Wanapum Reservoir, risk of avian predation on hatchery juveniles may be related to either the location or method of release. For Wanapum Reservoir release, a proposed study design to test the avian predator hypothesis is as follows:

- To eliminate any facility effects on study results, all 2224 fish released in Wanapum Reservoir will be provided by MDH;
- The Wanapum Reservoir fish releases will be split evenly and released in two groups, with one group released at the 2011 release site at Columbia Siding Road and the other group released in a deeper, downstream location. Group 1 (1112 fish, 11 acoustic-tagged) will be released during the day at the Columbia Siding release site near RM450.6
- Group 2 (1112 fish, 11 acoustic-tagged) will be released during the day at a downstream deep-water site, likely at Columbia Cliffs Eddy near RM 442 and will be released from a boat in the channel thalweg.

A similar release experiment will not be conducted in Priest Rapids Reservoir as there was no clear indication that avian predation affected post-release survival in this reservoir. Also, the small numbers of fish released (i.e., 664 fish, 6 acoustic-tagged) would reduce the likelihood of sufficient numbers being recaptured to assess effects.

Fish transfer will likely be conducted in mid-May and is tentatively scheduled for the week of May 20. CBH 2012BY released into Priest Rapids Reservoir will be transported by Golder staff in the Grant PUD transport trailer and released into the Wanapum Dam tailrace at the boat launch (UTM: 11T, 274163E 5195756N).

In Wanapum Reservoir, Group 1 will be released at the Columbia Siding boat launch (UTM: 10T 720350 5243643), situated ~2.5 miles downstream of Rock Island Dam. The proposed downstream release location for Group 2 is at Columbia Cliffs eddy (UTM: 10T 725506 5234729), which is a large deep eddy pool approximately 11 miles downstream of Rock Island Dam that has been identified as a frequently used site for juvenile and adult white sturgeon (Golder 2012). The 2012BY will be transported by trailer to the boat launch at Crescent Bar Resort Marina, where they will be transferred into the live-well holding tanks on-board the Colville Confederated Tribes' (CCT) sampling boat, and transported a short distance upstream and released into Columbia Cliffs Eddy.

If a substantial temperature differential (>8°C) between the hatchery pens and the Columbia River exists, fish will be gradually acclimated (2°C/day) at the hatchery (by hatchery staff) from 16°C, the hatchery ground water temperature, to approximately 8°C, the likely temperature of the Columbia River in mid-May. During the transfer, crews will monitor water temperature and dissolved oxygen (DO) using a portable DO meter and will adjust oxygen and water levels to maintain DO near 8.0 mg/L. A VR2W or VR100 acoustic receiver will be used to ensure all acoustic tags are active upon release.

Assumptions: Objective 1 Task 3.2 Juvenile Transport

Key assumptions of the 2012BY Juvenile Transport component are:

1) Grant PUD will have a separate contract with the Yakima Tribe to provide Marion Drain Hatchery staff and the Yakima fish transport trailer to assist with transport of juveniles if required.

2) DO meter and complete fish transport tank and trailer (with oxygen tanks and DO meter) will be supplied by Grant PUD.

3) Fish release will be conducted in conjunction with the May VR2W download (Objective 2 Task 1)

Objective 1 Task 3.2 Juvenile Transport Schedule

Date	Task
May 20	Travel
May 21	2012BY Release Wanapum Reservoir[1]
May 22	2012BY Release Priest Rapid Reservoir[2]

[1] Two trips between Crescent Bar and MDH

[2] One trip between CBH and Priest Rapids Reservoir

Objective 2 Task 1 - Juvenile White Sturgeon Movement Assessment

Telemetry data from the VR2W acoustic tag receiver array will be used to monitor juvenile White Sturgeon movement within the Project area to assess post-release juvenile dispersal, seasonal movements, and net out-migration from the Project area. Currently, 12 Vemco VR2W sonic receivers are deployed in the Project area (six in Wanapum Reservoir, five in Priest Rapids Reservoir, and one in the tailwater area of Priest Rapids Dam). When possible, inspection and downloading the VR2W stations will be conducted in conjunction with other field studies (e.g., broodstock assessment or spawn monitoring study components) to reduce study costs. In 2013, the VR2W array will be inspected and serviced in mid-May, concurrent with the 2012BY release work, in late-July following D-ring larval sampling, and in the fall. To maintain the integrity of the array, field crews will have one or more spare VR2W's and the equipment necessary during service visits, to allow immediately deployment of a spare VR2W in the event one of the current VR2W stations is lost. Active tracking with a VR100 will be conducted at each VR2W station to confirm the presence or absence of same day detections at the station. Range testing using a specially programmed test tag will be conducted opportunistically to determine the reception range of each station.

Assumptions: Objective 2 Task 1 Juvenile White Sturgeon Movement Assessment

The key assumption of the white sturgeon movement assessment study component is that Grant PUD would provide the VR2Ws and mooring gear for the stationary array, and a VR100 receiver and hydrophones to conduct the active tracking. The session 1 download in May will be conducted in conjunction with the 2012BY release. The session 2 download will be conducted at the end of the July D-ring larval capture program. The third session will be conducted in October.

Objective 2 Task 1 2013 Juvenile Movement Assessment Schedule

Date	Task
May 23&24	Session 1 VR2W download and station inspection
May 25	Session 1 Travel
July 20 and 21	Session 2 VR2W download and station inspection
July 22	Session 2 Travel
October 21 & 24	Session 3 Travel
October 22 and 23	Session 3 VR2W download and station inspection

Objective 4 Task 1 - Evaluation of Existing Spawning Use

Objective 4 Task 1a – Larval Collection Pilot Study

In 2013, Golder and the CCT will conduct an investigation of white sturgeon natural production by collecting white sturgeon larvae in Wanapum Reservoir. The study will serve as a pilot evaluation of the potential for collecting white sturgeon larvae for use in conservation aquaculture. Drifting post-hatch white sturgeon will be captured using the same D-ring plankton nets and mooring configuration developed for the Lake Roosevelt Sturgeon Recovery Project (LRSRP). This system allows for simultaneous sampling of multiple stations, thereby maximizing catch rates and sampling efficiency.

Sampling will be conducted beginning at dusk and continuing until dawn, from a Golder boat. Two crew members (one Golder staff member, and one CCT staff member), will fish up to six stations each night, depending on debris loading and catch rates. Nets will be checked approximately once every two hours to limit debris loading in collection buckets and to maximize larval survival. Flowmeters will be affixed to net frames to allow for calculation of catch rates (number of larvae per volume of water filtered).

All captured larval sturgeon will be sorted by developmental stage and tallied. Larval disposition (live or dead at capture) will also be recorded. Live larvae will be placed in 18.9 L (5 gallon) cylindrical insulated water coolers filled with river water. Periodically, water in the coolers will be partially replaced (approximately one quarter of the volume) and dissolved oxygen levels will be monitored using a handheld meter.

Ideally, sampling stations will be located in areas where near-bottom water velocities are in the range 0.25 to 0.50 m/s and where the river bottom topography is relatively level and substrate is composed of particles no larger than small cobbles. The preferred area for sampling is the general vicinity of Crescent Bar, because 1) lodging is available at this location which reduces crew travel, 2) the area is located approximately the same distance downstream from a known spawning location as the area used by the LRSRP for collecting larvae on Lake Roosevelt, and 3) previous sampling experience in this area of the river indicates that channel morphology (relatively narrow, promoting concentration of larvae and improving catch rates) and substrates are suitable for sampling with D-ring plankton nets. Sampling stations will be selected during a reconnaissance of the upper reaches of Wanapum reservoir immediately prior to the start of the sampling effort. The CCT will provide a boat and crew to perform the reconnaissance and to deploy and retrieve station moorings.

The onset of sampling will depend upon the onset of sturgeon spawning. Generally speaking, white sturgeon spawning in the Columbia mainstem commences when water temperature reaches 14^{o}C during the springtime. At this temperature, the duration of the subsequent incubation period is approximately 5-7 days. Hatchlings then require a further 10-12 days to reach the first feeding stage – the stage of interest in this pilot study. Sampling for the larval stage should therefore commence no sooner than approximately two weeks following the onset of spawning or water temperatures reaching 14^{o}C. Water temperature records for the tailrace of Rock Island Dam for the period 2003-2012 indicate that, on average, water temperature first exceeds 14^{o}C on 25 June. The foregoing suggests that a reasonable tentative date to commence sampling for larval stages in 2013 would be Tuesday, July 9. To obtain a reasonable picture of larval dispersal timing and catch rates, sampling will be conducted over 10 nights to conclude the morning of July 19. An additional three days will be required for travel, pre-sampling reconnaissance, and deployment/retrieval of mooring systems.

Objective 4 Task 1a – Larval Collection Pilot Study Schedule

Date	Task
July 7	Travel and reconnaissance
July 8	Set moorings and test gear operation
July 9-19	Night sampling
July 22	Retrieve moorings and travel

Following the completion of sampling in the early morning of each day, larvae will be delivered to the Wells Fish Hatchery. This will be achieved by coordinating with CCT staff working on Douglas County PUD larval collection efforts during the same timeframe as the Wanapum work.

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, coolers will be supplied with oxygen via small air stones. Dissolved oxygen levels, water temperature, and fish disposition will be checked periodically during transport. Coolers filled with river water will also be carried to allow for partial water exchanges, if necessary. Based on previous experience of the Lake Roosevelt Sturgeon Recovery Plan (LRSRP) larval collection program, maximum loading densities will be approximately 1,000 larvae per transport vessel.

Assumptions: Objective 4 Task 1a Larval Collection Pilot Study

1. Grant PUD will provide all sampling equipment (nets, frames, moorings, flowmeters, sorting trays, and supplies).
2. Specific work instruction and data collection forms will be provided by the CCT.
3. All live larvae will be transported to Wells Fish Hatchery. Larval transport equipment and supplies will be provided by either the Douglas PUD project or by Grant PUD.
4. Larval transport will be conducted in coordination with the Douglas PUD project.
5. Golder and the CCT will operate under Grant PUD's 2013 state and federal fish transport and collection permits.

Objective 4 Task 3 – Conservation Aquaculture Database Requirements

Golder will modify and update its existing field and office white sturgeon databases to meet specific 2013 data collection obligations for adult white sturgeon capture, juvenile release tracking, and acoustic telemetry tracking. All indexing databases allow field entry of the following variables:

1) Annual stocking data (fish lengths, weights, deformities, scute marks, PIT tag number);
2) Annual index monitoring results (lengths, weights, deformities, capture location, scute marks, PIT or sonic tag number); and,
3) Annual results obtained from tracking actively tagged juveniles (location records).

In addition to being a repository for the data collected under this Project, the database system will be used to provide data for specific reports to assist with provision of quarterly and annual data summaries, fish movement summaries, and allow upload of release and capture data to external databases (i.e., PTAGIS)

Assumptions: Objective 4 Task 3 Conservation Aquaculture Database Requirements

Key assumptions of our proposed approach are:

1) LGL staff will collect and provide data to Golder from juveniles sampled and marked at the Marion Drain Hatchery and released into the Project area.
2) Golder and its subconsultants will assist Grant PUD in uploading the PIT tag data to PTAGIS.

Objective 4 Task 3 Conservation Aquaculture Database Requirements Schedule

Date	Work Period
2013	Ongoing

Objective 4 Task 4 – 2013 Annual WSMP Report

To facilitate effective management of data from the monitoring programs and support the requirements of the PRFF, aprogress report will be prepared in 2013 to:

1) Briefly describe the methods used to address the statement of work;

2) briefly present the data and results of field investigations;

3) highlight key findings of the investigations; and,

4) provide the proposed study program for the following year.

The general report format will follow that developed for the 2012 report and to comply with Federal and State sampling permit requirements.

Assumptions: Objective 4 Task 4 2013 Annual WSMP Report

Key assumptions of our proposed approach are:

1) Deliverable date for the 2013 annual report will be January 30, 2014.

Objective 4 Task 4 2013 Comprehensive Annual WSMP Report Schedule

Date	Work Period
January 30, 2014	2013 draft report

LITERATURE CITED

Golder Associates Ltd. 2003. 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. + 6 app.

Golder Associates. 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.

Golder Associates. 2011. 430-2905 White Sturgeon M&E Program Annual Data Report 2010. Draft Report prepared for Priest Rapids Hydroelectric Project (FERC No. 2114), Public Utility District No.2 of Grant County, Ephrata, WA, by Golder Associates Ltd, Castlegar, BC.

Appendix E

PRFF Comments on 2012 White Sturgeon Management Plan Annual Report & Year Five Biological Objective Status Report

From: Mike Clement
To: Debbie Firestone
Subject: FW: 2012 White Sturgeon Annual Report
Date: Tuesday, March 19, 2013 12:28:56 PM

Below is the only comments received on the 2012 WSMP Annual and Biological Objectives Status Report

Thanks, Mike

From: Jackson, Chad S (DFW) [mailto:Chad.Jackson@dfw.wa.gov]
Sent: Monday, March 18, 2013 2:55 PM
To: Mike Clement
Cc: Verhey, Patrick M (DFW)
Subject: 2012 White Sturgeon Annual Report

Mike,

I don't think the deadline for comments has passed? I have only have one on the 2013 White Sturgeon Annual Report (below). I did find some verbiage formatting inconsistencies and a few grammar errors, but I figure GPUD and Golder will find all/most of those so I won't list them here.

Comment:

1.) Page 61-Prepare a brood stock collection and breeding plan within year one of the effective date of the New License and, if feasible, begin brood stock collection in year two of the New License→Sentence number three in the second paragraph reads "For this reason, alternative methods of aquaculture supplementation are being considered and the PRFF is investigating the feasibility of collecting white sturgeon larvae using D-ring drift nets and raising these larvae at a hatchery facility until large enough to release in the Project area." I would disagree with this statement as written. To me, I interpret this sentence to mean that the PRFF formally discussed and agreed upon alternative white sturgeon hatchery supplementation practices to brood stock collection, which to my knowledge didn't happen. There undoubtedly has been informal discussion amongst certain PRFF members about larval collection and hatchery supplementation, but that's it. I do know that GPUD drafted a three year white sturgeon study plan that the PRFF did review and formally discuss, which incorporated larval collection using D-ring nets. However, I do not recall any language tying larval collection to future hatchery supplementation. If I'm incorrect please let me know, thanks. At any rate, I think this sentence needs to be further qualified to mention and cite the three year study plan and then discuss the possibility of transition to using larval fish for hatchery supplementation pending PRFF discussion and approval.

Appendix F
Summary of PRFF Comments on 2012 white sturgeon Management Plan Annual Report and Grant PUD Responses

Summary Table of Agency/Tribal Comment and Grant PUD Responses for 2011 white sturgeon Management Plan Annual Report

Submitting Entity	Date Received	Paragraph #	Agency Comment	Grant PUD Response
WDFW	3/19/13	1	1.) Page 61-Prepare a brood stock collection and breeding plan within year one of the effective date of the New License and, if feasible, begin brood stock collection in year two of the New License→Sentence number three in the second paragraph reads "For this reason, alternative methods of aquaculture supplementation are being considered and the PRFF is investigating the feasibility of collecting white sturgeon larvae using D-ring drift nets and raising these larvae at a hatchery facility until large enough to release in the Project area." I would disagree with this statement as written. To me, I interpret this sentence to mean that the PRFF formally discussed and agreed upon alternative white sturgeon hatchery supplementation practices to brood stock collection, which to my knowledge didn't happen. There undoubtedly has been informal discussion amongst certain PRFF members about larval collection and hatchery supplementation, but that's it. I do know that GPUD drafted a three year white sturgeon study plan that the PRFF did review and formally discuss, which incorporated larval collection using D-ring nets. However, I do not recall any language tying larval collection to future hatchery supplementation. If I'm incorrect please let me know, thanks. At any rate, I think this sentence needs to be further qualified to mention and cite the three year study plan and then discuss the possibility of transition to using larval fish for hatchery supplementation pending PRFF discussion and approval.	Comment noted. Grant PUD has modified this paragraph (Page 61) to reflect WDFW's recommendation and clarification. As such, Grant PUD and the PRFF will continue to evaluate different methods (i.e., broodstock collection, larval sampling, etc.) to determine the most biological and cost-effective methods to satisfy Grant PUD's supplementation requirements. Previous PRFF discussions related to juvenile supplementation can viewed at http://www.grantpud2.org/rc/PRFF.htm.

Appendix G
Washington Department of Ecology's Approval Letter for the 2012 White Sturgeon Management Plan Annual Report & Year Five Biological Objective Status Report

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

March 22, 2013

Mr. Tom Dresser
Manager – Fish, Wildlife, and Water Quality
Grant County Public Utility District
P.O. Box 878
Ephrata, Washington 98823-0878

Re: Request for Approval – Priest Rapids Hydroelectric Project No. 2114 – submittal of Year Five Biological Objective Status Report for White Sturgeon, Section 6.2(5)(c) of the 401 certification.

Dear Mr. Dresser:

We have received your request to approve the Year Five Biological Objectives Status Report, Section 6.2(5)(c), which was emailed to the Department of Ecology (Ecology) on March 21, 2013.

We have reviewed the status report as contained within the 2012 White Sturgeon Management Plan Annual and Biological Objectives Status Report.

Ecology approves the report as fulfilling the requirement of Section 6.2(5)(c) for the White Sturgeon Management Plan in that recommendations contained within the report will be implemented and a Year Ten Biological Objectives Status Report will be completed as a required under Section 6.2(5)(d) of the 401 certification.

Please feel free to contact me at (509) 329-3450 or by email at dman461@ecy.wa.gov if you have any further questions regarding this matter.

Sincerely,

D. Marcie Mangold

D. Marcie Mangold
Water Quality Program

DMM: kla

cc: Ross Hendrick, GCPUD
David Knight, Ecology/WQP