Grant County
PUBLIC UTILITY DISTRICT

Connecting Generations
Since 1938

BY ELECTRONIC FILING

March 29, 2017

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. 2114-192
License Compliance Filing – Article 401(a)(11) – 2016 White Sturgeon Management Plan Annual Report

Dear Secretary Bose,

Please find enclosed the 2016 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 2016. The 2016 M&E program was developed in the context of Grant PUD's 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 2016, the study objectives and tasks to complete under the M&E program (Year 8 of the WSMP) were as follows:

- Conduct a pilot side scan sonar survey to assess the feasibility of this technique to enumerate adult White Sturgeon when fish aggregate at known overwintering areas in Wanapum Reservoir.
- Develop and implement a tagging, marking, and release plan for the 2015 Brood Year (BY) juvenile White Sturgeon based on the annual release target objectives as determined by the Priest Rapids Fish Forum (PRFF) and the revised stocking targets as outlined in the Priest Rapids White Sturgeon Stocking Statement of Agreement (SOA) dated March 11, 2016.
- Monitor dispersal of the 2015BY juvenile White Sturgeon, based on the movements of acoustic-tagged fish within each release group, and determine the extent of outmigration from each of the Wanapum and Priest Rapids reservoirs.
- Collect broodstock from John Day Reservoir downstream of McNary Dam. This work was conducted directly by Grant PUD and Chelan PUD, with coordination and data collection conducted by Blue Leaf Environmental (BLE). A brief summary of 2016 broodstock collection efforts is provided in Appendix A.
- Conduct a mark and recapture program in September and October 2016 to obtain a population abundance estimate and the determine survival rate of juvenile White Sturgeon in PRPA.

On February 6, 2017, Grant PUD prepared and disseminated the draft 2016 WSMP Annual 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 (CCT), Yakama Nation, the Columbia River Inter-Tribal Fish Commission, Bureau of Indian Affairs, Wanapum People and the Confederated Tribes of the Umatilla Indian Reservation. No comments were received. On March 14. 2017 WDOE approved the 2016 WSMP Annual Report (Appendix B).

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

Sincerely,

Ross Hendrick
Manager - License Compliance & Environmental

Cc: Breann Zimmerman – WDOE
Priest Rapids Fish Forum

2016
White Sturgeon Management Plan
Annual Report

Priest Rapids Hydroelectric Project (FERC No. 21114)

Prepared for:

Public Utility District No.2 of Grant County
P.O. Box 878
Ephrata, WA 98823

Prepared by:

Golder Associates Ltd.
201 Columbia Avenue
Castlegar, British Columbia, CA

March 2017

Thanks are extended to our partners and contributors in this project as follows:

Mike Clement	Grant PUD
Chris Mott	Grant PUD
Sima Usvyatsov	Golder Associates Ltd.
Ron Giles	Golder Associates Ltd.
Lucia Ferreira	LGL Environmental Ltd.
Corey Wright	Blue Leaf Environmental

We wish to specifically acknowledge and thank Corey Wright for initiating the discussions to standardize juvenile White Sturgeon sampling gear in the mid-Columbia, as well as Chris Mott for coordinating the fabrication of the juvenile White Sturgeon sampling gear used in this study.

List of Abbreviations

401 Certification	Washington Department of Ecology Section 401 Water Quality Certification for the Priest Rapids Project
BY	Brood Year
Chelan PUD	Public Utility District No. 1 of Chelan County, Washington
CPUE	Catch-Per-Unit-Effort
CRITFC	Columbia River Intertribal Fisheries Commission
CBH	Columbia Basin Hatchery
FERC	Federal Energy Regulatory Commission
FL	Fork Length
Grant PUD	Public Utility District No. 2 of Grant County, Washington
GRTS	Generalized Random-Tessellation Stratified
MDH	Marion Drain Hatchery
M&E	Monitoring and Evaluation
PIT	Passive Integrated Transponder
PRPA	Priest Rapids Project area
PRFF	Priest Rapids Fish Forum
PTAGIS	PIT-tag Information System
RISFWC	Rock Island Forebay Waterbird Colony
RM	River Mile
UCWSRI	Upper Columbia White Sturgeon Recovery Initiative
UTM	Universal Transverse Mercator
WSMP	White Sturgeon Management Plan

Table of Contents

List of Figures

List of Tables

List of Appendices

1.0 INTRODUCTION

The Priest Rapids Project area (PRPA) is located in the mid-Columbia River region and contains two Columbia River mainstem hydroelectric facilities, Wanapum Dam and Priest Rapids Dam, within its boundaries. Approximately 99 km long (61.5 miles), the upstream and downstream boundaries of the Project are defined by Rock Island Dam (River Mile [RM] 453.5 and Vernita Bar (RM 392.0) below Priest Rapids Dam, respectively (Figure 1). 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 (FERC No. 2114) to operate the Project. Consistent with the provisions of the Washington Department of Ecology Section 401 Water Quality Certification for the Project (401 Certification), Article 401 of the FERC license required 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 PRPA. The overarching goal of Grant PUD's WSMP is to restore and maintain White Sturgeon populations to levels commensurate with the available aquatic habitat in the PRPA. The 2016 M&E program was developed as part of the ongoing evaluation effort to provide the necessary metrics required to accurately assess mitigation efforts conducted to date and provide information on which to base future program decisions.

- In 2016, the study objectives and tasks to complete under the M&E program (Year 8 of the WSMP) were as follows:
- Conduct a pilot side scan sonar survey to assess the feasibility of this technique to enumerate adult White Sturgeon when fish aggregate at known overwintering areas in Wanapum Reservoir.
- Develop and implement a tagging, marking, and release plan for the 2015 Brood Year (BY) juvenile White Sturgeon based on the annual release target objectives as determined by the Priest Rapids Fish Forum (PRFF) and the revised stocking targets as outlined in the Priest Rapids White Sturgeon Stocking Statement of Agreement (SOA) dated March 11, 2016.
- Monitor dispersal of the 2015BY juvenile White Sturgeon, based on the movements of acoustic-tagged fish within each release group, and determine the extent of outmigration from each of the Wanapum and Priest Rapids reservoirs.
- Collect broodstock from John Day Reservoir downstream of McNary Dam. This work was conducted directly by Grant PUD and Chelan PUD, with coordination and data collection conducted by Blue Leaf Environmental (BLE). A brief summary of 2016 broodstock collection efforts is provided in Appendix A.
- Conduct a mark and recapture program in September and October 2016 to obtain a population abundance estimate and the determine survival rate of juvenile White Sturgeon in PRPA.

The following introductory sections summarize previous work conducted within the PRPA relevant to the 2016 study objectives and provide the rationale for the 2016 White Sturgeon M&E program.

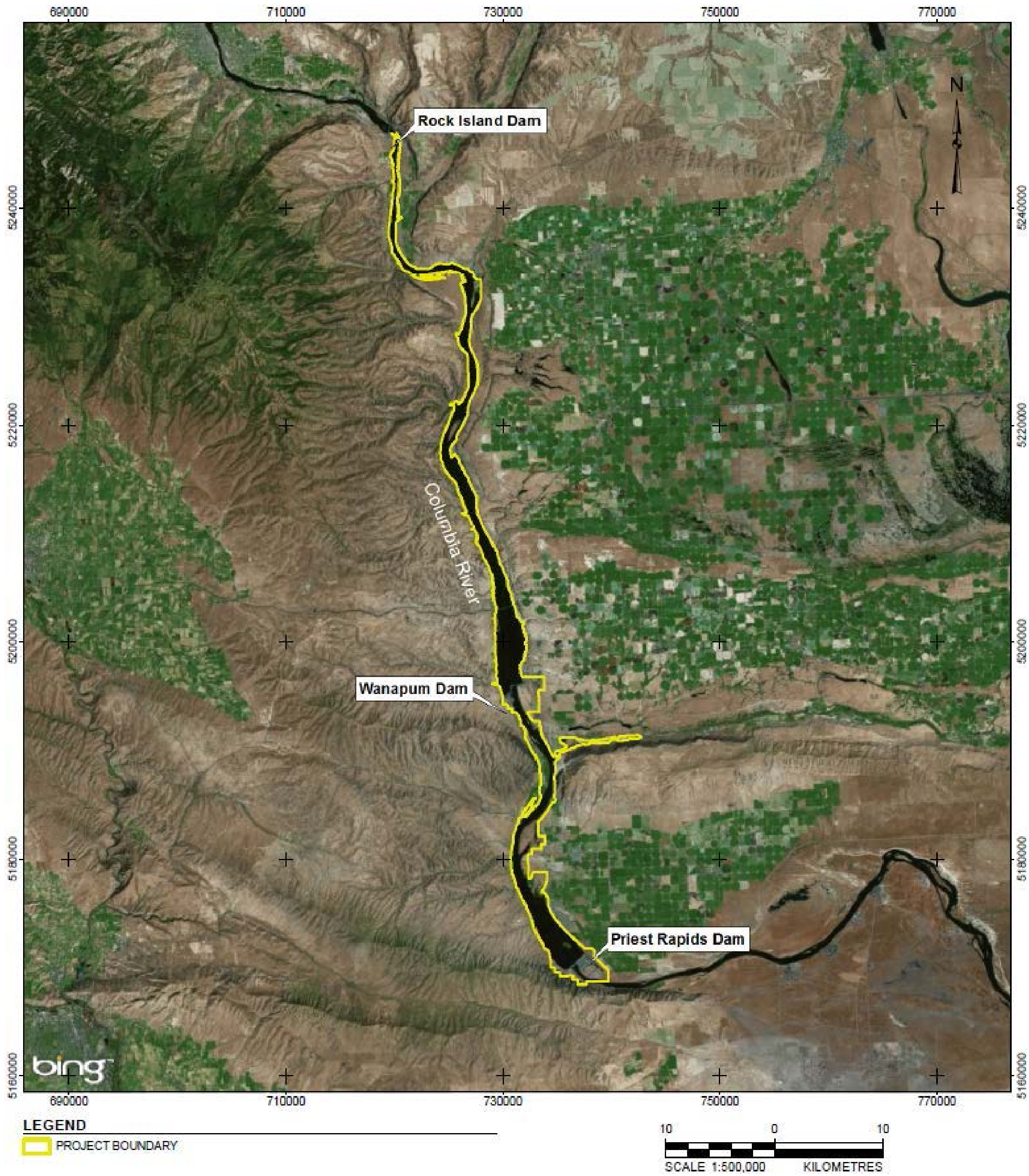


Figure 1 The Priest Rapids Project area.

Use of Side Scan Sonar to Enumerate Adult White Sturgeon

Acoustic seasonal telemetry data suggests that most acoustic-tagged adult and juvenile White Sturgeon in Wanapum reservoir reside at some point in the winter period within known overwintering areas near Columbia Cliffs Eddy and/or downstream of Sunland Estates (Golder 2012). An underlying assumption in the telemetry data is that the behavior of acoustic-tagged fish is similar to untagged fish, and if this assumption is valid, the numbers of White Sturgeon within these two overwintering areas may represent a substantial proportion (e.g., from 75% to 90%) of the entire Wanapum reservoir White Sturgeon population. Annual aggregations of White Sturgeon at specific holding sites (i.e., overwintering sites) during the winter months has been documented in the upper Columbia River (Golder 2005) and Nechako River (RL&L 2000). When fish aggregate in this manner, the opportunity potentially exists to sample the population through both live capture (e.g., setlines, nets, angling, etc.) and remote sensing approaches. There are several advantages of a remote sensing approach, but the primary advantage is that both fish counts and some morphometric attributes (e.g., length, species, etc.) can be determined for substantial numbers of fish *in situ* with less effort compared to physical capture methods. A secondary benefit is that handling stress, injury, and possible mortality associated with the physical capture methods are also avoided. In 2016, a pilot side scan sonar survey was conducted within Wanapum Reservoir at the two known overwintering locations to determine the feasibility of the approach and if a reliable estimate of sturgeon abundance could be measured.

Juvenile White Sturgeon Releases

As of May 2015, PRPA juvenile White Sturgeon supplementation program had released 26,194 hatchery-raised juvenile sturgeon from four brood years (2010, 2012, 2013, and 2014) into the PRPA (Golder 2011, 2013, 2014, and 2015). For the reasons described in previous annual reports, release numbers, strategies, and locations have varied from year to year (Table 1). Under the 2016 SOA, revised hatchery juvenile White Sturgeon annual stocking targets were established for years 2016 (Year 8 of the WSMP) to 2020 (Year 12). This report describes the release numbers, locations, and strategies used in 2016 for 2015BY fish.

Table 1 Summary of hatchery white sturgeon juveniles in 2011 (2010BY), 2013 (2012BY), 2014 (2013BY), and 2015 (2014BY) in the Priest Rapids Project area.

							Fork Length (cm)		Weight[4] (g)	
Brood Year	**Reservoir**	**Release Location**	**River Mile**	**Brood Source**	**Release Date**	**Number Released**	**Mean**	**SD**	**Mean**	**SD**
2010	Wanapum	Columbia Siding	450.6	UCW[1]	26 April 2011	2,020	24.6	3.0	174	97
				MCW[2]	29 April 2011	2,996	28.8	3.6		
				LCC[3]	27-29 April 2011	2,000	34.7	3.6		
				All	--	7,016	29.3	5.1		
	Priest Rapids	Wanapum tailrace	415.6	UCW	26 April 2011	900	24.8	2.8	187	105
				MCW	28 April 2011	601	29.0	3.6		
				LCC	28 April 2011	600	35.9	2.9		
				All	--	2,101	29.8	5.3		
2012	Wanapum	Columbia Siding	450.6	MCW	14 May 2012	1,135	29.2	2.7	156	45
		Columbia Cliffs	442.0	MCW	14 May 2012	1,129	29.8	2.6		
		All	--	MCW	--	2,264	29.5	2.6		
	Priest Rapids	Wanapum tailrace	415.6	MCW	14-15 May 2013	1,717	28.5	2.4	149	41
2013	Wanapum	Rocky Coulee	421.5	MCW	6 May 2014	3,331	26.6	4.0	129	63
				MCW	18 September 2014	1,762	29.1	4.4		
	Priest Rapids	Wanapum tailrace	415.6	MCW	5 May 2014	997	27.2	4.2	133	62
				MCW	17 September 2014	504	28.1	4.3		
2014	Wanapum	Frenchman Coulee	424.5	MCW	30 April to 1 May 2015	5,007	31.3	2.9	199	55
	Priest Rapids	Wanapum tailrace	415.6	MCW	1 May 2015	1,495	31.5	3.5	194	57

[1]Upper Columbia Wild (UCW) - the progeny of wild broodstock captured in the upper Columbia River in Canada and reared by the Freshwater Fisheries Society at Kootenay Sturgeon Hatchery in British Columbia

[2]Mid Columbia Wild (MCW) - the progeny of wild broodstock captured either in PRPA or below McNary Dam and reared at the Yakama Nation Marion Drain Hatchery (MDH)

[3]Lower Columbia Cultured (LCC) - the progeny of captive broodstock originally captured below Bonneville Dam in the lower Columbia River

[4]Calculated for entire broodyear release

Broodstock Capture

Concerted broodstock capture efforts within the boundaries of the PRPA were conducted from 2010 to 2014 at several locations. Based on catch results in 2010 and 2011, broodstock captures were below the requirements recommended in the WSMP breeding program. As such, other capture location were examined in an attempt to provide the supplementation program with sufficient broodstock to meet the programs genetic diversity objectives. Despite additional efficiencies and efforts to increase broodstock captures within the PRPA in 2012 to 2014, broodstock capture efforts within the PRPA were discontinued after 2014 in favor of focusing efforts below McNary Dam where capture success was substantially higher. Capture efforts below McNary Dam were initiated by Chelan PUD in 2012; their consultant team continues to lead and coordinate this work, with funding and logistically support provided by Grant PUD. The present report summarizes broodstock collection efforts for 2016 and provides an attached memo report with additional details (Appendix A).

Monitor Dispersal of the 2015BY Juvenile White Sturgeon

The movements of acoustic-tagged White Sturgeon in PRPA are monitored using ten to twelve continuous-monitoring acoustic telemetry receiver stations. The receivers were first deployed in 2010 and have been maintained on an annual basis, with up to four services sessions conducted per year to download data and maintain the array (i.e., cleaning, repairs, and battery exchange). In 2015, all stations were refurbished with new stainless steel components to improve longevity and reduce the risk of component failure. A shore based deployment system was also deployed in 2015 at select monitoring locations considered less suitable for the float and cable-mooring system. This report provides details of the array maintenance and results obtained on fish detections in 2016.

Juvenile White Sturgeon Population Indexing

A critical component of the M&E program is to assess the abundance and survival of each juvenile White Sturgeon brood year release. This data is needed to inform future annual release numbers in response to brood year specific abundance and survival estimates. Pilot mark-recapture studies were conducted in 2012 and 2014 to determine the appropriate methodology and level of effort necessary to collect data that would yield juvenile survival estimates with sufficient precision on which to base stock management decisions.

In 2012, juvenile White Sturgeon population indexing was conducted from August 29 to September 2 to capture juvenile sturgeon using overnight gill net sets. In total, 80 overnight gill net sets were deployed (60 sets in Wanapum Reservoir and 20 in Priest Rapids Reservoir) for a total of 1,705.8 hours of fishing effort. Despite the relatively intensive survey effort, only one hatchery juvenile White Sturgeon was captured. However, the magnitude of the by-catch recorded during the survey (2,358 fish from 13 species) indicates that the nets were fished effectively, which suggests that 2010BY juvenile sturgeon densities were lower than expected in the areas sampled in 2012. Possible reasons for the low capture rates are discussed in the 2012 report (Golder 2013).

For the 2014 juvenile White Sturgeon indexing survey, gill net gear was abandoned in favor of baited setlines. Setline sampling was conducted in Priest Rapids Reservoir from August 12 to 22, and in Wanapum Reservoir from August 25 to September 5. In total, 367 White Sturgeon were captured and processed during GRTS and supplemental setlining in Wanapum (GRTS n = 233; Supplemental n = 16) and Priest Rapids (GRTS n = 89; Supplemental n = 29) reservoirs. These captures represented 362 individual fish (five fish were captured twice: four in Wanapum and one in Priest Rapids).

The approach used and lessons learned during the 2014 study in terms of gear configuration and study design were used in the development of the 2016 small hook setline juvenile indexing program in the PRPA. Methods used are described in this report along with a summary of the results and a discussion on the effectiveness of the program at meeting the study objectives.

1.1 Consultation

Pursuant to the reporting requirements, Grant PUD provided a complete draft of the WSMP Annual Report to the PRFF on February 06, 2017 for review. There were no comments received after the 30 day review period. A letter of approval from Washington Department of Ecology was received on March 14, 2017 (Appendix B).

2.0 METHODS

Most aspects of the study methodologies used in 2016 closely followed those used in previous studies conducted in PRPA (e.g., VR2W acoustic receiver station servicing, downloading etc.) These methods are described in detail in the previous reports (Golder 2011, 2012, 2013, 2014, 2015, and 2016). The following sections provide general descriptions of methods used; more detail is provided for new methods or methods modified from previous studies.

2.1 Environmental Variables

2.1.1 Discharge and Temperature

Total river discharge and temperature data recorded in the tailwater of Rock Island Dam were used to document these environmental variables within PRPA during each study component. Mean hourly total river discharge and water temperature data from January 1 to November 8, 2016 were obtained from the Columbia River Data Access in Real Time webpage (DART 2016).

2.2 Side Scan Sonar Survey

Side scan sonar surveys were conducted at known White Sturgeon overwintering areas located at Columbia Cliff Eddy near RM442.0 and within a 2 km long section of the reservoir near RM426.5. Prior to the start of the sonar surveys, mobile acoustic telemetry tracking with a portable receiver equipped with an omnidirectional hydrophone (i.e., Amerix-Vemco model VR100) was conducted to confirm the presence of acoustic-tagged White Sturgeon within the survey area. Side scan surveys were conducted within the deepest section at each location, which generally corresponded to the thalweg of the original river channel. Within the survey areas, the Columbia River bottom bathymetry and substrate composition was expected to be highly variable, with uniform silt-covered flat sections interspersed with deep canyons, basalt boulder fields, and basalt columns.

Surveying was conducted off the Golder Associates vessel Caribou from February 9 to 11, 2016. An Edgetech 4125 dual frequency 600/1600 kHz side scan sonar was used in conjunction with a Hemisphere AtlasLink differential geographic positioning system (DGPS) to complete data collection. The sonar and GPS were input directly into EdgeTech Discover software.
The onboard Garmin navigation system also simultaneously collected depth and position information which was input into Hypack software for navigating survey transects. Survey transects were positioned based on existing bottom bathymetry data and plotted in GlobalMapper. In the field, GlobalMapper was operated on a second computer equipped with a Garmin 78 GPS system to provide real-time positioning of the boat in relation to the survey transect.

Two sonar survey methods were attempted during this pilot study. In locations with relatively uniform bathymetry, where transect length generally exceeded 500 m, the sonar towfish was deployed on its umbilical cable with no additional weight and towed behind the boat. This deployment method is the standard deployment method outlined in the manufacturer's specifications. Deployed in this manner on a 50 m long umbilical, the sonar can reach depths of 30 m when towed at speed of 3.7 km/hr (2 knots) relative to the current. This deployment method was less technical, quick, and involved minimal additional equipment, but once deployed, the ability to change the elevation of the towfish in response to a sudden change in bathymetry was limited to increasing or decreasing tow velocity, which caused the towfish to plane either higher or lower, respectively, in the water column. Changes in current velocity, wind, and wave action increased the level of difficulty for the boat operator to maintain a constant speed and a constant towfish deployment depth. Manual adjustments of the towfish elevation by retrieving or extending the umbilical was possible at slow speeds but more difficult at high tow speeds, given the unit weight of 23 kg (50 lb.) and water drag. This deployment method was most effective at the overwintering site near RM426.5 where transect lengths were generally longer and bathymetry was more uniform. Most survey transects were conducted moving upstream against the current. Due to the slow current at this location, attempts were also made to survey while drifting downstream and using power only to maneuver the vessel as it drifted. This approach saved time and effort in terms of gear retrieval and reduced travel time between transects.

Within the tighter confines of the overwintering site at Columbia Cliffs eddy, the unit was deployed on a short 1m tether behind a 45 kg (~100 lb.) sounding weight which was raised and lowered in the water column with a manual cable sounding reel (Scientific Instruments). This allowed the sonar towfish to be towed at depth essentially directly below the tow vessel. Deployment in this manner also required securing the towfish umbilical to the sounding reel cable with metal clips attached to the umbilical at 3 m intervals along its length. Due to the weight of the suspended equipment and the manual sounding reel, substantial physical effort was required to retrieve the sounding reel cable in response to sudden changes in bottom bathymetry and when doing so, changes in towfish elevation were not smooth due to the retrieval method and exertion required. This deployment configuration also required a crew of four: two crew to handle the raising and lowering of the sonar, one person responsible for monitoring data collection, and a boat operator.

Data was collected by EdgeTech Discover software and converted to Hypack format for mosaicking. Prior to conversion to Hypack, an adjustment for 15 of declination was applied. As an objective of this pilot study was primary to enumerate White Sturgeon, pinpoint accurate positioning of targets (i.e., large fish with the ability to move) was not required and layback (i.e., tow distance behind boat) offset adjustments were not applied to the data. To create mosaics, raw HSX files were processed and saved to H2S files. Smoothing of heading and bottom track were applied during processing and towfish altitude was corrected manually if needed. A median pre-filter was also applied prior to mosaicking. Time-Varied Gain (TVG) was set to 35 Decibel-seconds/100 meters and the water column (nadir) was removed. Georeferenced tif files were then created using an average filter and an overlay method for overlapping areas. Data collected during turns or while the sonar was moving quickly were not converted to tif format.

2.3 2015BY Marking and Release

Working in conjunction with staff from Marion Drain Hatchery (MDH), the combined 2015 broodstock capture efforts by Grant PUD and Public Utility District No. 1 of Chelan County, Washington (Chelan PUD) resulted in the production of 85 genetic crosses (9 unique crosses, 76 half-sib crosses) of BY2015 juvenile White Sturgeon.

The 2016 target was to mark and tag approximately 3,250 juvenile 2015BY White Sturgeon for release. As in previous tagging efforts, fish were tagged in equal proportion across all genetic crosses sorted into specific holding pens based on release location. Under the revised release strategy outlined in the SOA (March 11, 2016), 2,000 of these fish were to be released in Wanapum Reservoir with the remaining 1,250 to be released in Priest Rapids Reservoir. Processing of the 2015BY (e.g., tagging, marking, etc.) was scheduled for early April 2016, with the fish to be released by late April after a recuperation period of approximately two weeks.

All hatchery White Sturgeon received a 12.5 mm, 134.2 kHz ISO full-duplex PIT-tag inserted on the left side of the fish at the base of the 4th dorsal scute, with the tag oriented with the body axis towards the head of the fish. All fish were externally marked as hatchery fish by removing the three left-lateral scutes posterior of the imaginary vertical line extending down from the origin of the dorsal fin (Figure 2). Approximately 1% of the total juvenile release group were implanted with acoustic telemetry tags (Vemco® V9 coded pingers) to allow examination of post-release movements by a portion of the release group. If a fish received an acoustic tag, the tag was inserted into in the coelom through a horizontal incision in the lateral wall; the incision was closed with two interrupted single sutures (Figure 2). Surgical implantation of the acoustic tags was conducted by an LGL biologist on a select group of candidate fish set aside after processing of all fish was complete.

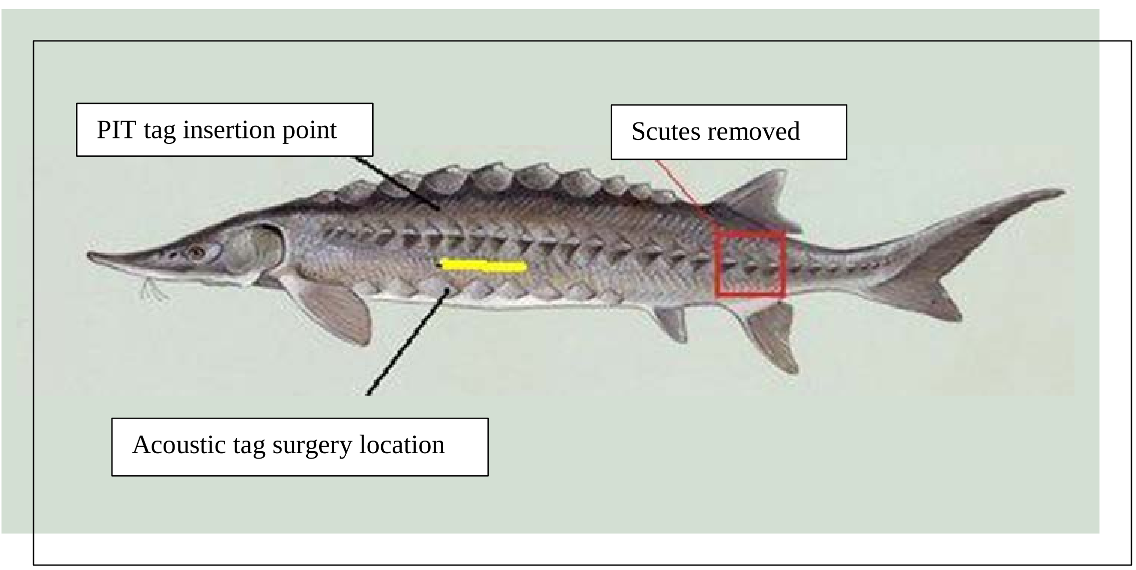


Figure 2 Juvenile white sturgeon tag implementation and mark locations.

In total, 32 Vemco V9 acoustic tags were purchased for implantation in the 2015BY juveniles (Table 2). When possible, fish that weighed at least 235 g were selected to ensure that the tag weight did not contribute more than 2 percent to total weight of the tagged fish. Even though this optimum fish weight is typically greater than the mean fish size at release for most brood releases (see Table 1), the V9 tag was considered the best choice both in terms of tag life and that could still be implanted into a fish comparable to the mean release size and likely to exhibit similar behavior, movement patterns, and survival rate. These acoustic-tagged fish were distributed in PRPA following the same approach used in 2015, with 77% (n = 25) acoustic-tagged fish released in Wanapum Reservoir and 23% (n = 7) in Priest Rapids Reservoir.

Table 2 Vemco V9-2L coded pinger tag specifications.

Vemco V9 Tag Parameters	V9-2L Specifications
Output (dB/m)	145
wt in air (g)	4.7
Tag length (mm)	29
Tag diameter (mm)	9
Tag life at 170-310s burst interval (days)	912

Tagging logistics and data collection were coordinated by BLE, with assistance by Marion Drain Hatchery (MDH) staff during PIT-tagging and scute-marking. Data were recorded electronically into the P3 data processing program to limit errors associated with manual data entry.
The BLE biologist was responsible for implementing appropriate quality control/quality assurance protocols (e.g., spot inspections of processing methods, daily data verification, and backup, etc.) during fish processing and data recording. The data fields recorded were selected to document the genetic origin, holding and rearing conditions, morphometry, abnormalities, the identifying tags and marks applied to each fish (Table 3).

Table 3 Data recorded for the 2015BY white sturgeon tagged and released in the Priest Rapids Project area in 2016.

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
Brood Year Cross	2015
Rearing Pen-Stock Id	See Table 5
Release Pen #	WP or PR
Scute removal	3 left lateral scutes below dorsal,
PIT-tag placement	left lateral, behind head
Notes	Record deformities and if fish are in poor health

2015BY Release

The 2015BY were held at MDH from 10 to 17 days post-tagging and allowed to recover from the tagging process. All 2015BY were tentatively scheduled to be released by late April to allow MDH staff time to clean and prepare the facility for receipt of 2016 broodstock captured in May. The release of 2015BY in the PRPA was coordinated by BLE biologists, who worked with staff and equipment provided by MDH and Grant PUD.

In Wanapum Reservoir, hatchery fish were released at Frenchman Coulee boat launch (RM424.5). Consistent with previous years, fish destined for Priest Rapids Reservoir were released at the Wanapum Dam tailrace launch (RM415.6). Transport of the fish from the MDH to the release sites was accomplish with Grant PUD hatchery truck and the Grant White Sturgeon transport trailer. Fish were released to the river through either a flexible flume or chute to avoid damage to the fish. Buckets of water and nets were used to evacuate any remaining fish from each transport vehicle. An effort was made to chase any fish away from around the wheels of the transport truck before the transport vehicle was removed from the water.

BLE field staff assisted with fish transfer and transport efforts, as well as monitored water temperature and dissolved oxygen of the transport and/or receiving waters during the following stages of the release:

- during fish transfer from holding pens to the transport vehicle at MDH;
- during transport at a minimum of two scheduled check stops, and;
- during release of the fish.

Transport manifest forms were completed by BLE staff to record the above information, as well as the date and time of water quality checks and the arrival, release, and departure times.

2.4 Broodstock Capture

White Sturgeon broodstock capture was conducted in 2016 as part of a collective broodstock program conducted in the mid-Columbia basin in support of White Sturgeon conservation aquaculture program at MDH. This capture effort consisted of guide-assisted angling conducted by BLE biologists, Chelan and Grant PUD personnel, and volunteers. All broodstock capture efforts in 2016 were conducted over 10 days from May 16 to 25 below McNary Dam in John Day Reservoir. Candidate broodstock were transported to Marion Drain Hatchery by BLE staff with the Grant PUD White Sturgeon transport trailer. Following transportation to the hatchery, fish were weighed and transferred to a holding pen where additional gonad inspections were conducted to determine egg maturity (i.e., PI index) and milt viability in preparation for egg take and fertilization efforts.

2.5 Juvenile White Sturgeon Population Indexing

In early 2016, discussions were held to standardize the setline sample gear used to assess juvenile White Sturgeon populations in the mid-Columbia. These discussions involved Grant PUD, Chelan PUD, the Colville Tribe, Blue Leaf Environmental, and Golder Associates. The overarching objective of these discussions was to allow greater comparability of study results throughout the upper and mid-Columbia system by standardizing juvenile White Sturgeon setline sample gear. This standardization would help to reduce the effect of sampling gear bias when comparing catch results, both in terms of the number and size of fish caught, between study years and study areas. Through these discussions, a consensus was reached that established the design specifications for a “standard juvenile White Sturgeon setline” in terms of the ground line length and the type of line used, gangion design, and the number of gangions fished per line.

Juvenile White Sturgeon mark-recapture efforts were conducted in 2016 from September 7 to October 6 to obtain growth data, population estimates, and survival estimates of wild and hatchery juvenile White Sturgeon in Wanapum and Priest Rapids reservoirs. Sturgeon actively feed throughout the summer and early fall and, as was shown in the 2014 survey, can be effectively captured with baited hooks deployed on setlines. The timing of the 2016 sampling effort was selected in part based on past seasonal sampling that recorded the highest White Sturgeon capture rates during setline surveys in September and October (Golder 2003). Sampling at this time also avoided high summer time air and water temperatures, as well as higher levels of recreational activity, that could potentially cause additional stress on captured fish.

Sampling was conducted in Wanapum Reservoir by Golder and BLE field crews using two Golder research vessels to deploy gear and process fish. Sampling in Priest Rapids Reservoir was conducted by Grant PUD biologists using Grant PUD research vessels. Setline sampling gear and sample methodology was essentially identical for all vessels, with each boat equipped with ten complete setlines. Each setline was 122 m (400 ft) long and constructed of 0.63 cm (0.25 inch) diameter Everson Aqua tarred 3 strand nylon line. Float retrieval lines between 25 m to 50 m long were attached to each end of the setline. The retrieval lines were constructed from either the same material as the setline or from 0.95 cm (0.375 inch) diameter Goldbraid line and were equipped with either one or more foam-core floats (8 lb. flotation per float) or a LD2 polyform float. Metal rail pieces (approximately 25 kg each) were used to anchor each setline end. Float lines were tied into end loops of the setline and generally remained attached, with additional line tied on or removed as dictated by deployment depth. The anchors, equipped with carabineers, were attached immediately prior to deployment to the setline end loops and removed and stored separately after the line was retrieved. Plastic totes were used to store and organize the setlines, with up to two setlines per tote. In fast flowing or deep water, additional anchors, sections of float line, and additional floats were added as needed to secure the line and facilitate retrieval.

Configured to fish 40 equally spaced gangions, each setline was painted with flag-orange marks applied at 3 m (9 ft.) intervals to identify the gangion attachment locations. Each gangion consisted of a single circle hook, either size 2/0 or 4/0 (Mustad Demon Circle Perfect 2X Strong), a 30.5 cm (12 inch) 150 lb. test monofilament lead, and a stainless steel snap and swivel (check size). Each research vessel was equipped with 10 sets of gangions – a set for each setline – as well as spares (i.e., 200 2/0 gangions, plus 60 spares; 200 4/0 gangions, plus 40 spares). The snaps of the 2/0 gangions were spray-painted red to allow crews to easily distinguish between gangion sizes without seeing the hook itself. Gangions were baited with commercially available pickled squid (Gilmore Smokehouse). A simple gangion organizer, consisting of a five gallon bucket with 40 3.2 cm (1.25 inch) diameter PVC tubes, was used to keep the gangions separate and untangled prior to deployment. Gangions for up to five complete setlines were stored in this manner. Gangions not in use were either taped in bundles or stored in a spare gangion organizer. Once baited and prepared for deployment, the gangions for a setline were selected at random so that gangions of different sizes were distributed randomly over the length of the line.

Setline locations in 2016 were selected using a single pass, unstratified, unequal probability general random tessellation stratified (GRTS) sampling design (Stevens and Olsen 2004).

This sampling methodology was also used during the 2014 indexing survey (Golder 2015). The GRTS sample locations were determined with the SPSURVEY package (Kincaid 2007) developed for the R statistical program (R version 3.2.3; R Core Team 2016). The PRPA acoustic telemetry data and White Sturgeon areal distribution data collected to date suggests moderate to high use of the upper and middle portions of each reservoir by White Sturgeon (Golder 2011, 2015). In a typical unstratified, equal probability GRTS sample design, a uniform population distribution is assumed and sampling intensity (i.e., effort per unit area) is equal over the areal extent of the reservoir, with the consequence that in PRPA, most sampling would be conducted in the much larger lower section of each reservoir. By using an unequal probability GRTS design, different levels of sampling intensity were specified between reservoir sections ("multi-density categories") with the intention to maximize catch by allocating more sample effort per unit area in the middle and upper sections of each reservoir where sturgeon are suspected to aggregate. The 2016 survey used the same sample multi-density reservoir categories ("lower", "mid", and "upper" sections) used during the 2014 survey (Golder 2015). These sections roughly reflected the transition from riverine to reservoir conditions in each pool.

To date, the sample frame polygons used for GRTS indexing surveys conducted in the PRPA have been based on selection of an appropriate bathymetric contour to constrain the areal extent of sample selection and exclude shallows with abundant macrophytes. In the development of the 2016 study design, a review of White Sturgeon capture data in Wanapum Reservoir was conducted and concluded that setlines at greater depths catch more fish than setlines set at shallow depths; this trend was also noted during the 2014 juvenile indexing study (Golder 2015). Previous Wanapum Reservoir GRTS sample frame polygons were based on the area encompassed within the 10 m bathymetric contour. Given the tendency for more fish to be caught at deeper sites, the Wanapum Reservoir GRTS sample frame polygon used in 2016 was based on the ≥15 m bathymetric contour and was considered a reasonable compromise for Wanapum Reservoir in terms of focusing sampling effort on deep water habitat, while maintaining sampling intensity and areal coverage within each reservoir section that was comparable to the 2014 study. In Priest Rapids Reservoir, site selection was constrained to the area encompassed within the ≥6 m bathymetric contour, which has been used in all previous GRTS sampling efforts within Priest Rapids Reservoir, with the result that areas of abundant aquatic macrophytes are generally excluded and without exclusion of large areas of the shallow upper and middle reservoir sections.

In Wanapum Reservoir, the R spsurvey package specified a GRTS sample draw of 270 sites (with a 50% overdraw) with sites allocated equally among sections (i.e., 90 sites per section). In Priest Rapids Reservoir, the specified GRTS draw was 90 sites (with 50% overdraw) with sites allocated equally among reservoir sections (i.e., 30 sites per section). In both reservoirs, sampling intensities increased from downstream to upstream reservoir section because the areal extent of sections progressively decreased moving upstream. Setlines were set overnight in block pattern (i.e., all sites set in given day were spatial adjacent) and pulled approximately every 24 hours. Each boat typically processed and re-set eight lines per day; however, up to ten setlines were deployed at select locations when sites were close together or travel time to the site was minimal (e.g., next to the boat launch). Lines generally were set off the research vessel's bow in an upstream-downstream orientation with river current, and pulled from the starboard side in reverse order; however, in very windy conditions, lines were deployed in the direction of the prevailing wind. Data recorded during gear deployment and retrieval included: set start and end date/time, water and air temperature, set depth (minimum, maximum, and the average of minimum and maximum depths observed during the set), number of gangions set, and the number of bent, broken or lost hooks at time of line retrieval.

During retrieval, an electric side winch and davit were used to retrieve the setline anchors, after which the ground line was usually pulled in by hand and the gangions removed. Captured sturgeon were left attached to the hook and were placed in one of three water-filled holding tubs, with the gangion clip secured to the side of tub. Fish were either processed as the line was pulled in or held and process after the entire line was recovered. Occasionally, a fish too large for the holding tub was captured; in these cases, retrieval of the setline was halted and the fish either immediately processed or temporarily secured to the outside of the boat on a suspended line and processed at the end. All captured fish were scanned for a PIT-tag and a PIT-tag applied if none was detected. Once the PIT-tag number was confirmed, weight and fork length were recorded. The fins of each sturgeon were inspected for deformities and if present, the specific fin or fins in which the deformity occurred was recorded. If fin deformity was present, fin deformities were categorized into two categories – either "missing" or "deformed". Fins that were less than 20% of normal size were considered not functional and were classified as "missing". Fins that were more than 20% of normal size and deformed, in that some aspect of the fin (e.g., shape, damage, curl, etc.) deviated from a normal healthy fin, were all classified as "deformed". Prior to release, the disposition of the fish was recorded as either alive, dead, or euthanized.

The relationship between sturgeon log10 transformed FL and weight data was estimated via linear regression for each reservoir separately. Sturgeon condition was estimated by calculating relative weight based on the standard weight (Ws) equation for White Sturgeon: Ws = 2.735 E-6 * $FL^{3.232}$ (Beamesderfer 1993). Absolute growth (cm) in FL, and average annual growth rate (cm y-1) in FL between tagging and capture was calculated for individual fish. For sturgeon caught more than once during the survey, data from the first capture was used in growth calculations. The proportion efforts where sturgeon catch was greater than zero (Ep; Counihan et al. 1999;Bannerot and Austin 1983; Uphoff 1993), also referred to as the proportion of positive catch, was calculated as median comparison of catch rate between the two reservoirs and reservoir section within each reservoir.

2.6 Juvenile White Sturgeon Survival and Abundance Estimation

Mark-recapture data from sampling conducted during the September-October juvenile White Sturgeon sampling programs in 2016 were used to construct a Cormack-Jolly-Seber model of survival of juveniles released in Wanapum and Priest Rapids reservoirs. The analysis was implemented using the statistical environment R, v. 3.2.3 (R Core Team 2016), interfaced with Program MARK (White and Burnham 1999) through the package 'RMark' (Laake 2013). Fish tagged in Wanapum Reservoir that were subsequently captured in Priest Rapids Reservoir were not marked as emigrated, since the analysis did not take into account reservoir of capture, only reservoir of release. The model used the following assumptions:

- Only hatchery fish released in the PRPA were included in the analysis (i.e., 29,449 fish as of April 2016)
- Ignore recaptured entrained fish that were released elsewhere (including from Rocky Reach)
- Ignore recaptured wild fish.

- Does not include any covariates (like fish weight at release), due to some missing release weight data.
- Assumes all fish were released at age-1
- Assumes no difference between survival for first year and subsequent years (due to lack of data and model convergence). Cohort survival rate was the average between first year survival and higher post release survival rate after year 1.

Models were constructed using all combinations of the following survival and recapture specifications:

- Survival as constant, as function of age, and as function of release reservoir;
- Recapture as constant, as function of sampling year, and as function of release reservoir

The candidate models were evaluated using Akaike's Information Criterion corrected for small sample size (AICc), where a lower value indicates better support for the model. The selected model-averaged results provided estimated survival and recapture values. The survival estimates were used to calculate cumulative mean annual population values with 95% confidence intervals, to describe abundance of hatchery juvenile White Sturgeon released in the PRPA for each calendar year from 2011 to 2016.

2.7 Telemetry Receiver Array Download and Maintenance

Up to 12 acoustic telemetry monitors (Amirix Vemco model VR2W) have been deployed on an annual basis since 2010 to monitor movements of acoustic-tagged adult and juvenile White Sturgeon in PRPA. Initial use of the telemetry data was to determine seasonal movements and habitat preference (e.g., spawning and overwintering timing, location, etc.). Currently, the primary use of the PRPA acoustic telemetry array is to monitor the movements of acoustic-tagged fish that comprise 1% of the total hatchery juvenile White Sturgeon released each year. This data is also used to estimate entrainment rates of hatchery fish from Wanapum Reservoir into Priest Rapids Reservoir, as well as entrainment from Priest Rapids Reservoir into McNary Reservoir.

In 2016, all receivers were downloaded in April, August, and November. Batteries of all receivers were replaced during the August service session. Unfortunately, three receivers station were vandalized in 2016. In Wanapum Reservoir, a critical station near the downstream-most overwintering site (VRRM426.5) was lost and had to be replaced with a temporary station (VRRM426.5B). This temporary station was eventually replaced in August with a permanent station (VRRM425.9) that was located slightly downstream of the original station at a site considered more secure, but still in range to detect acoustic-tagged fish holding within the overwintering area.

In Priest Rapid Reservoir, the station immediately downstream of Wanapum Dam tailrace (VRRM413.5) was lost due to vandalism that occurred at some point between the April and August service sessions. This station had been deployed in a custom metal housing, cabled to shore, and positioned in a back eddy at a depth of approximately 3.5 m. Both the receiver and the metal housing were not recovered. Replacement of this station was postponed pending relocation to a more secure location.

In McNary Reservoir, the station immediately below Priest Rapids Dam (VRRM396.1) was tampered with in late August 2016. This station was also deployed in a metal housing cabled to shore, which fortunately, was recovered by Grant PUD personnel. A second station deployed downstream of Priest Rapids Dam (VRRM384.1) was removed in 2016. Although the site was suitable and the station range tested, the station had not detected a single fish after a deployment period of one year. The location and deployment information of the remaining ten active VR2W stations in the Project are provided in Table 4.

Table 4 Current acoustic receiver station locations, deployment date, and status in the Priest Rapids Project area as of November 2016.

Station Name	River Mile	Zone	UTM E	UTM N	Reservoir	Deployment Date	Refurbished / Redeployed	Station Type [a]	Station Status	VR2W Serial No.
VRRM398.1	398.1	11	276803	5170825	Priest Rapids	22-Jun-10	15-Apr-15	LD2	Active	122200
VRRM403.0	403.0	11	273083	5177720	Priest Rapids	22-Jun-10	20-Apr-16	LD2	Active	126560
VRRM410.5	410.5	11	276891	5188323	Priest Rapids	23-Jun-10	17-Apr-15	LD2	Active	109731
VRRM415.5	415.5	11	274065	5195645	Priest Rapids	19-Sep-10	17-Apr-15	LD2	Active	109735
VRRM415.8	415.8	11	273714	5196132	Wanapum	13-Apr-15	13-Apr-15	Sboom	Active	109738
VRRM425.9	425.9	10	727773	5211426	Wanapum	11-Aug-16	11-Aug-16	LD2	Active	120241
VRRM437.1	437.1	10	726211	5227481	Wanapum	17-May-12	16-Apr-15	LD2	Active	120240
VRRM442.0	442.0	10	725351	5234884	Wanapum	21-Jun-10	16-Apr-15	LD2	Active	109723
VRRM446.9	446.9	10	719589	5237495	Wanapum	29-Jun-11	14-Apr-15	LD2	Active	109737
VRRM452.4	452.4	10	720484	5246202	Wanapum	20-Sep-10	14-Apr-15	LD2	Active	109725

[a] LD2 – float deployment system with the VR2W receiver deployed downward and vertical in the water column at a depth of 4 m. Sboom - deployed on a cable attached to forebay safety boom with the VR2W receiver oriented downward and vertical in the water column at a depth of 4 m

2.8 Juvenile Movements

The downloaded telemetry data from the receiver array were screened for errors. Spurious detections, defined as acoustic tag IDs that were detected only once on any given day, were removed from the dataset prior to analysis. Upstream-most and downstream-most detections by monitoring stations in the PRPA were determined for each fish, as was cumulative distance moved by each fish between its release date (i.e. all 2015BY were released April 28, 2016) and date of last detection. Movement of individual fish were plotted for fish identified as entrained from Wanapum Reservoir into Priest Rapids Reservoir based on consistent and multiple detections of acoustic-tagged Wanapum fish by acoustic receivers in Priest Rapids Reservoir. For each entrained fish, days at large prior to entrainment and approximate time of entrainment were estimated.

The screened telemetry data were also 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 spatial and temporal patterns of presence/absence of individual fish. Daily presence/absence data were then used to estimate: 1) a daily count of fish recorded at each station; and 2) a daily residency, calculated as the number of hours an individual fish was detected at each receiver station out of a daily 24 h. Individual residency proportions were then used to calculate daily mean and standard deviations of residency proportions across all fish detected by the receiver. Presence/absence data analyses were performed in the statistical environment R, v. 3.2.3 (R Core Team 2016). Plots were created in R using the package ggplot2 (Wickham 2009).

2.9 General Data Recording and Analysis

Custom task-specific field databases were designed and used to record field data. In particular, a new custom juvenile White Sturgeon indexing database was developed with custom data fields specific to the study data requirements. Within and between the various relational databases developed for the M&E studies, queries were used to extract, screen for error, and analyze annual and inter-year data pertaining to determine movement, growth, and capture history of adult and hatchery juvenile White Sturgeon. Additional post-collection error screening and data proofing was conducting using both Excel and R. Summary tables and simple figures were produced in Excel® using pivot tables and data filters. More complicated figures (e.g., GIS plots of brood year capture locations, etc.) were created in R using the package ggplot2 (Wickham 2009). Customized datasheets and manifests were used to record information during the juvenile release, and VR2W station installation, data downloading, and servicing.

3.0 RESULTS

3.1 Discharge and Temperature During Study Components

Physical conditions (discharge and temperature) in the PRPA during the 2016 M&E study components were considered in both the planning and data analysis phase of each study. Study results can be affected by discharge and temperature conditions at the time of sampling; as such, the seasonal timing of study components was considered as part of study program scheduling and logistics. Temperature and discharge were considered in the analysis and interpretation of all study data; however, more consideration was given to study components considered more sensitive to these variables (i.e., side scan sonar survey, 2015BY release and juvenile movements, broodstock capture, and juvenile White Sturgeon indexing) in the sections that follow.

In 2016, peak mean daily flows in the PRPA were recorded on April 22 (6,271 m^3/s) during a sustained period of high flows from mid to late April. Lowest mean daily discharge was recorded on September 17 (1,408 m^3/s). Peak mean daily water temperature was recorded on August 18 (19.9 C). The lowest mean daily water temperature was recorded on February 5 (3.6 C; Figure 3).

Side Scan Sonar Survey

During the side scan sonar survey, mean daily discharge gradually increased, with lower flows during the first sample day on February 8 (2,544 m^3/s) and higher flows on the last sample day on February 11 (3,288 m^3/s). Although total river discharge was not considered a critical factor to the success or failure of the survey, site specific water velocities (i.e., turbulence at Columbia Cliffs Eddy) were considered during the planning phase, as was preparation for inclement weather that could limit access to the reservoir. One key objective was to conduct the survey when the fish were aggregated in the overwintering areas. To achieve this objective, the survey was scheduled to coincide with the period of lowest water temperature under the assumption fish would be highly aggregated and more sedentary at this time. This objective was achieved, as the mean daily water temperature of 3.7 C during the survey was near the seasonal low immediately prior to survey on February 5 (3.6 C).

2015BY Release and Juvenile Movement

Scheduled release of the 2015BY juvenile White Sturgeon in April coincided with seasonal high flows in 2016. Although discharge and water temperature are likely important factors that affect post-release dispersal and entrainment, tagging and release schedules were determined primarily by hatchery operations in that each brood year is released to river after approximately ten months of hatchery rearing (i.e., typically in April of each year). During the 2015BY release on April 28, mean daily flows were (5,379 m^3/s) slightly lower than the peak discharge (6,271 m^3/s) on April 22. Mean daily Columbia River water temperature on the day of juvenile release was 9.9 C.

2016 Broodstock Collection

This study component was not conducted within the PRPA. The rationale behind the schedule and duration of the broodstock capture program, as well as the physical conditions during sampling, are appended to this report (Appendix A).

Juvenile White Sturgeon Indexing

Large variations in hourly and daily discharge were evident during the juvenile White Sturgeon indexing study from September 7 to October 6 (Figure 3). Typically, mainstem mid-Columbia River flows can vary considerably over a 24-hour period in response to power demands. During sampling, flows were high during the day (e.g., peak load mean hour discharge at 1800h = 2,464 m^3/s), with lower flows from late night to early morning (e.g., low load mean hourly discharge at 0300h = 478 m^3/s). These large daily fluctuations in discharge between peak and low load hours typically did not result in large changes in reservoir elevation as hydroelectric facilities in the PRPA and throughout the mid-Columbia generally operated as run-of-the-river (e.g., inflow equals outflow, reservoirs are not drafted). Because of the size of Wanapum Reservoir, Wanapum Dam operation has some reservoir capacity that can be opportunistically used to generate power; use of this reservoir capacity was occasionally noted by field crews, especially when research vessels were tied to shore to work up fish or prepare gear. During sampling, average mean daily discharge was 1,939 m³/s and ranged from 2,521 m³/s on September 9 to 1,408 m³/s on September 17; this low flow was also the lowest mean daily discharge recorded in 2016. Mean daily water temperature during sampling was 18.3 C (SD = ±0.2), which was only approximately 1 C cooler that the peak mean daily water temperature during the summer (August 18; 19.9 C). Water temperatures remained above 18 C throughout most of the sampling effort, but decreased below 18.0 C by October 5.

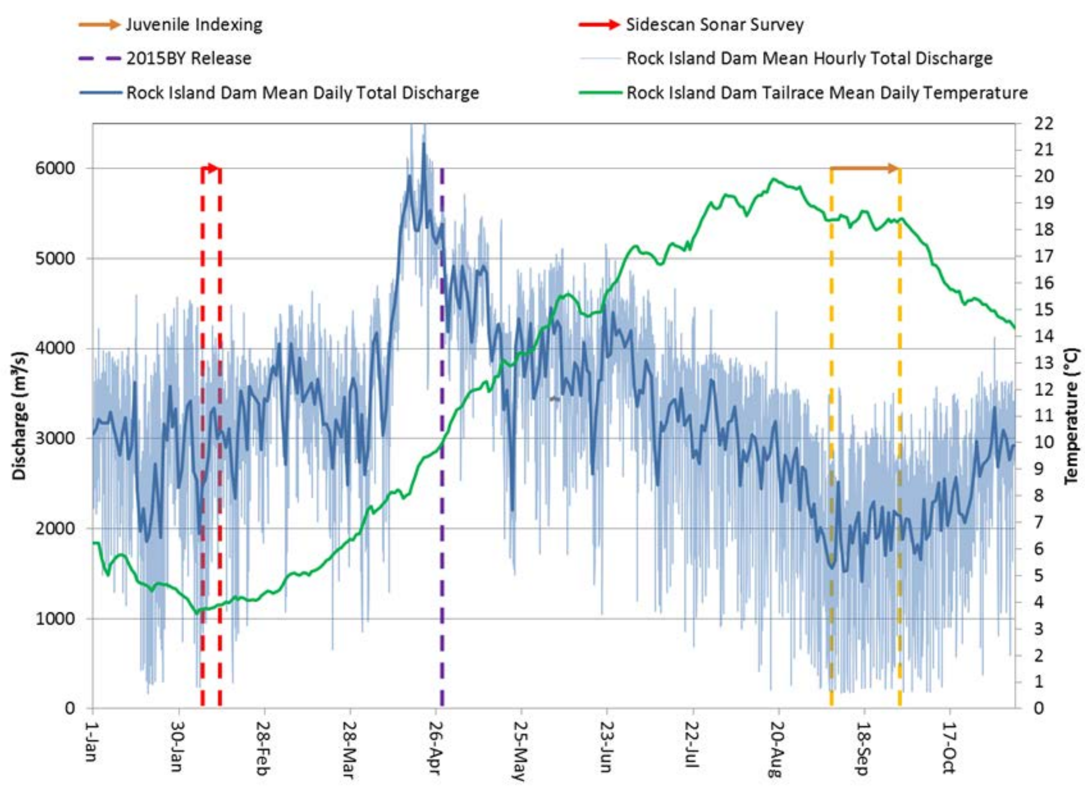


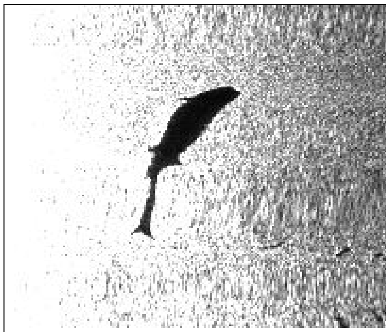
Figure 3 Mean daily discharge (dark blue line), mean hourly discharge (light blue ribbon), and mean hourly water temperature (green line) of the Columbia River in the Priest Rapids Project Area, as measured below Rock Island Dam. Horizontal arrows between the dotted vertical lines indicates the side scan sonar survey (red) and juvenile White Sturgeon indexing (yellow) sample periods. Vertical purple dashed line denotes the 2015BY juvenile White Sturgeon release date.

3.2 Side Scan Sonar Survey

Setup and testing of the side scan sonar in Wanapum Reservoir was conducted on February 9, 2016. Different deployment configures of the towfish were tested to confirm functionality both in terms of GPS position tracking and sonar image resolution during test survey transects to image a fixed target deployed under control conditions near the Vantage boat launch. Once functionality was confirmed, several survey transects were conducted at the White Sturgeon overwintering site downstream of Sunland Estates (RM426.5). Prior to the survey, mobile telemetry tracking was conducted, which confirmed the presence of acoustic-tagged White

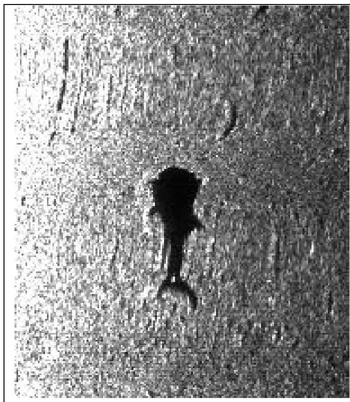
Sturgeon in the survey area. Large boulders and sudden changes in bathymetry required the crew to rapidly adjust the elevation of the towfish to either avoid collisions or keep the towfish at the optimal elevation above the river bottom (i.e., typically 2-4 m above bottom). Each vertical correction in elevation resulted in a distortion of the sonar image. In locations with many obstacles or variable depth, the sonar image recorded contained many distortions.

Even with the distortion, a review of the sonar image data found images that were clearly identifiable as White Sturgeon, based on body shape, fin position and fin size, and in many examples, a clearly defined heterocercal tail (Figure 4). Image resolution was best where the riverbed substrate was small (e.g., silt or sand). In locations with larger coarse substrate, shadows were created that broke up the outline of any fish in the image. Many large boulders and several basalt outcrops were observed throughout the overwintering area and potentially hid sturgeon from view (Figure 5). A mosaic of the overwintering area at RM426.5 was created to document the area covered during the four hour survey on February 9 (Figure 6).

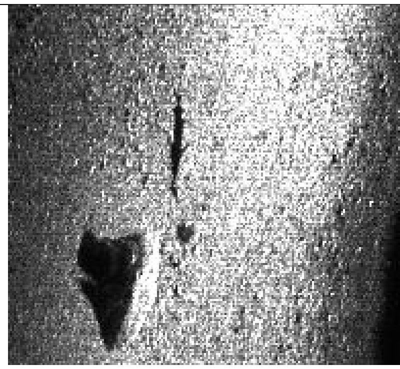


File: 212536 Date: February 11 Time (UTC): 212642

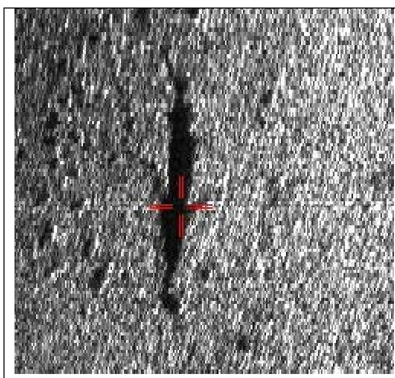
File: 212536 Date: February 11 Time (UTC): 212701



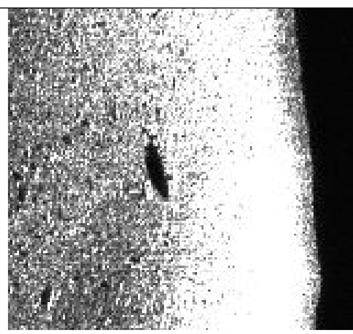
File: 212536 Date: February 11 Tim (UTC): 212928



File: 223236 Date: February 9 Time (UTC): 224019



File: 223236 Date: February 9 Time (UTC): 224019



File: 223236 Date: February 9 Time (UTC): 224054

Figure 4 Examples of white sturgeon detections in the side scan sonar data obtained from Wanapum reservoir.

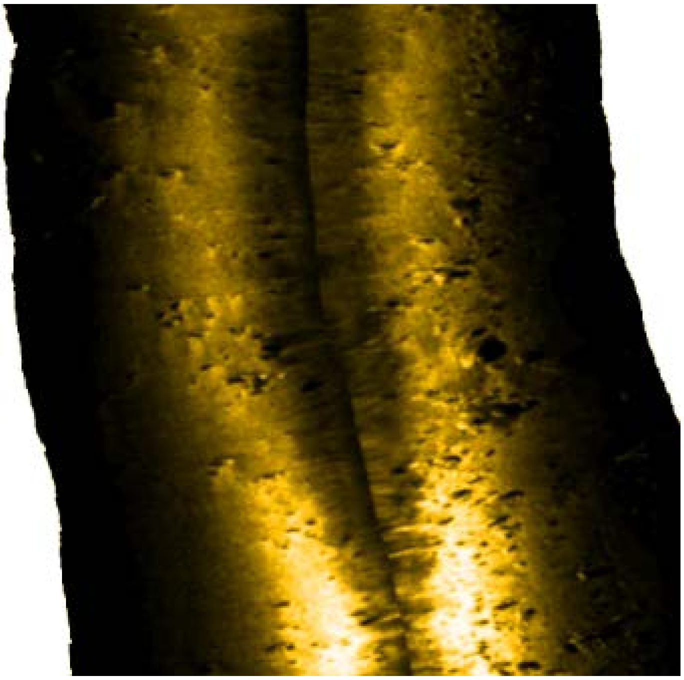


Figure 5 An example of bottom roughness recorded during the side scan sonar survey at an overwintering site in Wanapum reservoir, February 9, 2016.

Figure 6 Mosaic of the area covered by the side scan sonar transect through a white sturgeon overwintering site in Wanapum reservoir.

Sonar surveys were also conducted at the overwintering area near Columbia Cliffs on February 10 and 11, 2016. Prior to the surveys, acoustic telemetry monitoring confirmed the presence of over 40 acoustic-tagged White Sturgeon in this overwintering area.

Due to depth of the eddy (e.g., approximately 40 m) and step-walled bathymetry, the side scan sonar was deployed at depth using a sounding reel and weight. As with any new and untested methodology, several difficulties with this deployment method were evident after the initial survey attempts. Due to inaccurate bathymetric maps of the eddy, several attempts were required to locate the boundaries of the eddy and determine the areal extent of the deepest portion of the channel where it was assumed most of the sturgeon were located. Additional boat sonar depth data recorded during both reconnaissance and sonar surveys were used to identify high prior survey transects, but also to create a more accurate interpolated bathymetry map of Columbia Cliffs eddy (Figure 7). During each survey transect, frequent vertical adjustments in towfish elevation were required due to unexpected changes in bathymetry. With each vertical adjustment, the sonar image was distorted to the extent that the first and last portion of each transect during the deployment and retrieval efforts were of limited value. Hydrodynamic imperfections of the sounding weight (e.g., bent guides, etc.) caused the weight and the tethered towfish to wander off track or hunt after the boat when towed at speeds necessary to keep the towfish horizontal and parallel with river bottom. These continuous changes in sonar aspect (yaw) also created a significant amount of image distortion. Even with the issues, images of fish clearly identifiable as White Sturgeon were recorded (see Figure 4).

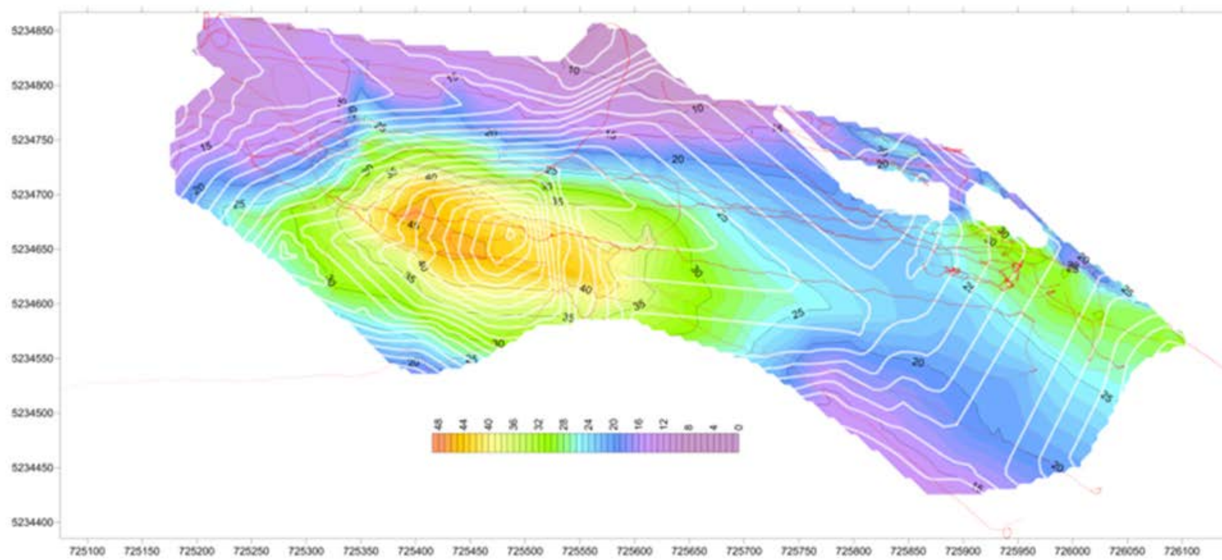


Figure 7 Comparison of existing Columbia Cliffs Eddy bathymetry (white lines) to data collected on the Caribou depth sounder and interpolated. Colored shading represents the interpolated contours from the Caribou sounder, as processed in Hypack and Surfer software. Red dotted lines show the tracklines taken by the Caribou, where there are more tracklines, the bathymetry is interpolated based on the increased coverage.

3.3 2015BY Juvenile Marking and Release

The 2016 Grant PUD juvenile White Sturgeon release program entailed the marking and release of the 2015BY reared at the Marion Drain Hatchery (MDH). The 2015BY release were the progeny of nine maternal families (9Fx10M) that resulted 85 genetic crosses (9 unique crosses; 76 half-sib crosses). All 2015BY fish were PIT-tagged and scute marked over three days from April 5 to 7, 2016. In total 3,258 fish were tagged and marked. The 2016 tagging instruction called for the removal of three left lateral scutes, below and anterior to the dorsal fin origin, to create an obvious external mark to indicate hatchery origin. However, during marking, the three left lateral scutes below and posterior to the dorsal fin origin were removed instead. This oversight was considered inconsequential as the resulting mark was still obvious and clearly visible.

The release proportion by reservoir outlined in the Priest Rapids White Sturgeon Stocking SOA, March 11 2016, stipulated the release 2,005 fish (62%) in Wanapum Reservoir at the Frenchman Coulee Launch (RM426.5) and the release of the remaining 1,253 fish (38%) in Priest Rapids Reservoir at the Wanapum Dam tailrace launch (RM415.6; Table 5). Mean fork length and weight of the 2015BY release was 303 mm (SD ± 27 mm) and 171 g (SD ± 46 g), respectively. Acoustic telemetry tags were surgically implanted in 32 2015BY, with 25 acoustic-tagged fish released in Wanapum Reservoir and 7 acoustic-tagged fish released in Priest Rapids Reservoir.

All fish were released on April 28, 2016 after more than 20 days to recover. Five shed PIT-tags were found in the holding pens once drained and cleaned. During transport, oxygen levels remained nominal (i.e., between 7 and 8 mg/L) and receiving water temperature was nearly identical the transport tank water (i.e., both at ~10 C). All fish were released alive; dead or moribund fish were not observed after the release.

Table 5 Number of 2015BY juvenile White Sturgeon released in Wanapum and Priest Rapids reservoirs and the mean fork depth (FL) and mean weight of fish in each release, April 28, 2016.

	2016 White Sturgeon 2015BY Release		
Release Location Reservoir (River Mile)	**No. of Fish (acoustic-tagged)**	**Mean FL (± SD) mm**	**Mean Weight (± SD) g**
Wanapum (424.5)[1]	2,005 (25)	304 (27)	173 (47)
Priest Rapids (415.6)[2]	1,253 (7)	301 (26)	167 (44)
Total	3,258 (32)	303 (27)	171 (46)

[1] Frenchmen Coulee Launch

[2] Wanapum Tailrace Launch

During tagging, fin deformities were recorded for 14% (456 of 3,258 fish) of the 2015BY. Fin deformity, when noted, was primarily associated with the pectoral fins (Table 6).

Table 6 Fin deformity type and occurrence noted during processing of 2015BY juvenile White Sturgeon that were subsequently released in the Priest Rapids Project area, 2016.

2015BY Primary Fin Deformity	Fin Deformity Sub-type	No. of fish with Primary Deformity	No. of fish with Sub-type Deformity
Caudal deformity only		31	
	deformed, curled, or damaged		30
	one missing fin		1
Both caudal and pectoral deformity		3	
	two deformed, curled, or damaged fins		3
Pectoral deformity only		421	
	one deformed, curled, or damaged fin		368
	one missing fin		16
	one missing fin, one deformed fin		2
	two deformed, curled, or damaged fins		35
Pelvic deformity only		1	
	one deformed, curled, or damaged fin		1
Total fish with deformities		456	

3.4 Broodstock Capture and Juvenile Production

In 2016, angling for broodstock took place over 10 days from May 16 to 25. In total, 148 individual White Sturgeon were captured; 5 were captured twice for total of 153 sturgeon landings. Of the individuals captured, 42 were greater than 150 cm FL and based on size were considered mature sturgeon and the gonads of each were surgically inspected to determine maturity and broodstock candidacy. The remaining 106 fish captured were less than 150 cm FL and were immediately released after basic processing. In total, 9 ripe females and 10 ripe males were transported to MDH. One female was determined to have a PI value too far out (i.e., not mature) and was returned to the river. The Yakima Nation contributed to the capture effort below McNary Dam by providing a boat and fishing guide for a day when staff were made available due to bad weather and poor fishing conditions on John Day Reservoir. This additional effort resulted in the capture and transport of two additional females and one male to MDH. Broodstock were spawned on May 27 and a 6x6 spawning matrix was performed to produce 36 genetic crosses (6 unique crosses and 30 half-sib crosses).

3.5 2015BY Juvenile White Sturgeon Movement

Acoustic telemetry positional data from the 2015BY acoustic-tagged juveniles recorded from April 28 to November 4, 2016 were analyzed to determine the post-release dispersal of juvenile White Sturgeon from their release locations in each reservoir.

In Wanapum Reservoir, all 25 acoustic-tagged fish released at Frenchman Coulee (RM424.5) were detected at one or more acoustic receiver stations deployed in the PRPA. The data recorded allowed calculation of total cumulative distance moved by each fish. These data indicated some fish moved substantial distances (e.g., cumulative movement = 176 km; [109 miles]) while other fish moved less (e.g., cumulative movement = 3.2 km; [2.0 miles]) and remained near the release site. Overall, most of the fish exhibited movement after release (mean movement = 53 km, SD = ±37 km; [33 miles ± 23 miles]) with most (n = 24 of 25 fish) fish moving upstream after release. Half of the acoustic-tagged fish released in Wanapum Reservoir that moved upstream after release were detected at least once at the upstream-most monitoring station below Rock Island Dam near RM452.4, approximately 45 km [28 miles] from the release site. The remaining fish exhibited less upstream movement and were detected at stations located near RM446.9 (n = 7), RM442.0 (n = 1), RM437.1 (n = 1), or remained in the vicinity of the release site and were detected by the stations near RM426.5 (n = 3; Figure 8).

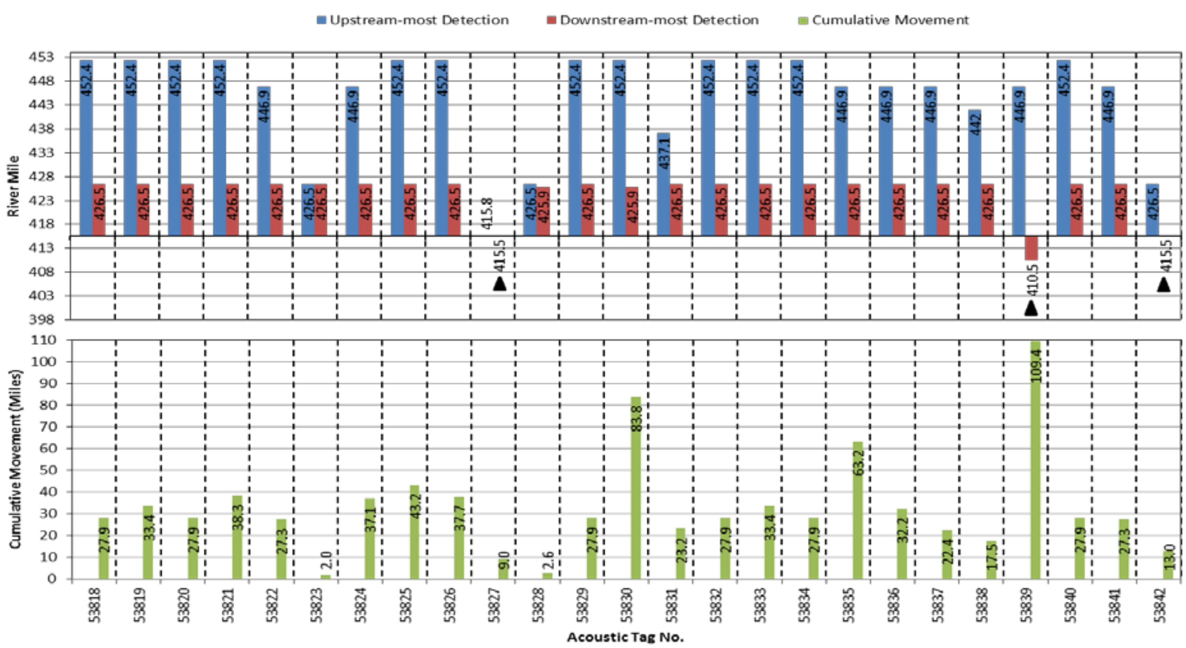


Figure 8 Upstream-most and downstream-most detection location (upper panel) and cumulative movements (bottom panel) of acoustic-tagged 2015BY White Sturgeon in Wanapum Reservoir from April 28 to November 4, 2016. Horizontal black line in upper panel represents Wanapum Dam location. Fish without a downstream-most detection were last detected at either Wanapum Dam forebay or tailrace. Black triangles indicate fish entrained from Wanapum Reservoir into Priest Rapids Reservoir.

Entrainment of 2015BY juvenile White Sturgeon from Wanapum Reservoir into Priest Rapids Reservoir was detected for 3 of 25 fish (12.0%) released on April 28 (Figure 9). All the entrained fish were initially detected by the Wanapum forebay receiver (near RM415.8) and subsequently detected by one or more acoustic receivers in Priest Rapids Reservoir after entrainment. Days at large in Wanapum Reservoir prior to entrainment were 11 days (i.e., tag 53827 on May 9), 63 days (i.e., tag 53842 on June 30), and 114 days (i.e., tag 53839 on August 20). The amount of movement and movement patterns exhibited by the fish differed as well, with some fish either moving downstream immediately after release (i.e., tag 53827; cumulative movement n = 14 km [9 miles]), remaining stationary near the release site (tag 53842; cumulative movement n = 21 km [13 miles]), or exhibited sustained and extensive movement before entrainment (tag 53839; cumulative movement n = 176 km [109 miles]). Once entrained, upstream movement by entrained fish (i.e., evidence the fish survived entrainment) was not recorded and these fish were only subsequently detected either near the Wanapum Dam tailrace station (i.e., RM415.5) or the next downstream station near RM410.5.

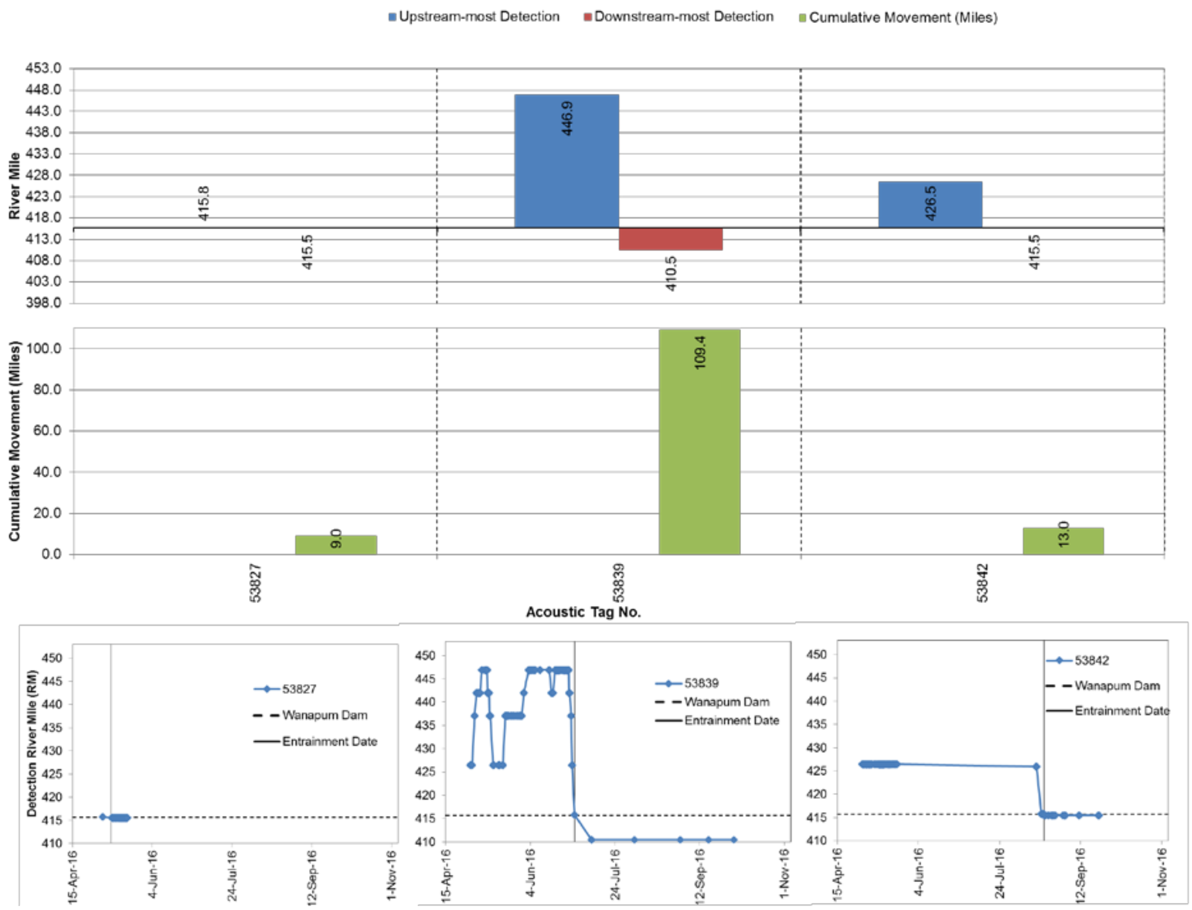


Figure 9 **Upstream-most and downstream-most detections (upper panel), cumulative movement (middle panel), and movement plots showing date of entrainment (bottom panel) of 2015BY White Sturgeon entrained from Wanapum Reservoir into Priest Rapids Reservoir.**

Post-release dispersal rates and distribution of the 2015BY juvenile White Sturgeon were assessed for Wanapum Reservoir based on the movement of acoustic-tagged fish in the release group. After release on April 28, the dispersal occurred rapidly based on the large numbers of acoustic-tagged fish were detected by early May at the next station near RM426.5, approximately 2 km upstream from the release location (Figure 10). Detections near RM426.5 declined into late May as the acoustic-tagged fish continued to move upstream as confirmed by an increase in detections at the next three upstream acoustic monitoring stations near RM437.1, RM442.0, and RM446.9. Acoustic-tagged fish were first detected at the upstream-most monitoring station near RM452.4 on May 22. With exception of the three entrained fish, downstream movement from the release site by other 2015BY was not detected.

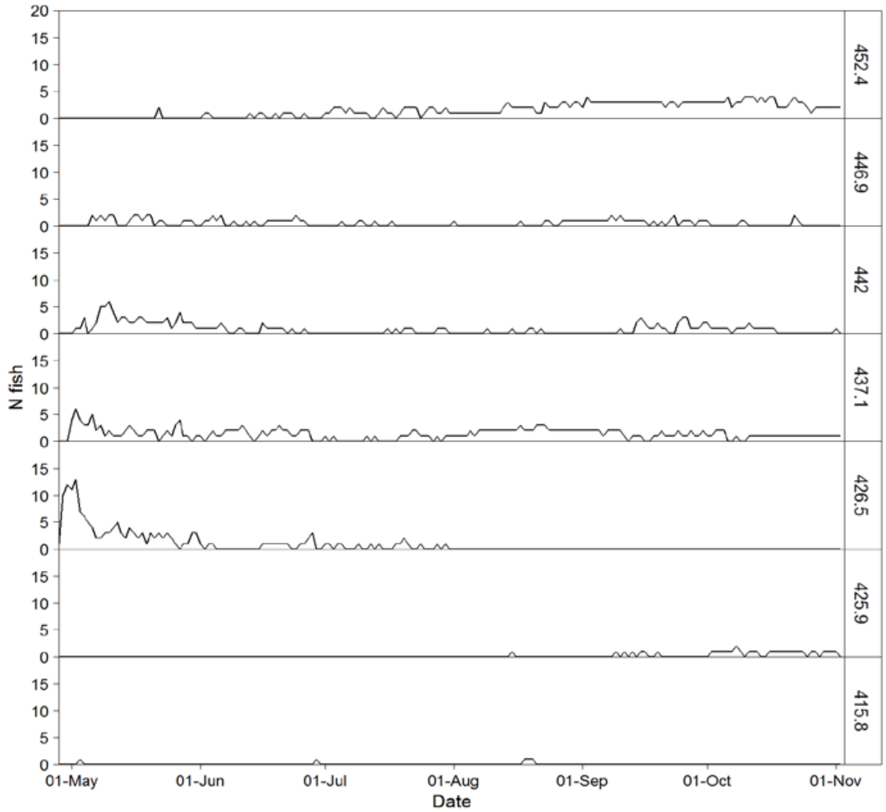


Figure 10 **Number of acoustic-tagged 2015BY White Sturgeon detected at acoustic monitoring stations (on right Y-axis) in Wanapum Reservoir from April 28 to November 4, 2016. Note that the monitoring station at RM425.9 was installed on August 11, 2016, after which monitoring at RM426.5 was discontinued.**

Daily residency proportion (i.e., the amount of time fish remained in range of a receiver each 24-hours) were examined to identify seasonal use of habitat near each of the monitoring stations in Wanapum Reservoir (Figure 11). High daily residency (>0.75) by one or more fish was recorded for extended periods near RM437.1 and RM452.4 and residency at these stations exceeded the residency recorded at the known overwintering sites (i.e. near RM426.5 and RM442.0). The high residency recorded near RM437.1 in August corresponded to consistent detection of up to three fish in range of the receiver, whereas as the high residency at the same station in December was due a single fish that remained effectively stationary in range of the receiver.

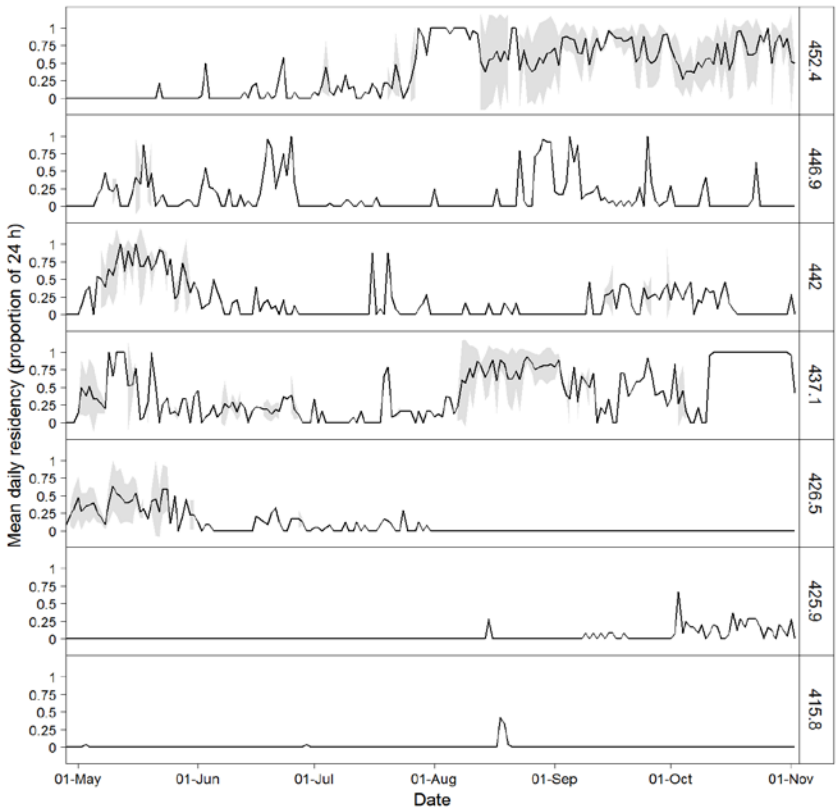


Figure 11 Mean daily residency (black line; SD grey ribbon) of acoustic tagged 2015BY white sturgeon at Wanapum reservoir acoustic monitoring stations (on right Y-axis) from April 28 to November 4, 2016.

In Priest Rapids Reservoir, seven acoustic-tagged 2015BY White Sturgeon were released in the Wanapum Dam tailrace at RM415.6 on April 28, 2016. After release, acoustic-tagged fish were only detected near the release site or in the upper section of the reservoir. Movement by acoustic-tagged fish into the Priest Rapids Dam forebay or entrainment through the Priest Rapids Dam was not detected. All seven acoustic-tagged fish were detected at least once at the tailrace station. Two of these fish eventually moved downstream and were detected by the station at RM410.5 near the mouth of Crab Creek. With the loss a receiver station at RM413.5 between the tailrace and Crab Creek, the ability to detect upstream movement in the immediate vicinity of the tailrace area was also lost. Cumulative movements of individual fish based on movement between stations ranged between 0.16 km (0.1 mile) and 25 km (15 miles) over the monitoring period from April 28 to November 4, 2016 (Figure 12).

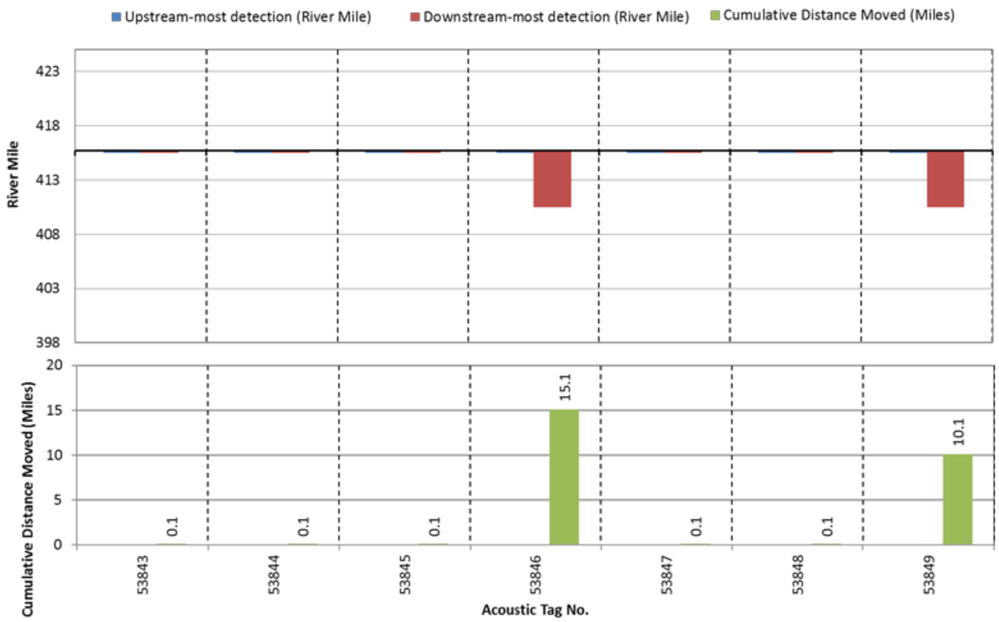


Figure 12 Upstream-most and downstream-most detections (upper panel) and cumulative movements (lower panel) of 2015BY White Sturgeon in Priest Rapids Reservoir from April 28 to October 12, 2015.

Post-release dispersal rates and distribution of the 2015BY were assessed for Priest Rapids Reservoir based on the movement of acoustic-tagged fish in the release group. Fish detections and residency estimates also include signal detections from the three acoustic-tagged 2015BY entrained from Wanapum Reservoir into Priest Rapids Reservoir. After initial detection of seven acoustic-tagged fish in the Wanapum Dam tailrace immediately after release, the number of acoustic-tagged 2015BY detected in the tailrace rapidly decreased by early May before increasing again by late May and into June (Figure 13). The number of fish detected at this station again gradually decreased over June to zero detections by early July. From mid-July onward from one to three fish were detected in at the tailrace station. Downstream at the station near RM410.5, up to two acoustic-tagged fish were consistently detected from early June to November.

Mean daily residency rate of fish detected in the Wanapum Dam tailrace ranged between 1.0 and 0 (Figure 14). This variation could result from fish movements, in that tag detection decreased over time, which could indicate fish moved out of receiver range. Other factors can also affect signal reception, such as hydraulic noise from a variety of sources, as well as signal collisions from other acoustic-tagged fish with stronger tag signals that move into receiver range.
The 2015BY residency rates in the tailrace, however, were moderate to high and suggested fidelity to the tailrace area once occupied. Similarly, the fish that dispersed downstream also exhibited high mean residency once established and remained in the vicinity of the downstream receivers for extended durations.

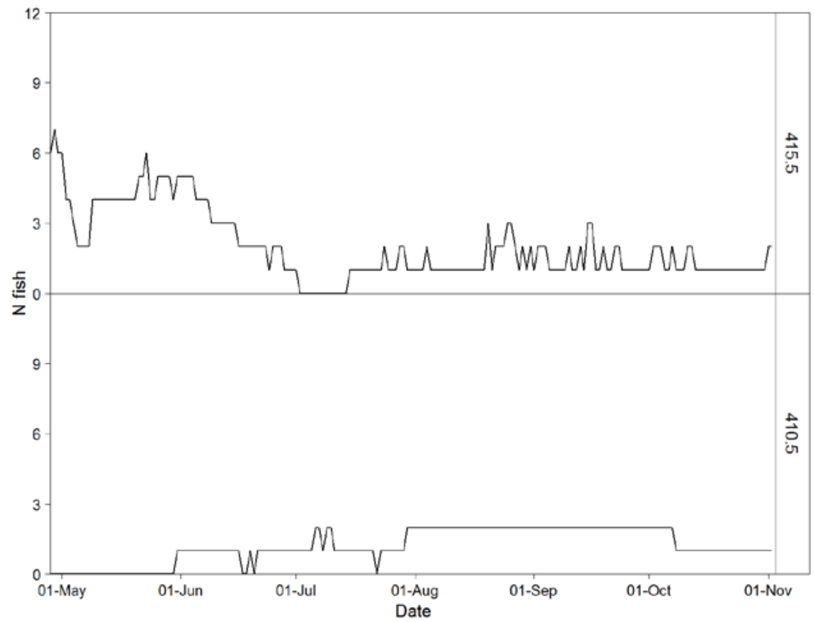


Figure 13 **Number of individual 2015BY White Sturgeon detected at acoustic monitoring stations (on right Y-axis) in Priest Rapids Reservoir from April 28 to November 4, 2016.**

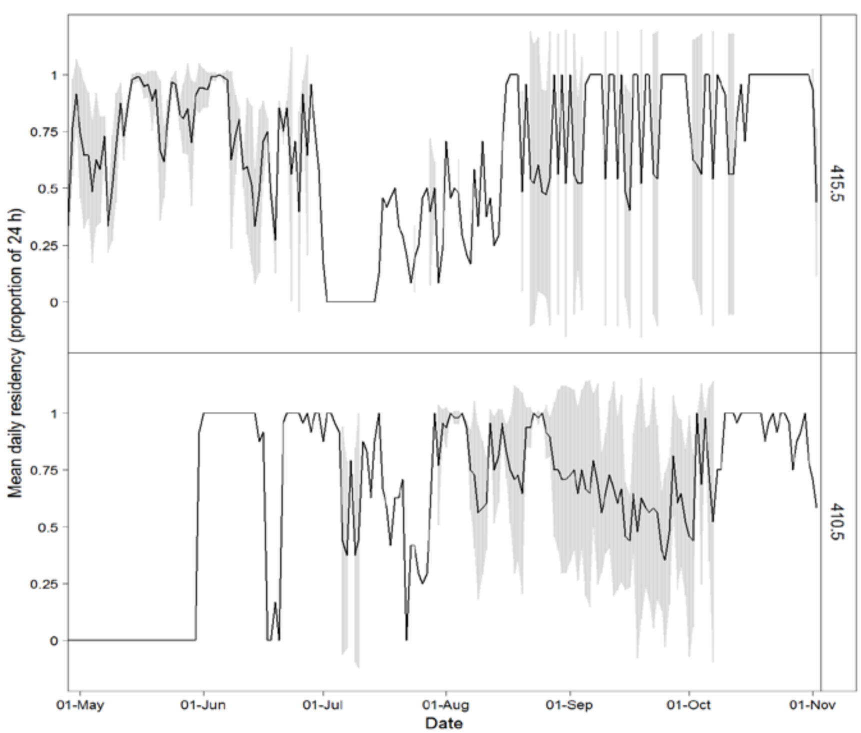


Figure 14 **Mean daily residency (black line; SD grey ribbon) of 2015BY White Sturgeon at Priest Rapids Reservoir acoustic monitoring stations (on right Y-axis) from April 28 to November 4, 2016.**

3.6 Juvenile White Sturgeon Population Assessment

Sample Effort

In Wanapum and Priest Rapids reservoirs, areal-based GRTS unequal probability site selection assigned approximately equal number of sites among the three defined sections in each reservoir (i.e., lower, middle, and upper sections). After initial site screening and selection of oversamples to replace sites that were obviously not feasible (e.g., inside safety booms, below spillways, etc.,) the actual number of sites samples in each reservoir section were approximately equal to intended sample effort (i.e., equal numbers of sites per section; Table 7). Due to the decline in the areal extent of the sample area from downstream to upstream, sample intensity (i.e., samples per unit area) within the respective reservoir sections increased accordingly, with the sample intensity within the upper reservoir section from 6 to 7 times higher compared to the lower reservoir sections.

The mean depth and the range of depths sampled was greater in Wanapum Reservoir (mean = 20.8 m, range = 10.0 to 45.0 m) than in Priest Rapids Reservoir (mean = 11.2 m, range = 3.0 to 24.0 m). Mean sample depth of each reservoir section also was greater in Wanapum Reservoir (range = 19.8 to 21.3 m) than in Priest Rapids Reservoir (range = 9.1 to 15.2 m). As expected, lower mean sample depths were recorded in the upper sections of Wanapum and Priest Rapids reservoir compared to the lower and middle sections. Setlines in both reservoirs were deployed, on average, for approximately 22 hours at each sample site, with the exception of four sample sites within lower section of Wanapum where retrieval was delayed 24 hours due to high wind and wave conditions. In Wanapum Reservoir, setlines were successfully deployed at all the selected GRTS sites identified in the lower and middle sections and in-the-field selection of oversample replacement sites was not required. In the upper section of Wanapum Reservoir, over samples were selected in-the-field to replace five sites that were considered either a high risk for gear loss or were too dangerous. In Priest Rapids Reservoir, oversamples were selected to replace one site in the lower section and five sites in the upper section that were too close to spillways and considered unsuitable for sampling.

Table 7 Details of GRTS sample site distribution among Wanapum and Priest Rapids reservoir sections, areal extent of reservoir sections, estimates of sampling intensity, and setline sample depths and durations recorded during the 2016 White Sturgeon juvenile indexing program, September 7 to October 6, 2016.

		Reservoir							
		Wanapum (15m Bathymetric Contour)				**Priest Rapids (6 m Bathymetric Contour)**			
		Lower	**Middle**	**Upper**	**All**	**Lower**	**Middle**	**Upper**	**All**
Sample design specified sample effort		90	90	90	270	30	30	30	90
Number of GRTS sites sampled		91	90	90	271	29	31	30	90
Sampling area (Ha)		1,664	727	308	2,699	1,369	346	213	1,928
Samples/100Ha		5.5	12.4	29.2	10.0	2.1	9.0	14.1	4.7
Sample depths (m)									
	mean	21.2	21.3	19.8	20.8	15.2	10.1	9.1	11.4
	min	11.4	11.1	10.0	10.0	4.5	3.0	3.0	3.0
	max	33.0	31.8	45.0	45.0	23.5	24.0	17.0	24.0
Sample duration (h)									
	mean	23.2	22.2	21.8	22.4	22.8	22.9	22.6	22.8
	min	18.6	19.5	16.0	16.0	19.0	20.8	19.7	19.0
	max	43.5	26.6	26.9	43.5	27.6	26.5	25.1	27.6

As noted in Section 3.1, discharge levels and water temperatures during the study were generally conducive for juvenile White Sturgeon setline sampling. Total river discharge was near the seasonal low and water velocity within the upper sections of each reservoir was low enough to allow sampling of areas that would likely be considered high risk and excluded at higher discharge levels. Water temperatures were generally in excess of 18.0°C during sampling. These elevated water temperatures, compounded by sun and warm air temperature, may have increased capture and processing related stress on captured sturgeon, particularly in instances where many fish were captured and held on board for longer than normal periods. The risk of heat stress was reduced through the use of shade canopies and frequent water exchange. As a result, nearly all fish captured required minimal recovery time and appear healthy and energetic when released.

2016 Juvenile White Sturgeon Indexing Catch

In total, 887 White Sturgeon were captured and processed during GRTS set lining in Wanapum (n = 746) and Priest Rapids (n = 141) reservoirs in 2016 (Figure 15; Table 8). These captures represented 859 individual fish (fish captured three times: 1 in Wanapum and 1 in Priest Rapids; fish captured twice: 22 in Wanapum and 2 in Priest Rapids). Bycatch during the survey included 211 Northern Pikeminnow (*Ptychocheilus oregonensis*), 6 Largescale Sucker (*Catostomus macrocheilus*), 2 bullheads (*Ameiurus sp.*), 2 sculpin (*Cottus sp.*), and 1 Channel Catfish (*Ictalurus punctatus*).

Wanapum Reservoir Catch

The White Sturgeon catch from Wanapum Reservoir was composed of both wild and hatchery origin fish. (Table 8). The largest group captured were hatchery fish from the five brood years released to date directly into Wanapum Reservoir. The second largest group of fish captured were also hatchery fish, but these originated from upstream reservoirs and were entrained into Wanapum Reservoir. The third group were captured wild fish that were assumed to have been spawned and reared within Wanapum Reservoir. A fourth group consisted of one hatchery juvenile that was released in Priest Rapids Reservoir and moved upstream into Wanapum Reservoir, presumably via the fish ladders.

Of the five hatchery brood years released in the PRPA since 2011 (i.e., 2010BY, 2012BY, 2013BY, 2014BY, and 2015BY), the 2013BY were the dominant brood year caught in Wanapum Reservoir (n = 269 or 36% of total catch), followed by moderate numbers of 2012BY (n = 130), 2014BY (n = 124), 2010BY (n = 98), and 2015BY (n = 69; Figure 15). In addition to differences in catch proportions of the five brood years, differences in catch of various release groups within each brood year were also evident. The within-brood year release groups were differentiated by release location, time of release, and genetic origin. In 2016, the following differences in catch proportion of brood year and the within-brood year release groups were identified:

- 2010BY: Although initial release numbers of the three within-brood year release groups (i.e., LCC = 2,000; MCW = 2,996; UCW =2,020) were similar, substantially fewer of the LCC release group (n =9) were captured in 2016 compared to the MCW (n = 42) and UCW (n = 39) groups.
- 2012BY: In 2013, fish were released in equal numbers at Columbia Siding (RM450.6; n = 1,135) and Columbia Cliffs Eddy (RM442.0; n = 1,129) to assess the effect of avian predation based on depth at the release location and proximity to upstream bird colonies. Of the 2012BY captured in 2016 (n = 128), the majority (i.e., 74%; n = 95) were fish released at Columbia Cliffs Eddy.
- 2013BY: Released in two groups at Rocky Coulee launch (RM421.4) in May (n = 3,331) and September (n = 1,762) 2014 during the Wanapum fracture emergency response. The 2016 catch of the May-released fish (n = 228) greatly exceeded the catch of September-released fish (n = 41). This ~5:1 catch ratio was substantially different than the 2:1 stocking ratio for these groups.
- 2014BY: The total release of the 2014BY (n = 5,007) was similar to 2013BY (n = 5,093); however, total 2014BY catch in 2016 was 124 fish, less than half of the 2015BY catch. This difference may be due to differences in catchability (e.g., the 2013BY are larger, feed more aggressively, etc.,) and may not indicate as difference in abundance.
- 2015BY: Catch of 2015BY (n = 69) was higher than expected in that 2015BY were only at large for 3+ months prior to the start of indexing and still relatively small compared to older fish.

Entrained hatchery sturgeon from upstream reservoirs were identified as 2002BY fish (i.e., CRITFC fish, n = 41), which were released in Rock Island Reservoir in 2003. A small number of 2010BY (n = 8) and 2012BY (n = 1) that were released in Rocky Reach Reservoir were also captured in the present study. The first occurrence of upstream movement was documented in 2016 with the capture of a 2012BY fish (n = 1) that moved upstream from Priest

Rapids Reservoir into Wanapum Reservoir, most likely via the fish ladders. Several wild fish (n = 7) were captured in Wanapum Reservoir. The determination that the fish were wild was based on the absence of a PIT-tag or scute removal marks, and no obvious fin deformities. Eight fish that had hatchery scute removal marks but no detectable PIT tag (likely lost) were classified as Unknown. Unknown fish with obvious fin deformities, a common occurrence in the earlier brood year releases (i.e., 2013BY and 2014BY specifically), were likely hatchery fish.

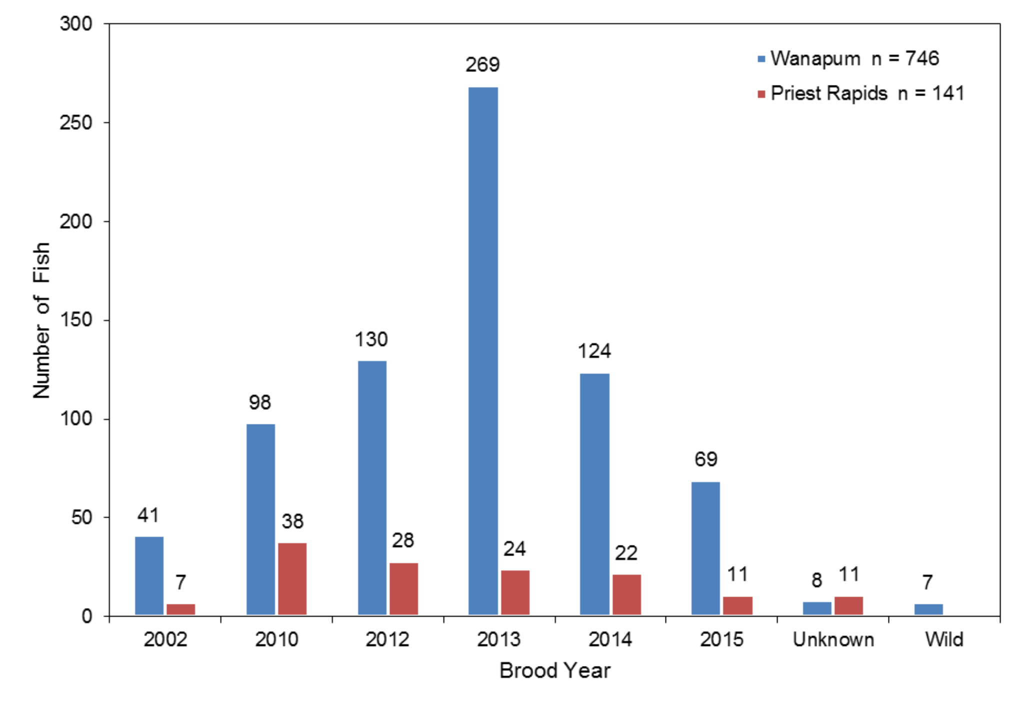


Figure 15 Hatchery and wild White Sturgeon captured during setline sampling in the Priest Rapids Project area, September 7 to October 6, 2016.

Table 8 Hatchery and wild sturgeon captured during setline sampling in the Priest Rapids Project area, September 7 to October 6, 2016.

						Capture Reservoir		
BY	**Release Reservoir**	**Release Location**	**Brood Source**	**Date**	**Number Released**	**Wanapum**	**Priest Rapids**	**Total**
2002	Rock Island	Unknown	Unknown	Unknown	20,600	**41**	**7**	**48**
2010	Rocky Reach	Unknown	All	21-Apr-11	6,376	**8**	**3**	**11**
	Wanapum	Columbia Siding	UCW[1]	26-Apr-11	2,020	39	4	43
			MCW[2]	29-Apr-11	2,996	42	3	45
			LCC[3]	27-29-Apr-11	2,000	9	6	15
			All	--	7,016	**90**	**13**	**103**
	Priest Rapids	Wanapum tailrace	UCW	26-Apr-11	900	--	11	11
			MCW	28-Apr-11	601	--	10	10
			LCC	28-Apr-11	600	--	1	1
			All	--	2,101	--	**22**	**22**

BY	Release Reservoir	Release Location	Brood Source	Date	Number Released	Capture Reservoir Wanapum	Capture Reservoir Priest Rapids	Total
2012	Rocky Reach	Entiat	All	14-Mar-13	7,975	**1**	**--**	**1**
	Wanapum	Columbia Siding	MCW	14-May-13	1,135	33	3	36
		Columbia Cliffs	MCW	14-May-13	1,129	95	1	96
			All	--	2,264	**128**	**4**	**132**
	Priest Rapids	Wanapum tailrace	MCW	14-15 May 2013	1,717	**1**	**24**	**25**
2013	Wanapum	Rocky	MCW	6-May-14	3,331	228	11	239
			MCW	18-Sep-14	1,762	41	3	44
			All		5,093	**269**	**14**	**283**
	Priest Rapids	Wanapum	MCW	5-May-14	997	--	8	8
			MCW	17-Sep-14	504	--	2	2
			All		1,501	**0**	**10**	**10**
2014	Wanapum	Frenchman Coulee	MCW	30-Apr to 1-May 2015	5,007	**124**	**5**	**129**
	Priest Rapids	Wanapum tailrace	MCW	30-Apr to 1-May 2015	1,495	**--**	**17**	**17**
2015	Wanapum	Frenchman	MCW	28-Apr-16	2,005	**69**	**--**	**69**
	Priest Rapids	Wanapum tailrace	MCW	28-Apr-16	1,253	**--**	**11**	**11**
Unknown	Unknown	Unknown	Unknown	Unknown	NA	**8**	**11**	**19**
Wild	NA	NA	NA	NA	NA	**7**	**--**	**7**
All						**746**	**141**	**887**

[1]Upper Columbia Wild (UCW) - the progeny of wild broodstock captured in the upper Columbia River in Canada and reared by the Freshwater Fisheries Society at Kootenay Sturgeon Hatchery in British Columbia

[2]Mid Columbia Wild (MCW) - the progeny of wild broodstock captured either in PRPA or below McNary Dam and reared at the Yakama Nation Marion Drain Hatchery (MDH)

[3]Lower Columbia Cultured (LCC) - the progeny of captive broodstock originally captured below Bonneville Dam in the lower Columbia River

Priest Rapids Reservoir Catch

The 2016 White Sturgeon catch from Priest Rapids Reservoir was mainly composed of hatchery fish released directly into Priest Rapids Reservoir and hatchery fish entrained from upstream reservoirs (Table 8; Figure 15). Unlike Wanapum Reservoir, the predominance of a particular brood year in the Priest Rapids catch was not evident. 2010BY fish were the most abundant (n = 38) in the total catch, followed by 2012BY (n = 28), 2013BY (n = 24), 2014BY (n = 22), 2015BY (n = 11), and 2002BY (n = 7). In addition to differences in catch proportion of the five brood years, the differences in catch of various release groups within each brood year release were also evident. Since 2011, all hatchery fish have been released at the Wanapum Dam tailrace launch, but similar to Wanapum, release groups within each brood year differed in terms of time of release and genetic origin. The following differences in catch proportion of brood year and the within-brood year release groups were evident in the 2016 catch data:

- 2010BY: Release numbers of the three release groups (i.e., LCC, MCW, and UCW) were similar (i.e., 600, 601, and 900, respectively). Fewer of the LCC release group (n = 7) were captured in 2016 compared to the MCW (n = 13) and UCW (n = 15). The combined catch of fish entrained from Wanapum Reservoir (n = 13) and Rock Reach Reservoir (n = 3) comprised 42% of the total 2010BY captured.
- 2012BY: Entrained Wanapum fish comprised 14% (n = 4) of the 2012BY catch (n = 28) in Priest Rapids Reservoir.
- 2013BY: The 2013BY were released in two groups at Wanapum Dam tailrace launch in May (n = 997) and September (n = 504) 2014. The 2016 catch of the May-released fish (n = 19) exceed the catch of September-released fish (n = 5). Entrained fish from Wanapum Reservoir comprised 58% (n = 14) of the 2013BY catch (n = 24) in Priest Rapids Reservoir.
- 2014BY: Entrained Wanapum fish comprised 23% (n = 5) of the 2014BY catch (n = 22) in Priest Rapids Reservoir.
- 2015BY: Catch of several 2015BY (n = 11) in Priest Rapids Reservoir was above expectation for the same reasons list above for the Wanapum Reservoir. Entrained Wanapum-origin 2015BY were not captured in Priest Rapids Reservoir in during 2016 sample efforts.

Other entrained hatchery sturgeon from upstream reservoirs were identified as 2002BY fish (i.e., CRITFC fish; n = 7). A small number (n = 3) of 2010BY that were released in Rocky Reach Reservoir were also captured in Priest Rapids Reservoir. A higher than expected number of unidentified sturgeon (i.e., not found in PTAGIS; n = 11) were also captured.

Catch rates and distribution

Comparisons of relative abundance and catch distribution of White Sturgeon in the PRPA were based on catch rates calculated as catch-per-unit-effort (CPUE) in hook-hours (i.e., 1 hook-hour = 1 hook fished for 1 hour) and as a proportion of positive catch (Ep; proportion of sites that captured at least 1 fish) for each reservoir and reservoir section.

In total, 323,825 hook-hours of setline sample effort was expended during juvenile White Sturgeon population indexing in 2016 (Table 9). Within each reservoir, sample effort per reservoir section was nearly identical, which the exception of the lower section of Wanapum Reservoir (due to the extended deployment of four sets due to inclement weather that prevent retrieval). Overall CPUE in the PRPA was 0.27 fish/100 hook-hours, with higher CPUE recorded in Wanapum Reservoir (0.31 fish/100 hook-hours) than in Priest Rapids Reservoir (0.17 fish/100 hook-hours). In both reservoirs, a progressive increase in CPUE with increased upstream distance was recorded; this CPUE gradient was more evident in Wanapum Reservoir than in Priest Rapids Reservoir.

Overall, Ep was higher in Wanapum Reservoir (all sections, Ep = 0.79) than in Priest Rapids Reservoir (all sections, Ep = 0.73; Figure 16) as substantially more zero-catch efforts were recorded in the latter (Figure 17). In general, Ep was lower in the lower sections and higher in the upper sections of each reservoir.

Table 9 Total setline sample effort, catch, and CPUE in the Priest Rapids Project area during the juvenile White Sturgeon population assessment program, September 7 to October 6, 2016.

Reservoir	Reservoir Section	Sample Effort (hook-hours)	Catch (No. of fish)				CPUE (No. fish/100 hook-hours)			
			Wild	H-123LAD	H-CRITFC	Total	Wild	H-123LAD	H-CRITFC	Wild &Hatchery
Wanapum	Upper	77985	3	303	25		0.004	0.39	0.03	0.42
	Middle	79720	1	240	7		0.001	0.30	0.01	0.31
	Lower	84194	3	155	9		0.004	0.18	0.01	0.20
	All	241899	7	698	41	746	0.003	0.29	0.02	0.31
Priest Rapids	Upper	27164		50	3		0.000	0.18	0.01	0.20
	Middle	28414		47			0.000	0.17	0.00	0.17
	Lower	26349		37	4		0.000	0.14	0.02	0.16
	All	81926	-	134	7	141	-	0.16	0.01	0.17
PRPA	Total	323825	7	832	48	887	0.002	0.26	0.01	0.27

[a] MDH Hatchery juvenile White Sturgeon reared at Marion Drain Hatchery, produced from brood years in 2010, 2012, 2013, 2014, and 2015 and released the following year; CRITFC Hatchery juvenile White Sturgeon reared by the Columbia Intertribal Fisheries Commission from a brood year in 2002 and released in 2003.

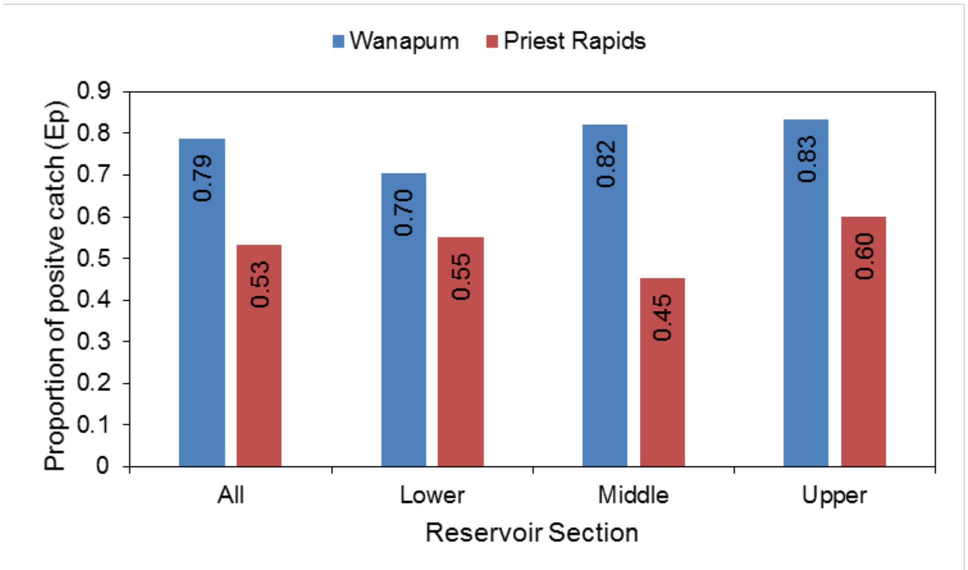


Figure 16 Proportion of positive catch recorded in the Priest Rapids Project area within the lower, middle, and upper section of each reservoir during the 2016 White Sturgeon juvenile indexing program, September 7 to October 6, 2016.

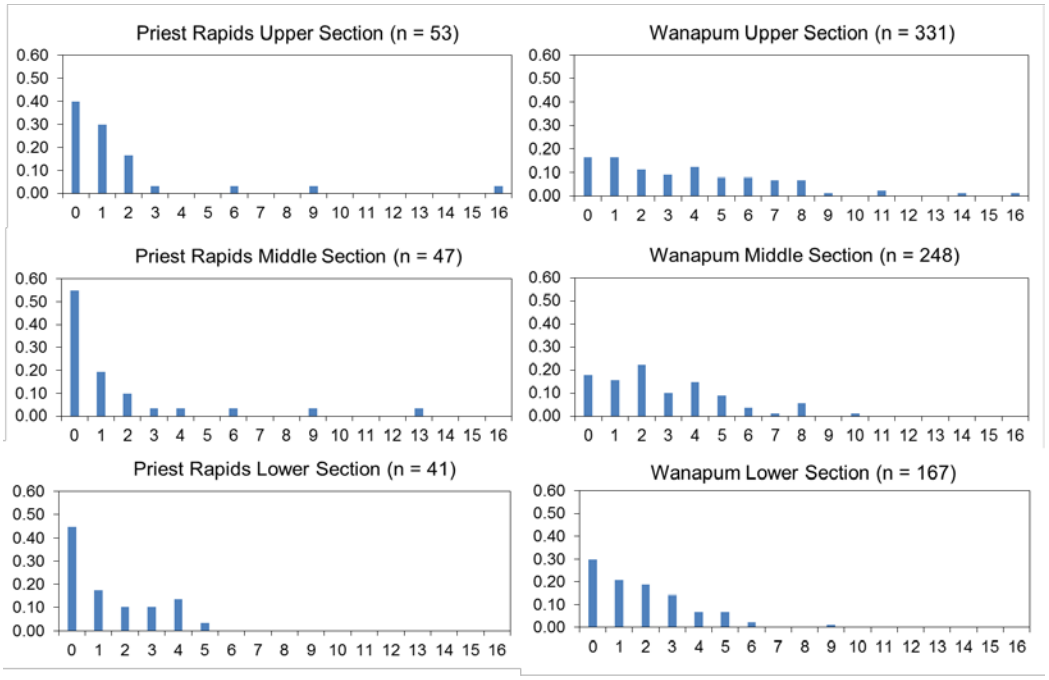


Figure 17 Frequency histograms of sturgeon catch-per-overnight-set in the Priest Rapids Project area during the 2016 White Sturgeon juvenile indexing program.

The GRTS unstratified unequal probability sample design distributed effort over the areal extent each reservoir. Histogram plots of catch, effort and CPUE by River Mile indicated general areas within each reservoir where higher captures of sturgeon were encountered (Figure 18). Overall, the lower sections, but in particular, the forebay area within one River Mile of the dam, had much lower catch rates of fish compared to upstream locations. Catch and CPUE varied considerably by River Mile over the length of both reservoirs.

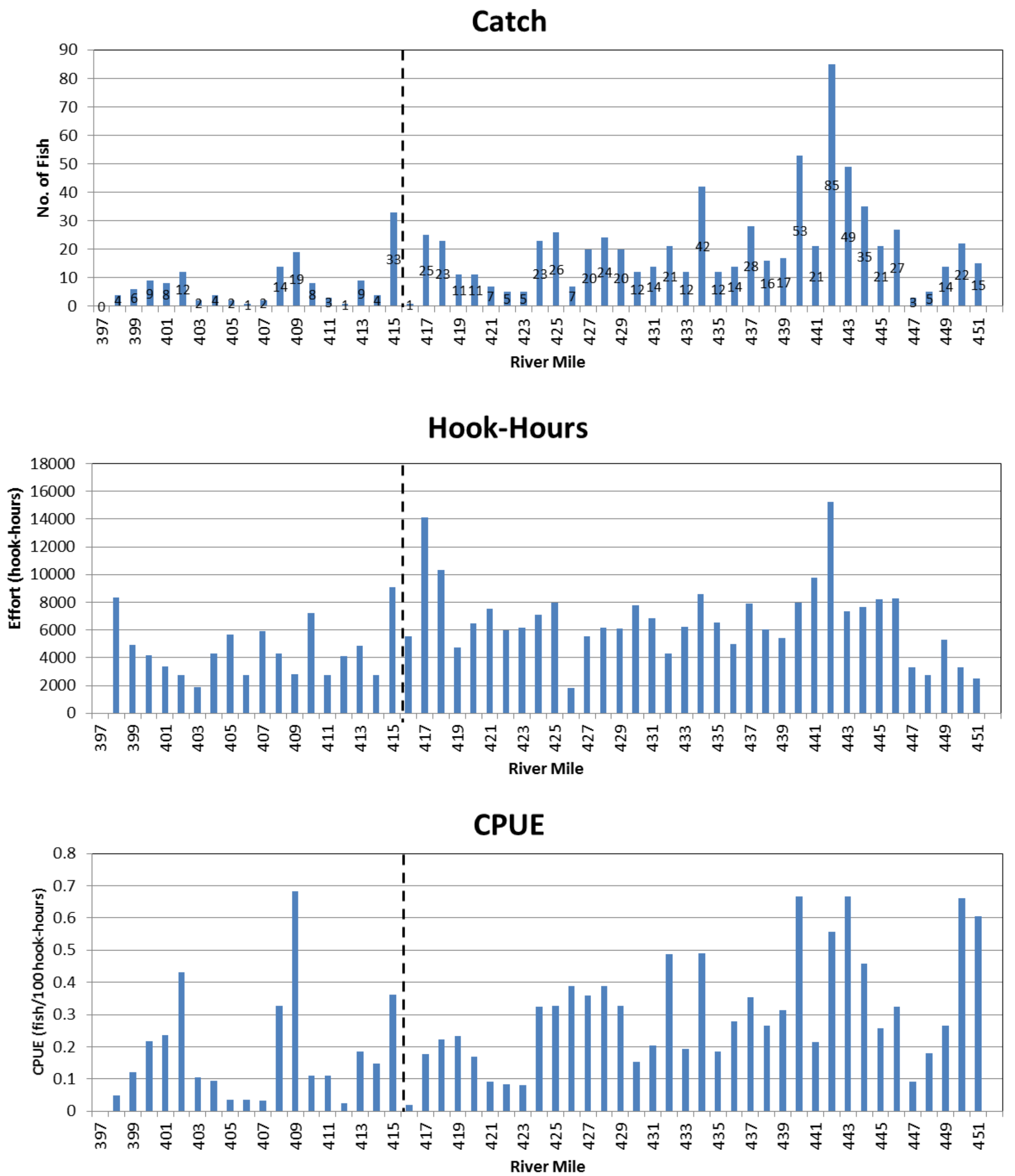


Figure 18 Juvenile White Sturgeon setline sampling catch, effort, and CPUE distribution by river mile in the Priest Rapids Project area, September 9 to October 6, 2016. Dash vertical line represents the location of Wanapum Dam.

The catch locations of sturgeon in Wanapum and Priest Rapids reservoirs were plotted on satellite images of the upper, middle and lower section of Wanapum Reservoir (Figure 19, Figure 20, and Figure 21) and for the entire Priest Rapids Reservoir (Figure 22). The image plots were of sufficient resolution to identify where high densities of fish were found, as well as the spatial separation between catch locations and some indication of the physical habitat features. In Wanapum Reservoir, the individual plots of brood year catch distribution indicate that 2013BY fish were broadly distributed through the entire reservoir and that overall, higher densities of fish from all brood years were caught primarily in the upper and middle reservoir sections. In Priest Rapids Reservoir, catch was more broadly distributed; however, as sampling efforts were relatively uniform over the spatial extent of the reservoir, the catch plots identified large areas of the reservoir where sturgeon were not captured.

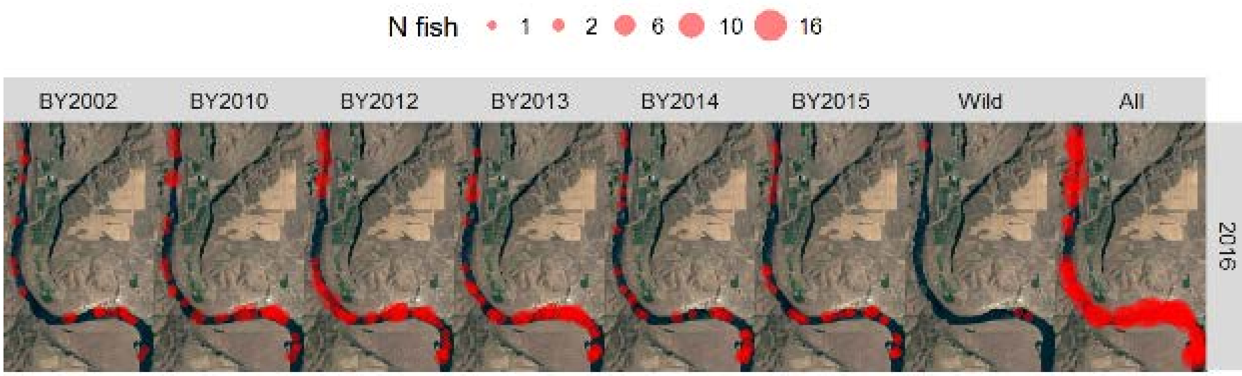


Figure 19 **Sturgeon catch distribution by release group in the upper section of Wanapum Reservoir during the White Sturgeon juvenile indexing program, September 9 to October 6, 2016.**

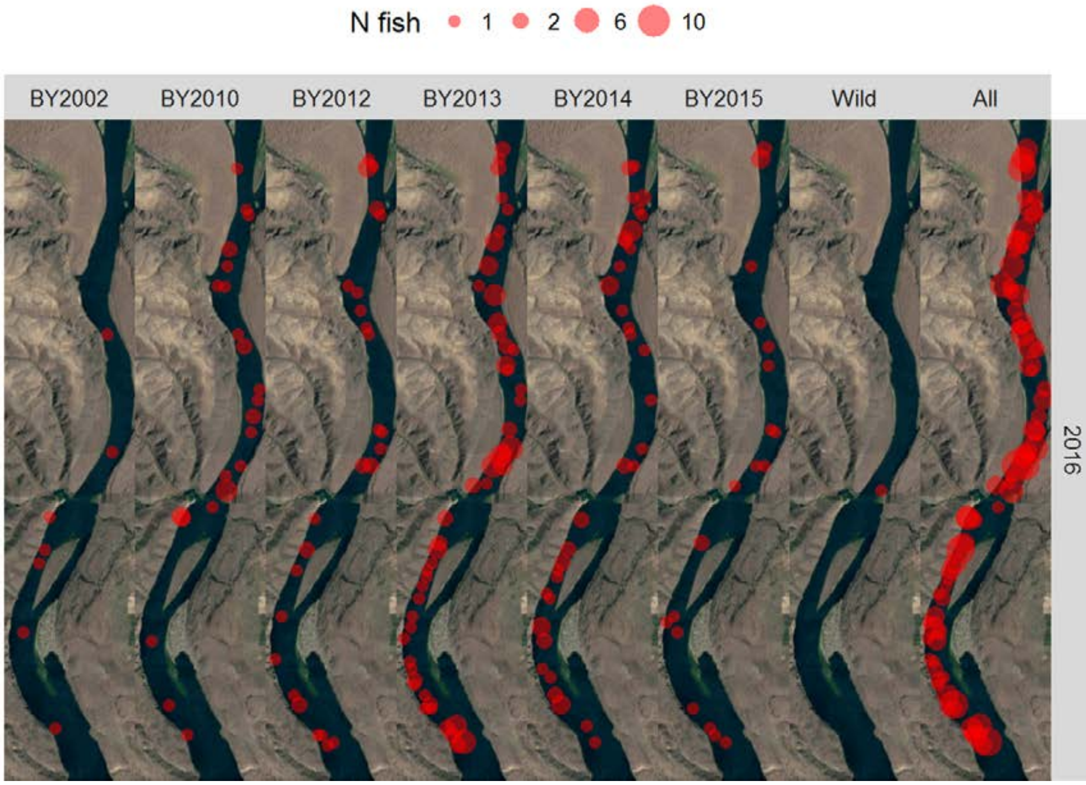


Figure 20 **Sturgeon catch distribution by release group in the middle section of Wanapum Reservoir during the White Sturgeon juvenile indexing program, September 9 to October 6, 2016.**

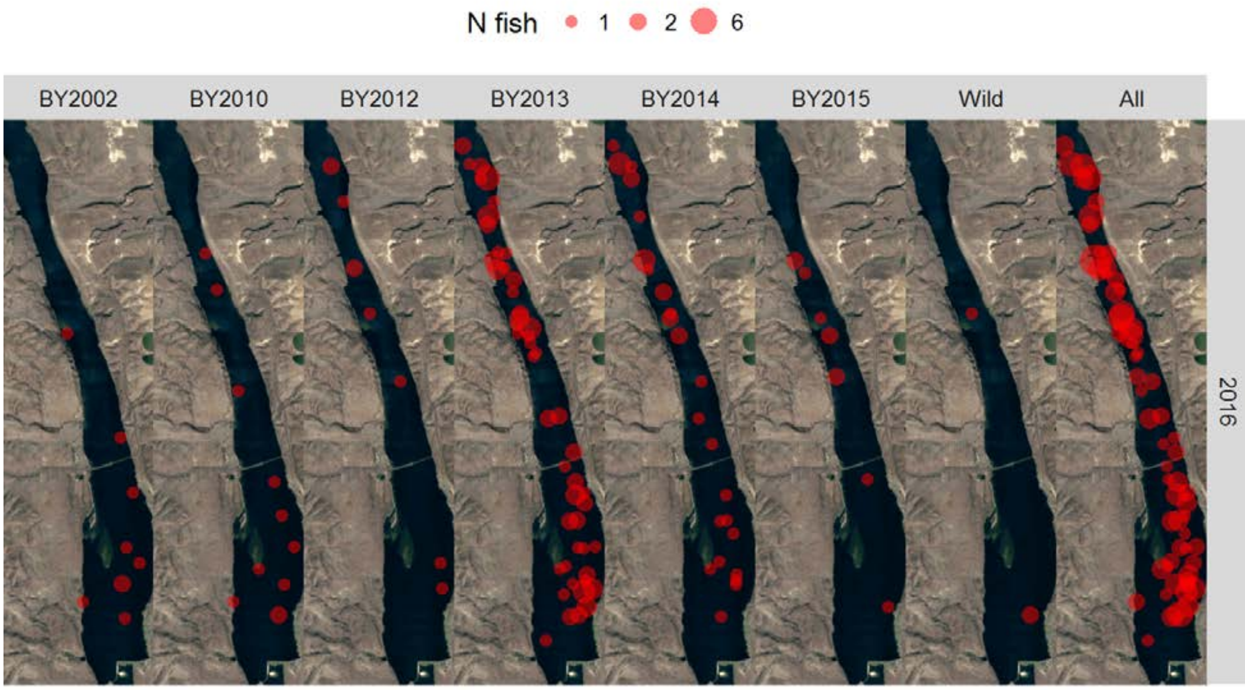


Figure 21 **Sturgeon catch distribution by release group in the lower section of Wanapum Reservoir during the White Sturgeon juvenile indexing program, September 9 to October 6, 2016.**

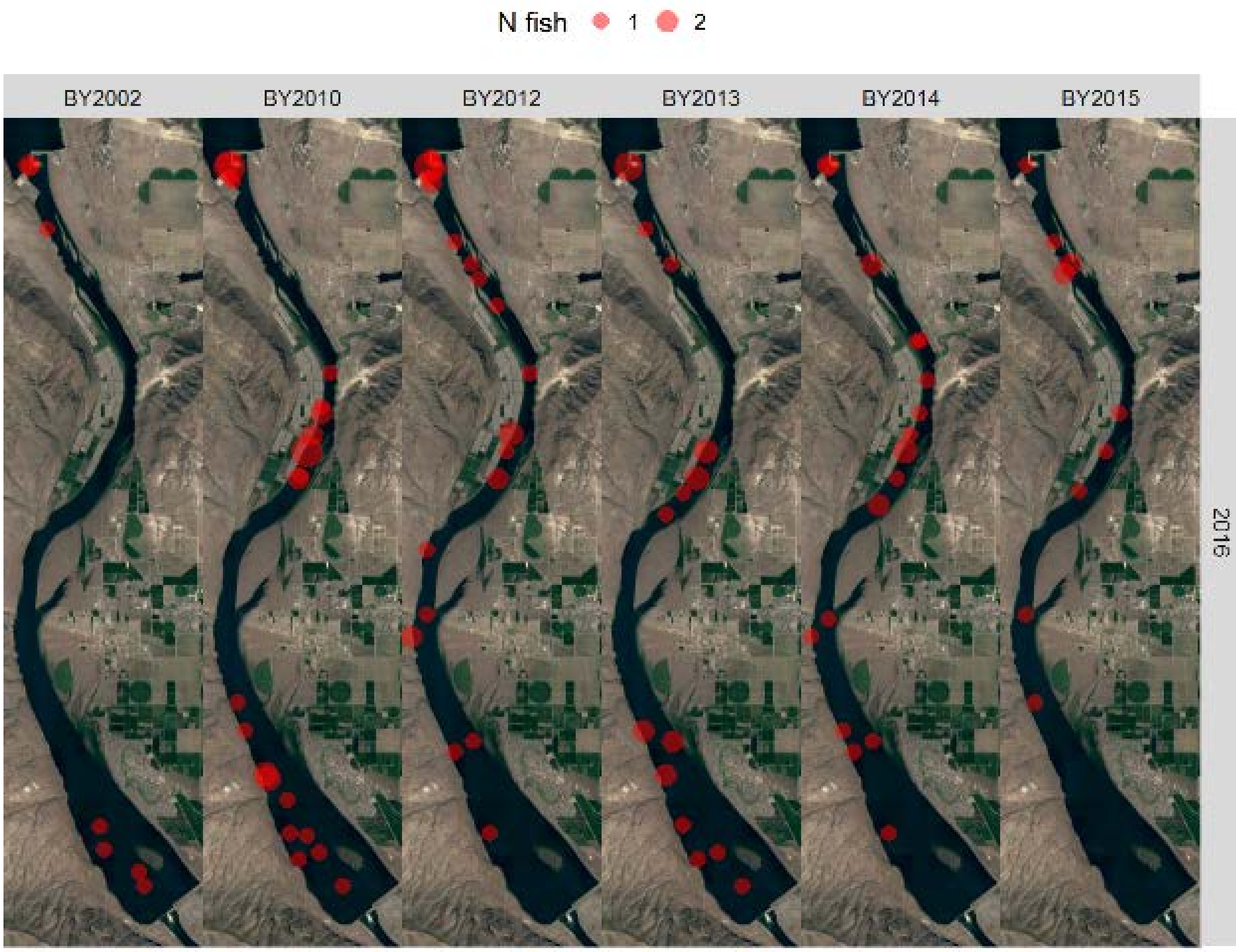


Figure 22 White Sturgeon catch distribution by release group based on GRTS sampling in the Priest Rapids Reservoir (all sections) during the 2016 White Sturgeon juvenile indexing program. Note that wild White Sturgeon were not captured in Priest Rapids Reservoir.

Based on the proportion of positive catches in Wanapum and Priest Rapids reservoirs, hatchery brood year fish were broadly distributed throughout each reservoir (Figure 23) In Wanapum Reservoir, fish were generally captured at higher rates in the middle and upper reservoir sections, whereas in Priest Rapids Reservoir, certain brood years were caught at higher rates in the lower reservoir section while others had higher CPUEs in the middle and upper sections. In Wanapum Reservoir, the highest Ep was recorded in the upper reservoir section for brood year releases 2002BY, 2010BY, 2012BY, and 2015BY, and the middle reservoir section for the 2014BY. The Ep of the 2013BY was in similar in all three reservoir sections. In Priest Rapids Reservoir, the highest Ep was recorded in the upper reservoir section for 2012BY, and in the lower reservoir section for the 2002BY, 2010BY, and 2013BY. Eps for the 2014BY and 2015BY were highest in the middle and upper sections.

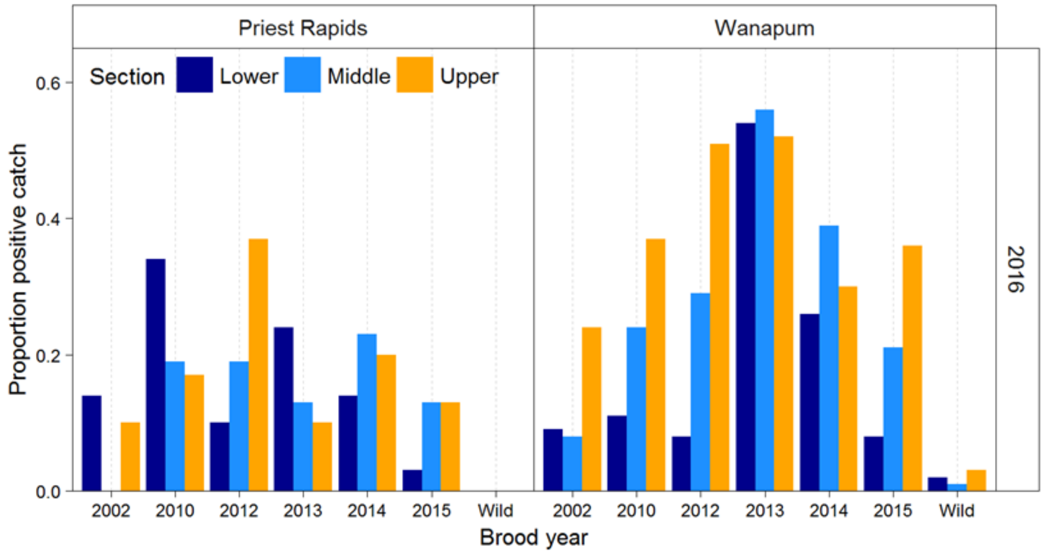


Figure 23 Proportion of positive catch (Ep) of wild and hatchery White Sturgeon in the Priest Rapids Project area, plotted for each reservoir section.

For each reservoir, Ep estimates for the entire reservoir and reservoir sections were calculated for each sturgeon catch group (e.g., hatchery brood year, wild, etc.) based on release reservoir, as well as for within-brood year release groups where applicable (Table 10 and Table 11). As the Ep estimates are derived from catch data, the general trends identified in the catch comparisons between brood years and the various within-brood year release groups identified in Table 8 are also reflected in Ep estimates. Additional detail specific to distribution by reservoir section of brood year fish by release reservoir and release group provide an indication of habitat preference by these groups in late summer when the indexing survey was conducted. The Ep data were presented but were not elaborate upon further as hatchery fish preference for specific sections of each reservoir was considered less critical to the overall M&E program or the information it provide is presented elsewhere in a more accessible form (e.g., telemetry data to document brood year entrainment, etc).

Table 10 Proportion of setlines with positive catch (Ep) in Wanapum Reservoir during the 2016 White Sturgeon juvenile indexing program. Double dashes (--) indicate zero values.

			Wanapum Reservoir (No. Sample Sites)			
			Ep			
Brood year	**Release Reservoir**	**Release group**	**Lower (n = 91)**	**Middle (n = 90)**	**Upper (n = 90**	**All (n = 271)**
2002BY	Rock Island	All	0.09	0.08	0.24	0.14
2010BY	Rocky Reach	All	0.02	0.01	0.06	0.03
2010BY	Wanapum	LCC	0.03	0.02	0.04	0.03

			Wanapum Reservoir (No. Sample Sites)			
			Ep			
Brood year	Release Reservoir	Release group	Lower (n = 91)	Middle (n = 90)	Upper (n = 90	All (n = 271)
		MCW	0.03	0.11	0.19	0.11
		UCW	0.02	0.14	0.21	0.13
		All	0.09	0.23	0.31	0.21
2012BY	Rocky Reach	All	--	--	0.01	<0.01
2012BY	Priest Rapids	All	0.01	--	--	<0.01
2012BY	Wanapum	Columbia Cliffs	0.03	0.24	0.42	0.23
		Columbia Siding	0.03	0.07	0.22	0.11
		All	0.07	0.29	0.50	0.28
2013BY	Wanapum	May	0.51	0.51	0.50	0.51
		September	0.19	0.18	0.07	0.14
		All	0.54	0.56	0.52	0.54
2014BY	Wanapum	All	0.26	0.39	0.30	0.32
2015BY	Wanapum	All	0.08	0.21	0.36	0.21
Wild		NA	0.02	0.01	0.03	0.02
Unknown		NA	0.02	0.03	0.03	0.03
All		All	0.70	0.82	0.83	0.79

Table 11 Proportion of setlines with positive catch (Ep) in Priest Rapids Reservoir during the 2016 White Sturgeon juvenile indexing program. Double dashes (--) represent zero values.

			Priest Rapids Reservoir (No. Sample Sites)			
			Ep			
Brood year	**Release Reservoir**	**Release group**	**Lower (n = 29)**	**Middle (n = 31)**	**Upper (n = 30)**	**All (n = 90)**
2002BY	Rock Island	All	0.14	--	0.07	0.07
2010BY	Rocky Reach	All	0.07	--	0.03	0.03
2010BY	Priest Rapids	LCC	0.03	--	--	0.01
		MCW	0.03	0.16	0.03	0.08
		UCW	0.14	0.10	0.10	0.11
		All	0.21	0.19	0.10	0.17
2010BY	Wanapum	LCC	0.14	--	0.03	0.06
		MCW	0.03	--	0.07	0.03
		UCW	--	0.03	0.07	0.02
		All	0.17	0.03	0.13	0.11
2012BY	Priest Rapids		0.10	0.16	0.37	0.21
2012BY	Wanapum	Columbia Cliffs	--	--	0.03	0.01
		Columbia Siding	--	0.06	0.03	0.03
		All	--	0.06	0.07	0.04
2013BY	Priest Rapids	May	0.10	0.10	--	0.07
		September	0.07	--	--	0.02
		All	0.17	0.10	--	0.09
2013BY	Wanapum	May	0.07	0.06	0.10	0.08
		September	0.07	0.03	--	0.03
		All	0.10	0.10	0.07	0.09
2014BY	Priest Rapids	All	0.14	0.23	0.13	0.17
2014BY	Wanapum	All	--	0.03	0.07	0.03
2015BY	Priest Rapids	All	0.03	0.13	0.13	0.10
Wild		NA	--	--	--	--
Unknown		NA	0.10	0.06	0.10	0.09
All		All	0.55	0.45	0.60	0.53

Size, Growth, and Condition

Sturgeon captured during juvenile White Sturgeon indexing program in the PRPA ranged from 32.5 to 155.0 cm FL (mean = 54.6 cm; n = 721; Table 12) in Wanapum Reservoir and from 33.0 to 145.5.0 cm FL (mean = 63.3 cm FL, n = 137) in Priest Rapids Reservoir. Length-frequency histograms of fish captured in Wanapum and Priest Rapids were similar (Figure 24). The mean FL of PRPA released hatchery sturgeon ranged between 38.5 cm FL (2015BY) to 74.2 cm FL (2010BY). Typical of sturgeon, the brood year releases overlapped in size, with the smallest 2010BY captured similar in size to average 2014BY fish. The largest 2010BY caught was 104 cm FL.

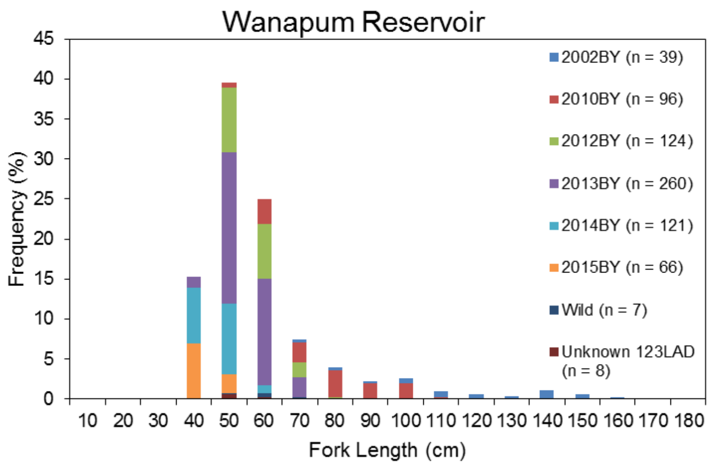
Although efforts were made to record weights for each fish, for large 2002BY CRITFC fish that were to be euthanized, only fork lengths were recorded. Consequently, the maximum weight reported here was likely an underestimate (Table 13). In Wanapum Reservoir, fish weight ranged from 175 g to over 16,000 g; in Priest Rapids Reservoir, the range was larger, with the smallest fish at 260 g and the largest at 24,900 g. For hatchery fish from 2010BY to 2016BY released in the PRPA, the mean weight of the 2010BY was substantially greater than the mean weight of 2012BYfish, which suggested fish growth increased considerable after age-4. In Wanapum Reservoir, the weight of 2010BY through 2015BY fish ranged from 175 to 7,630 g. In Priest Rapids Reservoir, the weight of 2010BY through 2015BY fish ranged from 260 to 9,600 g. Relationships between log^{10} FL and log^{10} weight were highly significant and regression parameter estimates were similar between reservoirs (Figure 25). Relative weight, as a condition factor, was slightly lower in Wanapum Reservoir (mean = 87%; n = 678) and ranged from 53 to 150%, compare to Priest Rapids Reservoir (mean = 92%; n = 114), with a range from 46 to 144% (Figure 26).

Annual growth rate was calculated for each brood year release based on the difference in fork length between release and capture divided by the total days at large (Table 14; Figure 27). Highest growth rates, and the greatest range in growth, was associated with the 2015BY, with annual growth rate from 4.5 to 42.2 $cm \cdot y^{-1}$ (mean = 17.1 $cm \cdot y^{-1}$). The mean growth rate of the 2010BY after nearly six years at large in the PRPA was 8.4 $cm \cdot y^{-1}$. Growth rates of fish in Wanapum and Priest Rapids reservoirs were similar.

Table 12 Fork length (cm) of sturgeon captured during the 2016 White Sturgeon juvenile indexing program, September 7 to October 6, 2016. The FL recorded during first capture was used for individuals captured twice or more during the survey.

Program	Brood Year	Wanapum					Priest Rapids					All				
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
CRITFC	2002	39	113.1	26.2	64.5	155.0	7	118.9	20.2	92.0	145.0	46	113.9	25.2	64.5	155.0
Chelan PUD	2010	8	82.1	19.6	53.0	103.5	3	91.7	4.9	86.0	95.0	11	84.7	17.1	53.0	103.5
	2012	1	52.0	n/a	52.0	52.0	-	-	-	-	-	1	52.0	n/a	52.0	52.0
Grant PUD	2010	88	72.0	14.6	46.5	101.0	35	79.6	15.2	49.0	104.0	123	74.2	15.1	46.5	104.0
	2012	123	51.9	6.5	41.0	74.0	26	58.4	11.3	43.0	82.5	149	53.0	7.9	41.0	82.5
	2013	260	50.2	6.7	34.0	67.5	23	51.9	8.0	41.0	68.0	283	50.3	6.8	34.0	68.0
	2014	121	42.2	4.8	33.5	56.0	22	45.7	5.0	36.0	54.0	143	42.7	5.0	33.5	56.0

Program	Brood Year	Wanapum					Priest Rapids					All				
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
	2015	66	38.3	3.3	32.5	46.5	11	39.5	3.2	33.0	43.5	77	38.5	3.3	32.5	46.5
Unknown	Unknown	8	49.8	10.3	34.5	69.0	10	63.0	16.5	46.5	97.0	18	57.1	15.3	34.5	97.0
Wild	Unknown	7	65.9	19.5	44.0	100.0	-	-	-	-	-	7	65.9	19.5	44.0	100.0
All sturgeon	All	721	54.6	19.7	32.5	155.0	137	63.3	22.4	33.0	145.0	858	56.0	20.4	32.5	155.0



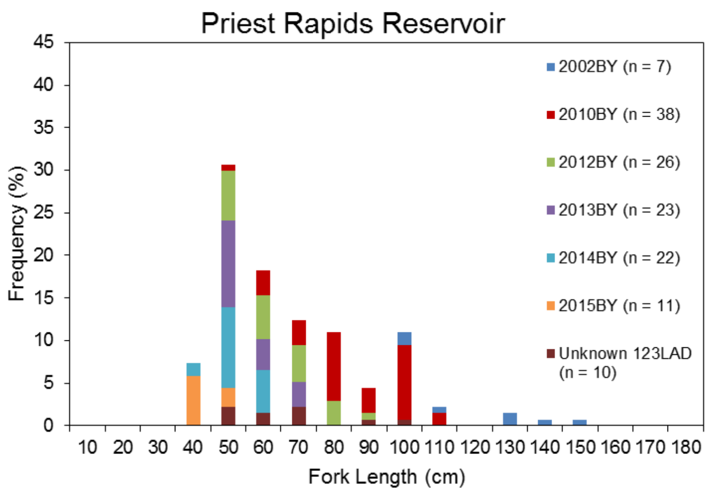


Figure 24 Length-frequency distribution of each brood year of hatchery White Sturgeon captured during the 2016 juvenile indexing program, September 7 to October 6, 2016.

Table 13 Weight (g) of White Sturgeon captured during the 2016 White Sturgeon juvenile indexing program, September 7 to October 6, 2016.

Program	Brood Year	Wanapum					Priest Rapids					All				
		n	Mean	SD	Min	Max	n	Mean	SD	Min	Max	n	Mean	SD	Min	Max
CRITFC	2002	25	7099	4567	1130	16000	7	14531	8111	4360	24900	32	8725	6215	1130	24900
Chelan PUD	2010	8	3983	3057	650	7610	3	5380	1308	3880	6280	11	4364	2704	650	7610
	2012	1	715	--	715	715	-					1	715	--	715	715
Grant PUD	2010	88	2721	1750	545	7630	35	3854	2560	530	9600	123	3043	2068	530	9600
	2012	123	836	418	390	2500	25	1375	812	460	3180	148	927	542	390	3180
	2013	260	862	656	240	9310	23	1025	563	380	2360	283	875	650	240	9310
	2014	121	481	435	195	4760	21	625	220	360	1100	142	502	413	195	4760
	2015	66	304	100	175	595	10	491	351	260	1460	76	328	166	175	1460
Unknown	Unknown	8	851	598	215	2115	9	2027	2301	560	7580	17	1473	1780	215	7580
Wild	Unknown	7	1425	1139	470	3790	-	-	-	-	-	7	1425	1139	470	3790
All sturgeon	All	707	1232	1804	175	16000	130	2545	3898	260	24900	828	1413	2288	175	24900

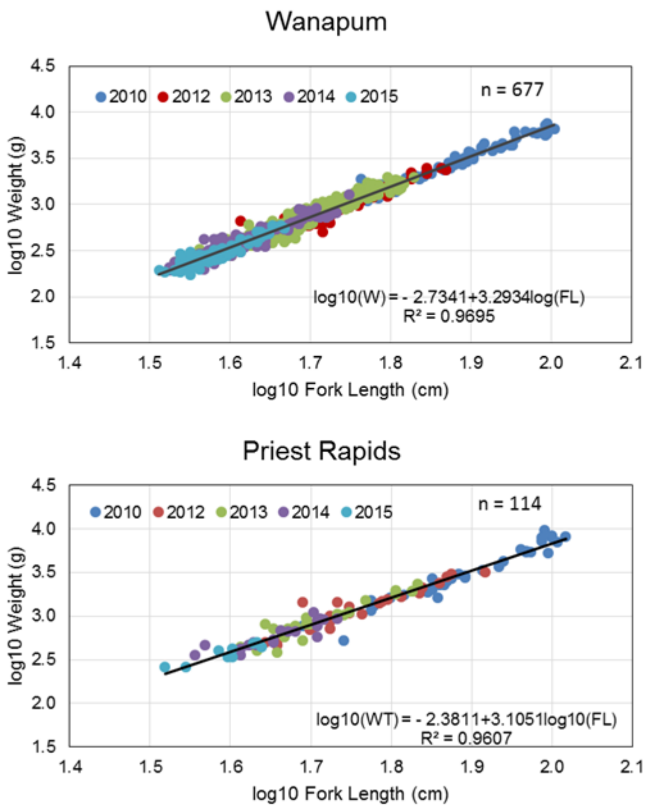


Figure 25 Length-weight relationships (log10 transformed) of hatchery juvenile White Sturgeon for each brood year captured during the 2016 White Sturgeon juvenile indexing program, September 7 to October 6, 2016.

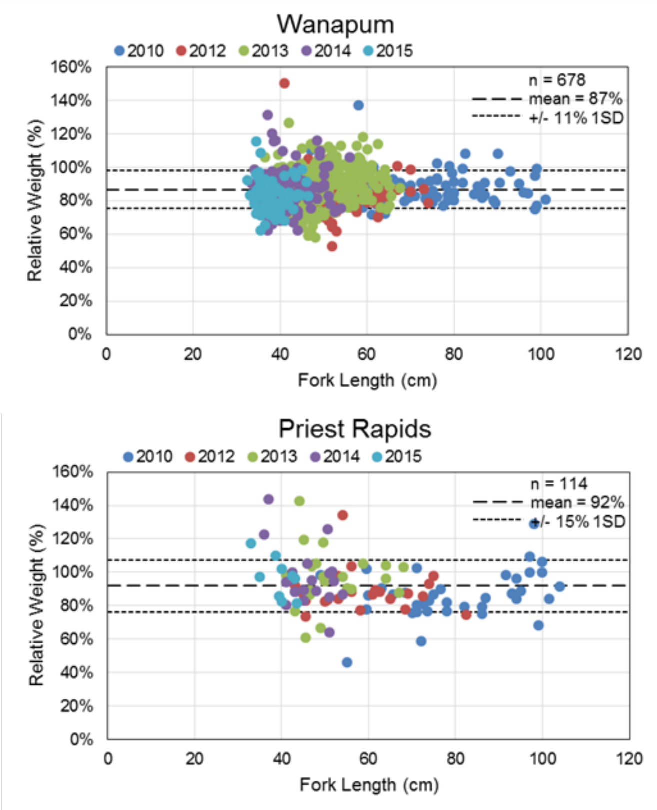


Figure 26 **Relative weight and fork length relationships for hatchery juvenile White Sturgeon of each brood year captured during GRTS in Wanapum and Priest Rapids reservoirs during the 2016 White Sturgeon juvenile indexing program, September 7 to October 6, 2016.**

Table 14 **Growth as change in fork length (FL; cm) and growth rate (FL; cm/year) of Marion Drain Hatchery fish captured during the 2016 juvenile White Sturgeon indexing program, September 7 to October 6, 2016.**

Reservoir	Program	BY	n	Time at Large (Years)				Growth (cm)				Growth Rate (cm· y^{-1})			
				Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Wanapum	Chelan PUD	2010	8	5.43	0.02	5.39	5.45	52.9	19.9	18.5	74.1	9.8	3.7	3.4	13.6
		2012	1	3.36	n/a	3.36	3.36	34.4	n/a	34.4	34.4	10.2	n/a	10.2	10.2
	Grant PUD	2010	88	5.41	0.02	5.37	5.44	43.1	14.0	15.5	79.0	8.0	2.6	2.9	14.6
		2012	123	3.37	0.01	3.33	3.38	21.9	6.6	7.5	43.2	6.5	2.0	2.2	12.9
		2013	260	2.32	0.14	1.98	2.41	22.8	8.5	5.1	46.0	9.8	3.6	2.5	19.3
		2014	121	1.39	0.02	1.36	1.42	10.5	4.5	3.4	24.3	7.6	3.2	2.4	17.6
		2015	66	0.40	0.02	0.37	0.42	6.8	3.5	1.9	16.4	17.1	9.0	4.5	42.2
Priest Rapids	Chelan PUD	2010	3	5.43	0.04	5.40	5.47	62.8	4.0	59.3	67.2	11.6	0.8	10.8	12.4
	Grant PUD	2010	35	5.42	0.03	5.37	5.45	51.7	14.4	24.4	78.5	9.5	2.7	4.5	14.6
		2012	26	3.38	0.02	3.34	3.40	29.0	11.1	9.2	47.4	8.6	3.3	2.7	14.2

Reservoir	Program	BY	n	Time at Large (Years)				Growth (cm)				Growth Rate (cm· y^{-1})			
				Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
		2013	24	2.31	0.16	1.98	2.42	25.0	6.9	14.9	39.6	10.9	3.2	6.2	17.5
		2014	22	1.41	0.02	1.38	1.44	13.1	5.7	0.7	25.0	9.3	4.1	0.5	17.7
		2015	11	0.42	0.02	0.38	0.44	7.7	2.9	4.6	13.8	18.1	6.8	10.6	33.1
All	Chelan PUD	2010	11	5.43	0.02	5.39	5.47	55.6	17.4	18.5	74.1	10.3	3.2	3.4	13.6
		2012	1	3.36	n/a	3.36	3.36	34.4	n/a	34.4	34.4	10.2	n/a	10.2	10.2
	Grant PUD	2010	123	5.41	0.02	5.37	5.45	45.6	14.6	15.5	79.0	8.4	2.7	2.9	14.6
		2012	149	3.37	0.02	3.33	3.40	23.1	8.0	7.5	47.4	6.9	2.3	2.2	14.2
		2013	284	2.32	0.14	1.98	2.42	23.0	8.4	5.1	46.0	10.0	3.6	2.5	19.6
		2014	143	1.40	0.02	1.36	1.44	10.9	4.7	0.7	25.0	7.9	3.4	0.5	17.7
		2015	77	0.41	0.02	0.37	0.44	7.0	3.4	1.9	16.4	17.1	8.6	4.5	42.2

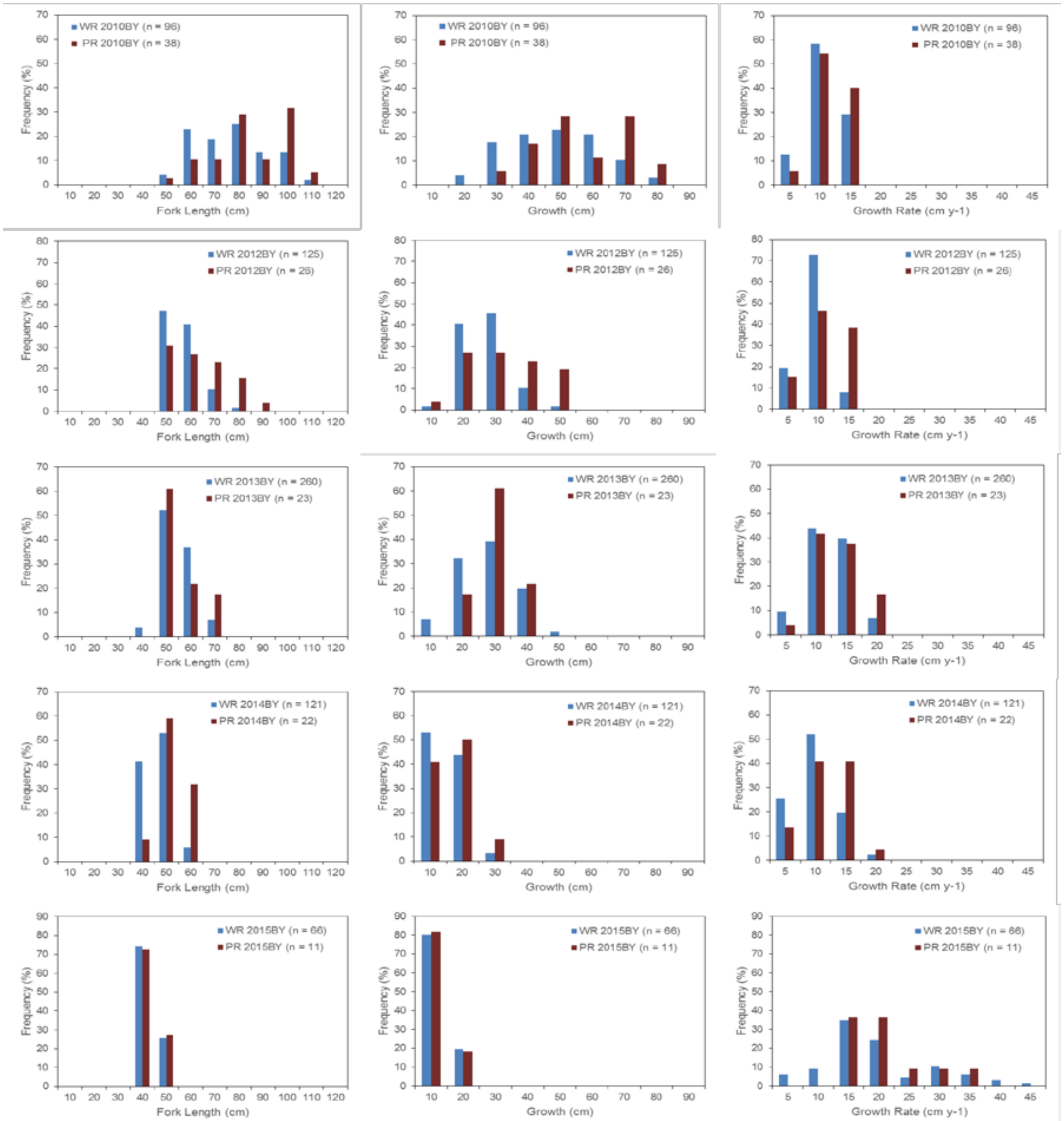


Figure 27 Comparisons of FL, growth in FL since tagging, and FL growth rate since tagging by brood year for hatchery sturgeon captured in Wanapum (blue bars) and Priest Rapids (red bars) reservoirs during the juvenile White Sturgeon indexing program, September 7 to October 6, 2016.

Gear performance

An objective of the 2016 juvenile White Sturgeon indexing program was to increase the total number of juvenile hatchery fish captured (i.e., 2010BY through 2015BY) and to improve the precision of population estimates, compared to previous study efforts, while reducing the capture of older, larger fish that would increase handling and processing times. In this regard, the newly designed juvenile setline gear exceeded expectations based on the high catch proportion of juvenile hatchery fish and a lower catch proportion of larger fish. One consequence of fishing small hook setlines was increased gear loss or damage in terms of bent and lost hooks (Table 15).

In total, 312 hooks (31%) of the 1,000 hook gear allotment for Wanapum Reservoir were damaged, with most hooks bent (n = 277 hooks) and the remainder lost (n = 35 hooks). Due to the strong monofilament leader material, lost hooks only comprised 11% (35 of 312 hooks) of hooks damaged. Gear loss in Priest Rapids Reservoir was less of an issue, with only 71 (14%) damaged hooks of the 500 hooks gear allotment. The primary cause of hook damage was large fish taking and straightening the hooks. In Wanapum, the number of damaged 4/0 gangions (36%) exceeded the number of damaged 2/0 gangions (27%), even though the 4/0 hook was stronger than the 2/0 hook. An adequate spare hooks supply and the addition of hook repair kits to fix and replace hooks at they get damaged should be considered in future studies. Catch by each hook size was similar both in terms of number and size of fish caught, with total catch and size of fish caught by 4/0 gangions only a marginally higher than the 2/0 gangions (Table 16).

Table 15 Hook fate and overall gangion damage during the White Sturgeon juvenile indexing program in the Priest Rapids Project area, September 7 to October 6, 2016.

Reservoir	Hook Size	Gangions		Hook/Gangion Fate				
		Set #	Gear Inventory	Bent	Lost	Total	Proportion of Set Gangions Lost/Bent	Proportion of Gangion Inventory Lost/Bent
		n	n	n	n	n	%	%
Wanapum	**2/0**	5419	520	126	13	139	2.6	26.7
	4/0	5419	480	151	22	173	3.2	36.0
Total		10838	1000	277	35	312	2.9	31.2
Priest Rapids	**2/0**	1800	260	35	0	35	1.9	13.5
	4/0	1800	240	32	4	36	2.0	15.0
Total		3600	500	67	4	71	2.0	14.2
PRPA		12638	1240	309	39	348	2.8	28.1

Table 16 White Sturgeon catch by hook size during the White Sturgeon juvenile indexing program in the Priest Rapids Project area, September 7 to October 6, 2016.

Reservoir	Hook Size	Catch	Fork Length (cm)			
		n	Mean	SD	Min	Max
Wanapum	2/0	337	52.0	14.3	33.5	140.0
	4/0	405	56.9	22.9	32.5	155.0
Priest Rapids	2/0	52	61.7	21.0	39.5	145.0
	4/0	89	64.1	22.9	33.0	133.0

3.6.1 Hatchery Juvenile White Sturgeon Abundance Estimates

Capture success during the 2016 juvenile White Sturgeon indexing program was sufficient to construct a Cormack-Jolly-Seber model to estimate survival and recapture probabilities of juvenile hatchery sturgeon released in Wanapum and Priest Rapids reservoirs (Table 17). The model-averaged survival and recapture estimates were used to calculate cumulative mean annual population values with 95% confidence intervals to describe abundance of hatchery juvenile White Sturgeon released in the PRPA for each calendar year from 2011 to 2016 (Figure 28; Table 18).

Mean survival estimates were 21% higher in Wanapum Reservoir when compared to Priest Rapids Reservoir. Each successive annual release of hatchery fish was reflected in step increases in annual population estimates; a decrease in population abundance was estimated in 2012, since hatchery fish were not released in that year. With the release of the 2015BY, the 2016 hatchery fish abundance estimate in Wanapum Reservoir was 13,339 (95%CI = 11,432 - 15,064) or 62% of total hatchery releases to date (n = 21,385 fish); in Priest Rapids Reservoir, the 2016 hatchery fish abundance estimate 3,335 fish (95%CI = 2,851 - 3,868) or 41% of total hatchery releases to date (n = 8,067 fish). Further refinement of the models, with the inclusion of survival and recapture probabilities specific to each brood year, should be possible with additional inter-year capture data.

Table 17 Estimates of annual recapture and survival parameters for hatchery juvenile White Sturgeon in the Priest Rapids Project area, derived from reservoir-specific Cormack-Jolly-Seber models.

Reservoir	Parameter	Estimate		
		Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Shared by both Wanapum and Priest Rapids	Recapture, 2013	Fixed	--	--
	Recapture, 2014	0.019	0.016	0.023
	Recapture, 2015	Fixed	--	--
	Recapture, 2016	0.044	0.038	0.05
Wanapum	Survival (Phi) All Years	0.867	0.822	0.901
Priest Rapids	Survival (Phi) All Years	0.719	0.662	0.770

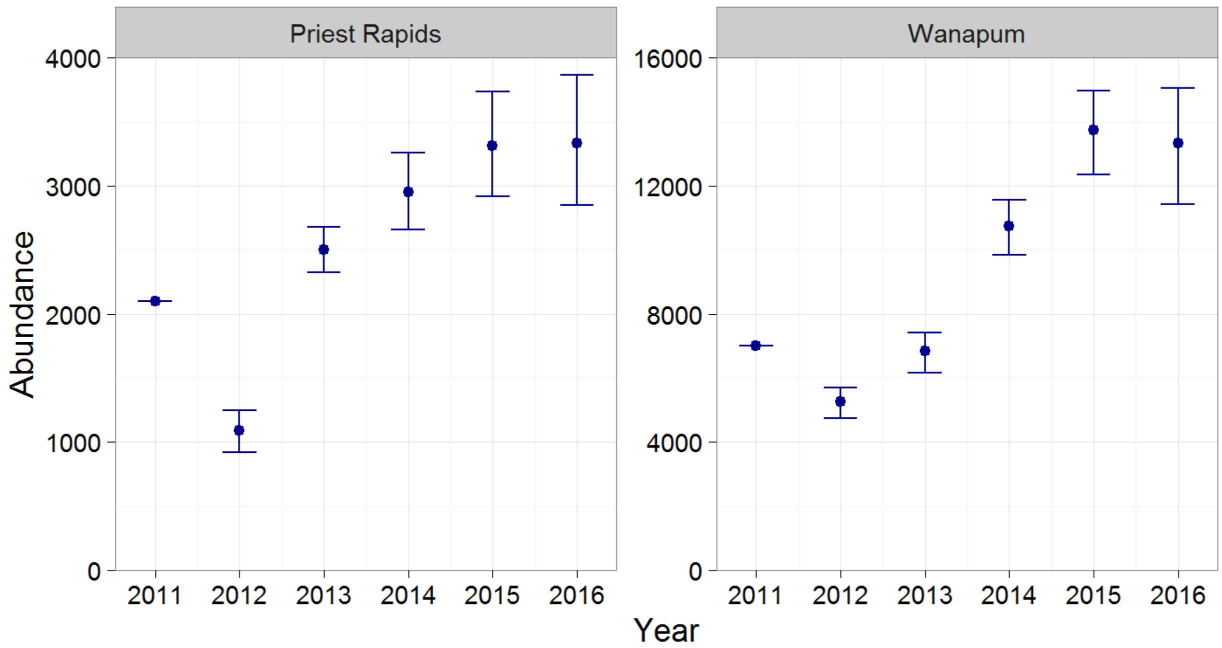


Figure 28 **Estimated abundance of hatchery juvenile White Sturgeon (based on survival of 2010BY to 2015BY releases in the Priest Rapids Project area) by calendar year for Wanapum and Priest Rapids reservoirs, from 2011 to 2016.**

Table 18 **Estimated total abundance of hatchery juvenile White Sturgeon (2010BY to 2015BY releases in the Priest Rapids Project area) population by calendar year and in relation to annual and cumulative hatchery releases, 2011 to 2016.**

	Calendar Year					
	2011	**2012**	**2013**	**2014**	**2015**	**2016**
Pool	**Abundance Estimate (95% CI)**					
Wanapum	7,015 (7,015 - 7,015)	5,271 (4,745 - 5,701)	6,833 (6,167 - 7,403)	10,754 (9,833 - 11,564)	13,742 (12,351 - 14,980)	13,339 (11,432 - 15,064)
Annual Hatchery Release No.	7,016	0	2,264	5,093	5,007	2,005
Cumulative Release No.	7,016	7,016	9,280	14,373	19,380	21,385
Priest Rapids	2,101 (2,101 - 2,101)	1,087 (921 - 1,246)	2,499 (2,327 - 2,677)	2,951 (2,656 - 3,258)	3,315 (2,918 - 3,739)	3,335 (2,851 - 3,868)
Annual Hatchery Release No.	2,101	0	1,717	1501	1,495	1,253
Cumulative Release No.	2,101	2,101	3,818	5,319	6,814	8,067

4.0 DISCUSSION

The following sections provide a brief discussion of the 2016 (Year 8) M&E program results for the PRPA. Activities included tagging and release of 2015BY juvenile White Sturgeon, broodstock capture and 2016BY production, and monitoring of acoustic-tagged 2015BY movements after release, and the 2016 juvenile White Sturgeon indexing study. Discussion of the indexing program will consist of a general overview of the study approach to identify strengths and limitations and the ability of the program to estimate the hatchery juvenile sturgeon population, as a whole, and for specific brood year cohorts.

Juvenile White Sturgeon Processing and Release (2015BY)

Tagging and marking of the 2015BY was completed in the first week of April. In past years, this work was conducted in mid-April. A possible drawback of the earlier processing date was that 2015BY growth may have been reduced as the fish were removed from feed early and processed during a period when hatchery water temperatures are typically warmer compared to winter and growth rates have increased. However, overwinter growth of the 2015BY was above average (C. Mott, Grant PUD, December 9, 2015, personal communication) and fish were comparable in size with the previous brood year releases by early April 2016. Processing the fish earlier allowed extra time (i.e., approximately 20 days) for recovery from tagging and handling stress a prior to release in late April.

Inconsistent removal of scutes during past marking events was evident in the 2016 juvenile indexing catch among the different hatchery brood year fish captured. Most fish captured in 2016, including the 2015BY that were released in April, had the standard scute mark pattern that consisted of three left lateral scutes removed posterior to the dorsal fin origin (see Figure 2). This marking pattern was easily identifiable by field crews and will likely continue to be obvious as the fish grows. However, a small proportion of fish caught had a different scute mark pattern that consisted of three left lateral scutes removed posterior to the dorsal fin insertion. This mark, while still noticeable to experienced staff, was less noticeable, especially in small fish, than the removal of the three anterior scutes. Moving forward, as of 2016, the recommended standard scute mark pattern for hatchery fish in the Columbia Basin has been changed to remove three left lateral scutes anterior to the dorsal fin origin. Future instructions issued for fish tagging and marking in the PRPA will clearly indicate this change.

The occurrence of fin deformities recorded during processing of the 2015BY was substantially lower (14%; n = 456 of 3,258 fish) than the 2014BY (78%; n = 5,104 of 6,502 fish) and 2013BY (64%; n = 4,246 of 6,594; Golder 2014) releases. The low occurrence of fin deformities for the 2015BY was attributed to earlier removal of the larval fish from incubation tanks where most of the fin damage occurs during early stage development (D. Miller, MDH, November 10, 2016, personal communication).

The Frenchman Coulee Launch site (RM424.5) was used as the Wanapum Reservoir release site for both the 2014BY and 2015BY releases. Due to the benefits of this release site, as indicated in previous reports (e.g., ease of access, reduced risk of avian predation, etc.), Frenchman Coulee launch will likely be the designated release site for all future hatchery releases to Wanapum Reservoir (Golder 2016).

Broodstock Capture

In 2016, broodstock collection effort was concentrated primarily below McNary Dam. Six ripe females and six ripe males were captured and transported to Marion Drain Hatchery for spawning. These adults were spawned to produce 36 genetic crosses (6 unique crosses, 30 half-sib crosses) of 2016BY progeny. Continued collaboration between Grant and Chelan PUD to fund a high intensity-short duration broodstock capture program below McNary Dam will likely continue to be the most effective approach to catch sufficient broodstock to meet Grant PUD juvenile release and genetic diversity objectives outlined in the 2016 SOA.

Movements of 2015BY Acoustic-Tagged White Sturgeon Juveniles

As part of each broodyear release conducted since 2011, the movements of acoustic-tagged juvenile White Sturgeon released with each broodyear have been monitored to determine initial short-term post-release dispersal patterns and longer-term movements in subsequent years. A component of both the short and long-term movement patterns is an estimation of the proportion of fish that become entrained either through Wanapum or Priest Rapids dams. Inherently, the general dispersal of each broodyear release within each reservoir would differ in terms of direction (i.e., upstream or downstream) and distance moved after release, due in part to release location within each reservoir (i.e., the lower section in Wanapum Reservoir; the upper section in Priest Rapids Reservoir). Increased risk of entrainment through Wanapum Dam was identified as a potential consequence of releasing hatchery fish in the lower section of Wanapum Reservoir. In both reservoirs, the areal extent of acoustic receiver coverage was limited, and as such, these data only describe large scale changes in fish distribution, seasonal movements, and habitat use in each reservoir. Despite data loss and reduced acoustic telemetry coverage in the Project due to vandalism of stations, the telemetry data recorded in 2016 provided sufficient data to assess post-release dispersal and distribution of the 2015BY in Wanapum and Priest Rapids reservoirs.

Wanapum Reservoir

In Wanapum Reservoir, the post-release dispersal pattern of the 2015BY fish released at Frenchman Coulee Launch (RM424.5) was a general upstream movement. This same general pattern was observed for the 2014BY release fish. In 2016, a large proportion (84%; n = 21 of 25 fish) of the acoustic-tagged 2015BY also exhibited a substantial amount of upstream movement after release. A large proportion of fish (48%; n = 12 of 25 fish) were detected at least once in the upper reservoir near the Haystack Eddy monitoring station (RM452.4), with the first fish detected at this station approximately three weeks after release. A similar tendency for upstream movement into the Rock Island Dam tailrace area in the first month after release was also observed in the 2013BY (Golder 2015) and 2014BY (Golder 2016) releases.

This tendency to disperse upstream after release reduces the risk that newly stocked juveniles, disoriented by their release into a strange environment, would drift or swim downstream and be entrained through Wanapum Dam. However, fish that move upstream into the Rock Island Dam tailwater area are exposed to a higher risk of avian predation from the bird colonies located in the Rock Island Dam forebay (PTAGIS mortality site = RISFWC). This risk has been confirmed annually by PIT-tag detection surveys of the colonies conducted by Chelan PUD. As of 2016, these surveys have detected 594 PIT-tags from hatchery juvenile White Sturgeon released in the Project since 2011 (Table 19). Assuming most or all of this predation occurs in the first year after release, avian predators are capable of capturing juvenile sturgeon over 300 mm FL and 200 g in weight. Based on the proportion of tags (i.e., percent of total release number) detected from each brood year, a general trend in the mortality data was that fish released at upstream sites experienced higher levels of avian predation than fish released at downstream sites. Due to volitional upstream movement into the Rock Island Dam tailrace area after release at Frenchman Coulee (RM424.5), both the 2014BY and 2015BY experienced similar rates of avian predation, albeit a lower rate than fish released upstream in previous years. The lowest level of avian predation rate (based on tag detections) was recorded for the 2013BY. These fish were released at the temporary Rocky Coulee Launch (RM421.5) in the spring and fall of 2014 during Wanapum fracture emergency response. During this period, the upper portion of Wanapum Reservoir temporarily returned to more riverine conditions, with higher water velocities and shallower depths compared to levels under normal reservoir operations. Under these conditions, some aspect of the predator-prey relationship between the avian predators and the juvenile sturgeon likely changed, with the result that overall predation on 2013BY was considerably reduced relative to predation levels experienced by the other brood year releases. The effect of avian predation of juvenile White Sturgeon populations will not be addressed further here other than to note the apparent relationship between reduced avian predation rate on 2013BY and the high catch proportion of 2013BY during juvenile indexing in Wanapum Reservoir (but not in Priest Rapids Reservoir).

Table 19 PIT-tags detected at the Rock Island Dam bird colony (PTAGIS mortality site RISFWC) that originated from hatchery White Sturgeon (2010BY to 2015BY) released into Wanapum Reservoir. Data to November 1, 2016.

Brood year	Release Location (RM)[b]	Wanapum Reservoir Hatchery Juvenile White Sturgeon Release No.	PIT-tags Detected at RISFWC	Fork Length (mm) at Release		Weight (g) at Release		Percent of BY release detected at RISWSC
			n	Mean	S.D.	Mean	S.D.	%
2010	450.6	7,016	278	272	34	127	43	4.0
2012	450.6	1,135	154	294	26	152	42	13.6
	442.0	1,129	53	298	25	163	43	4.7
	All	2,264	207	295	26	155	42	9.1
2013[a]	421.5	5,093	8	285	46	138	64	0.2
2014	424.5	5,007	74	310	26	192	46	1.5
2015	424.5	2,005	27	293	23	158	36	1.3
Grand Total		**21,385**	**594**	**286**	**33**	**146**	**48**	**2.8**

[a] The 2013BY were released in 2014 during reduced pool elevation level during the Wanapum Dam fracture repair efforts

[b] RM450.6 Columbia Siding; RM442.0 Columbia Cliffs Eddy (boat-based release), RM421.5 Rocky Coulee Launch, RM424.5 Frenchman Coulee Launch

The entrainment rate of 2015BY from Wanapum Reservoir into Priest Rapids Reservoir was similar to previous broodyear releases (Table 20). In total, 3 of the 25 (12.0%) acoustic-tagged

2015BY fish were detected by the Wanapum forebay station as the fish approached Wanapum Dam; these fish were subsequently entrained into Priest Rapids Reservoir. After release, one of the three acoustic-tagged fish entrained was detected downstream of the release site immediately after release and was entrained after only 11 days at large. The other two fish that were eventually entrained were initially detected upstream of the release site immediately after release and were at large for 64 days and 114 days, respectively. The fish at large for 114 days was detected as far upstream at Rock Island Dam and moved an estimated distance of 176 km between monitoring stations. Although the sample size was low, there was no apparent relationship between the timing of entrainment of acoustic-tagged fish with discharge, water temperature, or season.

Priest Rapids Reservoir

The seven acoustic-tagged 2015BY fish released in Priest Rapids Reservoir at the Wanapum Dam tailrace launch (RM415.6) remained in the upper section of Priest Rapids Reservoir after release, with higher residency rates recorded in the vicinity of the Wanapum tailrace receiver (RM415.5) and lower residency rates recorded downstream at the receiver (RM410.5) near Crab Creek. A similar movement pattern and distribution was observed for the 2014BY after release in 2015 (Golder 2016). High use and high residency by both acoustic-tagged adult and juvenile sturgeon in the Wanapum Dam tailrace area have been documented consistently since acoustic telemetry monitoring was initiated in 2010. However, unlike previous studies, residency in 2016 remained high into late fall, whereas in previous years, residency below Rock Island Dam typically declined by late fall (Golder 2015). Although a large number of White Sturgeon reside in the Priest Rapids tailrace area, previous telemetry studies suggested sturgeon moved on a seasonal basis between the lower and upper reservoir sections, with a portion of the population residing in the lower reservoir section during summer and returning to the Wanapum tailrace area in winter (Golder 2012).

Entrainment of 2015BY from Priest Rapids Reservoir into McNary Reservoir was not detected. This finding was consistent with movements of the 2012BY through 2014BY releases (Table 20). Entrainment of 2010BY fish was recorded in 2011; however, this entrainment event was specific to the LLC stock of hatchery fish released that year (Golder 2012), and most of these fish were entrained through Wanapum Dam and their downstream progress recorded in detail based on detections at multiple receiver stations throughout the PRPA. One benefit of these movements was that these fish confirmed early on the overall effectiveness of the Project acoustic monitoring array, and that the acoustic receiver stations were effective at detecting entrained fish below Wanapum and Priest Rapids dams. The stations vandalized in 2016 above and below Priest Rapids Dam will be reestablished in 2017.

Table 20 Entrainment rate of acoustic-tagged juvenile White Sturgeon released into the Priest Rapids Project area between 2011 and 2016, detailed by release pool, year, and dam of entrainment.

Release Details				Entraining Dam (RM)	Number Entrained	Percent Entrainment (%)
Pool	Year	n	Release RM			
Wanapum	2011 (2010BY)	70	450.6	Wanapum (415.6)	9	12.9
Wanapum	2013 (2012BY)	24	450.6/442.0	Wanapum (415.6)	0	0.0

Release Details				Entraining Dam (RM)	Number Entrained	Percent Entrainment (%)
Pool	Year	n	Release RM			
Wanapum	2014 (2013BY)	52	421.5	Wanapum (415.6)	3	5.8
Wanapum	2015 (2014BY)	48	424.5	Wanapum (415.6)	7	14.6
Wanapum	2016 (2015BY)	25	424.5	Wanapum (415.6)	3	12.0
Subtotal		194			19	9.8
Priest Rapids	2011 (2010BY)	21	415.6	Priest Rapids (397.1)	2	9.5
Priest Rapids	2013 (2012BY)	6	415.6	Priest Rapids (397.1)	0	0.0
Priest Rapids	2014 (2013BY)	14	415.6	Priest Rapids (397.1)	0	0.0
Priest Rapids	2015 (2014BY)	15	415.6	Priest Rapids (397.1)	0	0.0
Priest Rapids	2016 (2015BY)	7	415.6	Priest Rapids (397.1)	0	0.0
Subtotal		56			2	3.6

Juvenile Indexing

The 2016 juvenile White Sturgeon population indexing effort was considered successful. Refinement of the GRTS study design to sample deeper habitat in Wanapum Reservoir to increase catch, combined with the assistance from Grant PUD biologists increased overall sample effort in the PRPA (271 sample sites in Wanapum and 90 sample sites in Priest Rapids). This increased effort resulted in the capture of 887 juvenile White Sturgeon, of which 813 were from 2010BY to 2015BY releases in the Project (i.e., the primary fish of interest).

The standardized sampling gear specifically designed to catch small White Sturgeon was very effective in catching fish under 80 cm FL. Although fish above this size were also captured, hooks in these fish were often slightly bent or damaged and had to be replaced. In Wanapum Reservoir, 31% of the initial gangion inventory was damaged due to large fish taking and bending the hook; in Priest Rapids Reservoir, where there are likely fewer large fish, only 14% of gangions were damaged. Based on this data, future indexing programs can be supplied with sufficient spare hooks and repair kits. As expected, baiting and rebaiting hooks was the most time consuming task in any given sample day, whereas setting, pulling, and processing fish caught on setlines was relatively quick. In future indexing efforts with this sampling gear as currently configured, catch efficiency of brood year cohorts five years and older is expected to decline as the fish get larger. This reduced catch efficiency of larger fish by the gear used in 2016 was illustrated by the lower catch proportion of 2010BY (mean fork length = 74.2 cm FL) in 2016 compared to the 2014 survey.

In Wanapum Reservoir, fish from the 2013BY release contributed 36% of the total catch (n = 269 of 746 fish captured). The 2013BY were distributed almost equally throughout Wanapum Reservoir, with similar catch rates in the lower (Ep = 0.54), middle (Ep = 0.56), and upper sections (Ep = 0.52) of the reservoir, where as other brood year releases were mainly caught in the middle and upper sections. As previously discussed, the prevalence of the 2013BY in the present study catch may reflect reduced avian predation on this release group due to the Wanapum fracture, which produced lower reservoir levels that resulted in more riverine habitat conditions. Data from future indexing studies are needed to verify the high catch rates of the 2013BY in relation to other brood year cohorts. The 2016 Wanapum catch data supports the 2014 juvenile indexing study findings of differences in the catch rates of within-brood year release groups in the 2010BY (i.e., higher catch rates of 2010BY UCW and MCW releases compared to 2010BY LCC releases) and 2012BY (i.e., higher abundance of fish released upstream at Columbia Cliffs versus downstream at Columbia Siding; Golder 2015). Furthermore, evidence that the 2013BY spring release group was substantially more abundant in the catch than the fall 2013BY (i.e., ~a 5:1 catch ratio of spring to fall released fish, compared to a 2:1 stocking ratio for these groups) was also supported by the 2016 indexing data. Excluding the 2002BY, catch of entrained fish from upstream reservoirs was lower in 2016 at only 1.2% of the total catch (n = 9 of 746) compared to levels recorded in 2014 (7.2%; n = 18 of 249; Golder 2015).

In Priest Rapids Reservoir, 2010BY contributed almost 27% (n = 38 of 141 fish) to the total catch, with progressively fewer captures of 2012BY (n = 28), 2013BY (n = 24), 2014BY (n = 22), 2015BY (n = 11), and 2002BY (n = 7). Unlike Wanapum Reservoir, the Priest Rapids Reservoir catch consisted of a large proportion of fish entrained from upstream reservoirs, which included 42% (n = 16) of the 2010BY, 14% (n = 4) of the 2012BY, 58% (n = 14) of the 2013BY, and 23% (n = 5) of the 2014BY, or approximately 27% of the total fish captured. These data suggest fish entrained from upstream reservoirs are more likely to remain in the Priest Rapids Reservoir than continue their downstream movements and be entrained through Priest rapids Dam. If this continues to be the case, then the sturgeon population in Priest Rapids Reservoir will likely continue to be supplemented by entrained fish from upstream reservoirs and this immigration effect will have to be accounted for in future population estimate models and in future stocking rates. In general, White Sturgeon were broadly distributed throughout the reservoir, with similar catch rates recorded in the upper (Ep = 0.60) and lower reservoir sections (Ep = 0.55), and slightly lower catch rates in the middle section (Ep = 0.45). This finding was contrary to telemetry data that indicated higher use and residency of the upstream section of Priest Rapids Reservoir. This discrepancy was assumed to relate to the exclusion of indexing sample sites in the upper reservoir section due to safety concerns, particularly in the vicinity of closed spillways. However, high use of these area is suspected and their exclusion likely results in an underestimate in catch rate for the upper section of Priest Rapids Reservoir. Although none were captured, wild fish are known to occur in Priest Rapids Reservoir and adult spawning has been detected in previous studies (Golder 2011); however, previous adult and juvenile capture studies estimated the wild fish population to be very small (Golder 2011, 2013, 2015, 2016).

Length frequency and growth rates of White Sturgeon juveniles were generally similar for both reservoirs and comparable to rates recorded in the 2014 survey (Golder 2015). Relative weight in Wanapum Reservoir (87%) was slightly lower than in Priest Rapids Reservoir (92%); whether this difference was related to density dependent effects or other reasons is presently unknown. Continued monitoring of relative weight in future studies is required to address this question. Overall, however, growth of hatchery fish in both reservoirs appeared robust based on mean incremental growth measured between release and recapture for 2010BY fish (mean = 8.4 $cm\cdot y^{-1}$ FL).

Captures during the 2016 indexing program were sufficient to calculate preliminary population estimates for juvenile hatchery White Sturgeon in Wanapum Reservoir (n = 13,339 fish; 95%CI = 11,432 - 15,064) and Priest Rapids Reservoir (n = 3,335 fish; 95%CI = 2,851 - 3,868). These estimates represent the numbers of fish surviving from all of the hatchery fish released into the PRPA since 2011. Survival model parameters calculated for all brood years since release suggest that juvenile White Sturgeon survival rates are higher in Wanapum Reservoir (0.867) than in Priest Rapids Reservoir (0.719). The survival estimated calculated for Wanapum Reservoir, based on the results of two indexing studies to date (i.e., 2014 and 2016), closely aligned with the age-1 White Sturgeon survival estimate (0.86) used in the PRPA stocking model to determine stocking rates and estimate future White Sturgeon abundance and age class structure. Strengthening of confidence intervals around these estimates, as well as survival and population estimates of individual brood years, will likely be forthcoming with additional data collected in future indexing studies.

LITERATURE CITED

Bannerot, S.P. and C.B Austin. 1983. Using frequency distributions of catch per unit effort to measure fish-stock abundance. Journal: Transactions of The American Fisheries Society - TRANS AMER FISH SOC , vol. 112, no. 5, pp. 608-617, 1983

Beamesderfer, R.C. 1993. A standard weight (Ws) equation for white sturgeon. California Fish and Game 79:63-69.

Blue Leaf Environment. 2016. Broodstock Collection below McNary Dam in 2016. Technical memo for Chelan County Public Utility District No.1, July 6, 2016. 5pp.

Counihan, T. D., M. J. Parsley, D. G. Gallion, C. N. Frost, and Morgan. February 1999. Report C. Effects of Mitigative Measures on Productivity of White Sturgeon Populations in the Columbia River Downstream From McNary Dam, and Determine the Status and Habitat Requirements of White Sturgeon Populations in the Columbia and Snake Rivers Upstream From McNary Dam, Annual Progress Report, April 1997-March 1998, Report C in Effects of Mitigative Measures on Productivity of White Sturgeon Populations in the Columbia River Downstream from McNary Dam, and Determine the Status and Habitat Requirements of White Sturgeon Populations in the Columbia and Snake Rivers Upstream from McNary Dam, Annual Progress Report, April 1997-March 1998. Ward, D. L. (ed.), Portland, OR: Oregon State University, 94-129.

DART 2016. Columbia River Data Access in Real Time webpage www.cbr.washington.edu/dart/river.html

Golder Associates Ltd. 2003. White sturgeon investigations in Priest Rapids and the 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: 82pp. + 5 app.

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

Golder Associates Ltd. 2011. White sturgeon monitoring and evaluation program annual report 2010. Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington. Golder Associates Ltd. Report No. 10-3930-0300: 42pp. + 7 app.

Golder Associates Ltd. 2012. White sturgeon monitoring and evaluation program annual report 2011. Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington. Golder Associates Ltd. Report No. 10-3930-0301: 34pp. + 5 app.

Golder Associates Ltd. 2013. White sturgeon monitoring and evaluation program annual report 2012. Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington. Golder Associates Ltd. Report No. 10-3930-0302: 67pp. + 6 app.

Golder Associates Ltd. 2014. White sturgeon management plan annual data report 2013. Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington. Golder Associates Ltd. Report No. 10-3930-0304: 25pp. + 5 app.Kincaid, T. M. and Olsen, A. R. (2013). spsurvey: Spatial Survey Design and Analysis. R package version 2.6. URL: http://www.epa.gov/nheerl/arm/.

Golder Associates Ltd. 2015. White sturgeon management plan annual data report 2014. Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington. Golder Associates Ltd. Report No. 10-3930-0304: 57pp. + 6 app.

Golder Associates Ltd. 2016. White sturgeon management plan annual data report 2015. Report prepared for Public Utility District No. 2 of Grant County, Ephrata, Washington. Golder Associates Ltd. Report No. 10-3930-0305: 62pp. + 2 app.

Kincaid, T. 2007. User guide for spsurvey version, 1.6: probability survey design and analysis functions. Available at: http://www.epa.gov/nheerl/arm/analysispages/software.htm (accessed May 2007).

Laake, J.L. 2013. RMark: An R interface for analysis of capture-recapture data with MARK. AFSC Processed Rep 2013-01, 25p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115.

R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Upper Columbia White Sturgeon Recovery Initiative (UCWSRI). 2006. Columbia River Adult White Sturgeon Capture, Transport and Handling Manual. May 2006 Version. 21pp + 5 app.

Wickham, H. 2009. ggplot2: elegant graphics for data analysis. Springer New York Bannerot, S. P. and C. B. Austin (1983). Using Frequency Distributions of Catch per Unit Effort to Measure Fish-Stock Abundance. Transactions of the American Fisheries Society 112: 608-617.

Stevens, D. L., Jr. and A. R. Olsen. 2004. "Spatially-balanced sampling of natural resources." Journal of American Statistical Association 99(465): 262-278

Uphoff, J. H., Jr. 1993. "Determining Striped Bass Spawning Stock Status from the Presence or Absence of Eggs in Ichthyoplankton Survey Data." North American Journal of Fisheries Management 13(4): 645-656.

Appendix A
2016 White Sturgeon Broodstock Collection Chelan County PUD and Blue Leaf Environmental

MEMORANDUM

TO: Lance Keller, Chelan County PUD and Chris Mott, Grant County PUD

FROM: Corey Wright , *Blue Leaf Environmental*

DATE: July 6, 2016

SUBJECT: Broodstock Collection Below McNary Dam in 2016

For the sixth consecutive year professional fishing guides were utilized to capture white sturgeon (*Acipenser transmontanus*) broodstock for the Mid-Columbia sturgeon recovery effort. For the fifth year fishing took place in the white sturgeon spawning sanctuary below McNary dam on the Columbia River. Similar to last year this effort was jointly supported by Chelan County PUD and Grant County PUD.

In 2016, fishing took place over 10 days from the 16th to the 25th of May. These dates had slightly warmer water temperatures than past fishing efforts because Marion Drain was not able to receive fish until the 16th due to well maintenance. A total of 148 individual white sturgeon were captured and 5 of these fish were captured twice for a 153 sturgeon landings. Of the individuals captured, 42 were greater than 150 cm, or mature spawning sized sturgeon, and 106 were less than 150 cm. In total, 9 ripe females and 10 ripe males were transported to Marion Drain Hatchery. One female was determined to have a PI value too far out and was returned to the river. The Yakima Nation sent one guide to McNary from John Day due to bad weather and poor fishing conditions, BLE processed their fish for them and two additional females and one male were transported to Marion Drain from their effort. On the 27th of May a 6x6 spawning matrix was performed producing 36 families of brood.

The mean number of fish captured per day was 14 or 7 per boat and this was slightly higher than past years indicating 2016 was a good year for landings. A complete summary of capture history and biometrics are found in Table 1.

ACKNOWLEDMENTS

Blue Leaf Environmental thanks the staff of Chelan PUD and Grant PUD for allowing us to assist them in this effort. We also thank Dan and Neil Sullivan of Rivers West Sport Fishing and Stuart Hurd from Hurd's Guide Service for all of their fishing services and expertise. Donella Miller and the staff at Marion Drain Hatchery for assisting with transported fish. There were too many fishing volunteers this year to name but without them the fish would not get landed. We thank ODFW and WDFW and there permitting staff.

Table 1 . Catch data from white sturgeon broodstock collection efforts at McNary Dam from May 7th through May 18th, 2015.

No.	Date	Sex	Fork (cm)	Total (cm)	GIRTH (cm)	Fate	Tagged	Mark @ Capture	PIT
6	5/16/2016	UNK	93	106	40	released		L2,21	3DD.0077636194
7	5/16/2016	UNK	110	124	45.5	released	PIT		3D9.1C2DEC8670
8	5/16/2016	UNK	109	125	43	released	PIT	L24	3D9.1C2DF1B7A7
9	5/16/2016	Male	193		72.5	hatchery	PIT	L5	3DD.007752ABBF
10	5/16/2016	UNK	103.5	117	43	released	PIT		3D9.1C2DEC7038
11	5/16/2016	UNK	85	96	37	released	PIT		3D9.1C2DF17E45
12	5/16/2016	UNK	142	155	55	released	PIT		3D9.1C2DF15C5B
13	5/16/2016	UNK	134	156	55	released		L1	3D9.1C2D2F7E79
14	5/16/2016	UNK	81.5	94	31.5	released	PIT		3D9.1C2DF19DE9
15	5/17/2016	UNK	144	168	55.5	released		L2, R11	3D9.1BF1C51BBE
16	5/17/2016	UNK	139	155	53.5	released	PIT		3DD.0077535E96
17	5/17/2016	UNK	109		45	released		L2, R10	3D9.1BF1C9D93A
18	5/17/2016	Female	251	288	104	hatchery		L2	3DD.0077536116
19	5/17/2016	Female	236.5	272	94	released	PIT		3D9.1C2DC9459B
20	5/18/2016	Male	156		67.5	released	PIT		3D9.1C2DC8CC33
21	5/18/2016	UNK	116		50	released	PIT		3D9.1C2DC9AACF
22	5/18/2016	UNK	148		63.5	released	PIT		3D9.1C2DC8CD87
23	5/18/2016	UNK	95		41	released	PIT		3D9.1C2DC89B7E
24	5/18/2016	UNK	95		38	released	PIT		3D9.1C2DC93F03
25	5/18/2016	UNK	106		41	released	PIT		3D9.1C2DC9F44D
26	5/18/2016	Male	221	253	103.5	released	PIT	L2, R4	3D9.1C2DC90129
28	5/19/2016	Male	215		87	hatchery	PIT		3D9.1C2DC89C98
30	5/19/2016	Female	203	227	96	hatchery		L1,2,3, R11,14	3D9.1BF1C526FE
31	5/20/2016	UNK	104		40	released		L2	3D9.1C2DC92152
32	5/20/2016	UNK	111	124	46	released			3D9.1C2DC98895
33	5/20/2016	Male	212	235	86.5	released		L2	3DD.00775330EB
34	5/20/2016	Female	242	271	102	released			3D9.1C2DC8B149
36	5/21/2016	UNK	114		48	released	PIT		3D9.1C2DC92E95
37	5/21/2016	Male	211		89	released	PIT	R1,2,3	3D9.1C2DC923FD
41	5/22/2016	UNK	238		107	released	PIT		3D9.1C2DC8B3FD
42	5/22/2016	Female	226	252	99	hatchery		L2, R9	3D9.1BF1C51CB5
43	5/23/2016	UNK	247	272	114	released	PIT		3D9.1C2DC96DD5
44	5/23/2016	Female	207.5	233	95	hatchery	PIT	L6,8	3D9.1C2DC96BC9
45	5/24/2016	UNK	85	94	35	released	PIT		3DD.00778F54A3
46	5/25/2016	UNK				released	PIT		3D9.1BF1CA5933
47	5/25/2016	UNK	118	136	50	released	PIT		3DD.0077913A75
48	5/25/2016	UNK				released	PIT		3D9.1C2DF1C06C
49	5/16/2016	Female	253		120	hatchery	PIT		3D9.1C2DEC973D
50	5/16/2016	UNK	102	117	44	released			3D9.1BF2648515
51	5/16/2016	UNK	118	133	46	released		L2, R11	3D9.1BF1C51419
52	5/16/2016	UNK	56	67	23	released	PIT		3D9.1C2D798B06

No.	Date	Sex	Fork (cm)	Total (cm)	GIRTH (cm)	Fate	Tagged	Mark @ Capture	PIT
53	5/16/2016	Female	272.5	300	109	released	PIT		3D9.1C2DC945B8
54	5/16/2016	UNK	143	165	54	released	PIT		3D9.1C2DC98E73
55	5/16/2016	UNK	105	121	44	released	PIT	L1,2,9	3D9.1C2D6719E3
56	5/16/2016	UNK	134	154	57	released		L2,12	3D9.1BF233ED9D
57	5/16/2016	UNK	159	188	73	released		L7	985121020823952
58	5/17/2016	UNK	159	184	61	released	PIT		3D9.1C2D673A95
59	5/17/2016	Male	191.5		72	hatchery	PIT		3D9.1C2DC90BA7
60	5/17/2016	UNK	112	127	51	released		L2	3DD.007783CCAA
61	5/17/2016	UNK	139	157	59	released	PIT		3D9.1C2DC89091
62	5/17/2016	UNK	106	120	44	released		L2	3DD.007762FB95
63	5/17/2016	UNK	110	127	45	released	PIT		3D9.1C2D79C7FE
64	5/17/2016	UNK	108	125	43	released	PIT	R16	3D9.1C2D7981D5
65	5/17/2016	UNK	214	245	89.5	released		L2	3D9.1C2DECDE53
66	5/17/2016	UNK	130	152	54	released		L2	3D9.1BF2641622
67	5/17/2016	UNK	73	83	28	released	PIT		3D9.1C2DC8C0B8
68	5/18/2016	Male	217	251	88	hatchery	PIT		3D9.1C2DC98ED2
69	5/18/2016	UNK	120	142	49	released	PIT		3D9.1C2DC889DD
70	5/18/2016	Male	169		64.4	released	PIT		3D9.1C2DC96EE9
71	5/18/2016	UNK	101	119	42	released		L2	3D9.1C2DF15AE5
72	5/18/2016	UNK	97	111	43	released		L2	3D9.1BF264C42B
73	5/18/2016	UNK	102	118	41	released	PIT		3D9.1C2DC909F3
74	5/18/2016	UNK	97	112	40	released		L2	3D9.1BF23F6D17
75	5/18/2016	UNK	91	105	37	released		L2	3D9.1C2DC978F3
76	5/18/2016	Male	156		63	hatchery	PIT	L10	3D9.1C2DC991DE
82	5/19/2016	UNK	98	115	39	released		L2	3D9.1C2DCBC26B
83	5/19/2016	Female	187.5		81	released	PIT		3D9.1C2DC8E977
84	5/19/2016	Male	221	250	92.5	hatchery		L2	3D9.1BF10E27F3
85	5/19/2016	Male	218	243	90	hatchery	PIT		3D9.1C2DC8E588
86	5/19/2016	UNK	104	119	44	released	PIT		3D9.1C2D671366
87	5/19/2016	UNK	114	126	42	released	PIT		3D9.1C2DC9A5A2
88	5/19/2016	UNK	100	114	42	released	PIT		3D9.1C2DC88ACF
89	5/20/2016	UNK	132	148	55	released	PIT		3D9.1C2DC9A4C3
90	5/20/2016	UNK	104	119	42	released	PIT	L1	3D9.1C2DC96973
91	5/20/2016	Male	216	245	93	hatchery	PIT	L11,14,23,24,30	3D9.1C2DC9DC05
92	5/20/2016	UNK	75	86	30	released	PIT		3D9.1C2DC8CAA6
93	5/20/2016	UNK	110	126	48	released		L2	3D9.1BF10E9FBC
94	5/20/2016	UNK	97	107	44	released		L2	3D9.1C2E0A91AD
95	5/20/2016	UNK	103	114	45	released		L2	3D9.1BF1D0D442
96	5/20/2016	Female	258	292	121	hatchery	PIT	L21	3D9.1C2DC99282
97	5/21/2016	UNK	154		64	released	PIT	R9	3D9.1C2DC975C4
98	5/21/2016	UNK				released			3D9.1C2DC89298
99	5/21/2016	UNK	159	178	67	released	PIT	R9	3D9.1C2DC92D6D
100	5/21/2016	UNK	110	122	48.5	released	PIT		3D9.1C2DC9A43B

No.	Date	Sex	Fork (cm)	Total (cm)	GIRTH (cm)	Fate	Tagged	Mark @ Capture	PIT
101	5/21/2016	UNK	61	71	22	released	PIT		3D9.1C2DC99DDA
102	5/21/2016	UNK	129	153	51	released	PIT	L2 R3,11	3D9.1C2DC99BB0
103	5/21/2016	UNK	102	117	43	released	PIT		3D9.1C2DC9134A
104	5/21/2016	UNK	110	127	49	released		L2,3 R8,11	3D9.1BF1C759C6
105	5/22/2016	UNK	123	142	56	released		L2,9	3D9.1BF10DF7D7
106	5/22/2016	UNK	158	180	66	released	PIT		3D9.1C2DC8A84A
107	5/22/2016	UNK	117	135	50	released	PIT		3D9.1C2DC8A7C6
108	5/22/2016	UNK	61	72	27	released	PIT	L1	3D9.1C2DC8F6FF
109	5/22/2016	Male	245	274	114	released	PIT		3D9.1C2DC99B93
110	5/23/2016	UNK	52		22	released	PIT		3D9.1C2DC92D16
111	5/23/2016	UNK	95	108	39	released	PIT		3D9.1C2DC90A91
112	5/23/2016	UNK				released		L2	3DD.0077605DD4
113	5/23/2016	UNK	119	137	52	released		L2	3D9.1BF236753F
114	5/23/2016	UNK	83	94	34	released	PIT		3D9.1C2DC97A6A
115	5/23/2016	UNK	99	115	42	released	PIT		3D9.1C2DCBD7A6
116	5/23/2016	Male	225	253	92	released	PIT		3D9.1C2DC99B1F
117	5/23/2016	Female	234	259	101	hatchery		L1	3D9.1C2DC90564
118	5/24/2016	UNK	101	115	40	released	PIT		3D9.1C2DC8FF30
119	5/24/2016	Male	227	255	86	released	PIT		3D9.1C2DC9A54A
120	5/24/2016	UNK	51	59	19	released	PIT		3D9.1C2DC8E6DA
121	5/25/2016	UNK	225	260	105	released	PIT	L2	3D9.1C2DC93819
122	5/25/2016	UNK	121	137	52	released	PIT		3D9.1C2DC8F469
123	5/25/2016	UNK	143	168	60	released	PIT		3D9.1C2DC94686
124	5/25/2016	UNK	63	72	27	released		L17,18	3D9.1C2D87469A
125	5/25/2016	UNK	90	102	35	released	PIT		3D9.1C2DC96856
126	5/25/2016	UNK	234	258	90	released		L2	3D9.1BF155B38E
127	5/25/2016	UNK	153	177	61	released	PIT	L1 R10	3D9.1C2DC91AC4
128	5/19/2016	UNK	146		57	released	PIT	L3,4,5	3D9.1BF1B60897
129	5/19/2016	UNK	128		57	released		L2	3D9.1BF1B6B028
130	5/19/2016	UNK	92	103	34	released	PIT		3DD.007752DC34
131	5/19/2016	UNK	106		43	released		L2	3D9.1BF1C99921
132	5/19/2016	UNK	88	101	39	released	PIT		3D9.1C2DC95F9D
133	5/19/2016	UNK	106	125	43	released	PIT		3D9.1C2DC93BD3
134	5/19/2016	UNK	111	127	47	released	PIT		3D9.1C2DC95CFD
135	5/19/2016	UNK	99	112	38	released	PIT		3D9.1C2DC89D95
136	5/19/2016	UNK	103	118	43	released	PIT		3D9.1C2DC96A59
137	5/19/2016	UNK	114	129	43	released	PIT		3D9.1C2DC9906B
138	5/19/2016	Male	210	233	96.5	hatchery	PIT		3D9.1C2DC99251
139	5/20/2016	Female	264.5	295	117	hatchery	PIT		3D9.1C2DC8B38C
140	5/20/2016	Male	211.5	241	85	hatchery		L2,9	3D9.1BF10E240B
141	5/20/2016	UNK	99	114	41	released	PIT		3D9.1C2DF1C064
143	5/21/2016	UNK	95		36	released	PIT		3DD.007791257D
144	5/21/2016	UNK	107		46	released	PIT		3DD.007790617B

No.	Date	Sex	Fork (cm)	Total (cm)	GIRTH (cm)	Fate	Tagged	Mark @ Capture	PIT
145	5/21/2016	UNK	117		45	released	PIT		3DD.007790CCC3
146	5/21/2016	UNK	132		52.5	released		L2	3D9.1C2CDAE798
147	5/21/2016	UNK	105.5		44	released		L2,10 R3	3D9.1C2D31062A
148	5/21/2016	UNK	78		31	released	PIT		3DD.007791336C
149	5/21/2016	UNK	65		23.5	released	PIT		3DD.007783DC7B
150	5/21/2016	UNK	62		21.5	released	PIT		3DD.00778F33BB
151	5/22/2016	UNK	88		36.5	released		L2	3DD.007790617B
152	5/22/2016	UNK				released		L2	3DD.0077527D44
153	5/22/2016	UNK	87.5		39	released		L2	3D9.1C2D30F76E
154	5/22/2016	UNK	92		38	released		L2,22 R17	3DD.0077636194
155	5/22/2016	UNK	83		32.5	released		L2	3D9.1C2DCC3AC1
156	5/22/2016	UNK	98	111	48	released	PIT		3DD.007790F952
157	5/22/2016	UNK	110	124	45.5	released		L2	3DD.00778F33BB
158	5/22/2016	UNK	108.5	123	40.5	released	PIT		3DD.0077910B56
159	5/23/2016	UNK	97	111	43	released	PIT		3DD.00778F601F
160	5/23/2016	UNK	133	158	58	released	PIT		3DD.007790C4B8
161	5/23/2016	UNK	118		49	released			3D9.1C2D310A3A
162	5/23/2016	Male				released		L2	3DD.00775330EB
163	5/24/2016	UNK	100	113	39	released	PIT		3DD.007790A79D
164	5/24/2016	UNK	97	113	42	released	PIT		3DD.0077915A70
165	5/24/2016	Female	223	242	99	hatchery	PIT		3D9.1C2DC8B138
166	5/24/2016	UNK	101	116	42.5	released	PIT		3DD.007790F276
167	5/24/2016	UNK	84	98	33	released	PIT		3DD.007790B529
168	5/25/2016	UNK	91	106	37	released		L2	3D9.1C2DC89298
169	5/25/2016	UNK	91	103	35.5	released	PIT		3D9.1C2DC8A7DC
170	5/25/2016	UNK	112	126	48	released	PIT		3D9.1C2DF1A5D0

Appendix B
Washington Department of Ecology March 14, 2017 Approval Letter

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
1250 W Alder St • Union Gap, WA 98903-0009 • (509) 575-2490

March 14, 2017

Mr. Tom Dresser
Fish, Wildlife and Water Quality Manager
Grant County Public Utility District
PO Box 878
Ephrata, WA 98823

RE: Request for Ecology Review and Comments -
2016 White Sturgeon Management Plan Annual Report
Priest Rapids Hydroelectric Project No. 2114

Dear Mr. Dresser:

The Department of Ecology (Ecology) has reviewed the *2016 White Sturgeon Management Plan Annual Report* sent via email to Ecology on February 6, 2017.

Ecology has no comments for the *2016 White Sturgeon Management Plan Annual Report* as submitted. The report fulfills the requirements in:

1. FERC License Article 401(a)(11);
2. Section 6.2(5)(b) which mandates the White Sturgeon Management Plan, and
3. White Surgeon implementation measure "*1) Reporting*" requirements in Appendix C "*Biological Objectives and Implementation Measures*" of the 401 Certification.

Please contact me at (509) 575-2808 or breean.zimmerman@ecy.wa.gov if you have any questions.

Sincerely,

Breean Zimmerman

Breean Zimmerman
Hydropower Projects Manager
Water Quality Program

cc: Ross Hendrick, Grant County PUD
John Monahan, Grant County PUD
Chris Mott, Grant County PUD