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March 29, 2016

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) – 2015 White Sturgeon Management Plan Annual Report

Dear Secretary Bose,

Please find enclosed the 2015 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 2015. The 2015 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 PRPA to levels commensurate with the carrying capacity of available habitats. In 2015, the following tasks were completed under the M&E program:

- Develop and implement a tagging, marking, and release plan for the 2014 Brood Year (2014BY) juvenile White Sturgeon based on the annual release target objectives as determined by the Priest Rapids Fish Forum (PRFF).
- Conduct a mark and recapture program in September and October 2015 to obtain a population abundance estimate of adult White Sturgeon in the Project area.
- Monitor dispersal of the 2014BY juvenile White Sturgeon, based on the movement of acoustic-tagged fish within each release group and determine the extent of outmigration from the Wanapum and Priest Rapids reservoirs.
- Monitor White Sturgeon spawning below Rock Island Dam in June 2015 to determine spawning intensity and the feasibility of *in situ* incubation of wild spawned eggs and larval White Sturgeon to supplement juvenile stocking efforts.
- Collect broodstock from John Day Reservoir below McNary Dam and at The Dalles. 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 2015 broodstock collection effort has been provided in this report; the BLE summary memo for this work is provided in Appendix A.

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- Conduct a pilot drift-sampling larvae collection study in Bonneville and John Day reservoirs. This study was conducted on behalf of Grant PUD by Washington Department of Fish and Wildlife to collect larval White Sturgeon for subsequent hatchery rearing as an alternate source of juveniles for stocking in the Project area; the summary report for this study component is provided in Appendix B.

On February 10, 2016, Grant PUD prepared and disseminated the draft 2015 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. Comments were received from CCT. Grant PUD reviewed these comments and incorporated suggested edits into the attached report. A summary table of Grant PUD's responses to those comments are included in Appendix C. On March 10, 2016 WDOE approved the 2015 WSMP Annual Report (Appendix D).

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 and Implementation Services
Rhendr1@gcpud.org

CC: Pat McGuire – WDOE
Priest Rapids Fish Forum

2015
White Sturgeon Management Plan
Annual Report

Priest Rapids Hydroelectric Project (FERC No. 2114)

Prepared for:

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

Prepared by:

Golder Associates Ltd.
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March 2016

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

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Chris Mott	Grant PUD
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Ron Giles	Golder Associates Ltd.
Lucia Ferreira	LGL Environmental Ltd.
Corey Wright	Blue Leaf Environmental
Stuart Hurd	Hurd Guide Services

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
Project	Priest Rapids Hydroelectric Project
PRFF	Priest Rapids Fish Forum
RM	River Mile
UCWSRI	Upper Columbia White Sturgeon Recovery Initiative
UTM	Universal Transverse Mercator
WSMP	White Sturgeon Management Plan

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1.0 INTRODUCTION

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 Priest Rapids Hydroelectric Project (the Project) within the Priest Rapids Project area (the Project area), located in the mid-Columbia River (Figure 1). Article 401 of the FERC license, consistent with the provisions of the Washington Department of Ecology Section 401 Water Quality Certification for the Priest Rapids Project (401 Certification) requires that Grant PUD develop a White Sturgeon Management Plan (WSMP) and conduct an on-going Monitoring and Evaluation (M&E) program to evaluate the effects of the Project on White Sturgeon (*Acipenser transmontanus*) populations within the Project area. The 2015 M&E program was developed in context with Grant PUD's WSMP, with the overall goal to restore populations of White Sturgeon in the Project area to levels commensurate with available habitat.

In 2015, the objectives and tasks to complete under the M&E program were as follows:

1). Develop and implement a tagging, marking, and release plan for the 2014 Brood Year (BY) juvenile White Sturgeon based on the annual release target objectives as determined by the Priest Rapids Fish Forum (PRFF).
2). Conduct a mark and recapture program in September and October 2015 to obtain a population abundance estimate of adult White Sturgeon in the Project area.
3). Monitor dispersal of the 2014BY juvenile White Sturgeon, based on the movement of acoustic-tagged fish within each release group and determine the extent of outmigration from the Wanapum and Priest Rapids reservoirs.
4). Monitor White Sturgeon spawning below Rock Island Dam in June 2015 to determine spawning intensity and the feasibility of *in situ* incubation of wild spawned eggs to produce larval White Sturgeon to supplement juvenile stocking efforts.
5). 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 2015 broodstock collection effort has been provided in this report; the BLE summary memo for this work is provided in Appendix A.
6). Conduct a pilot drift-sampling larvae collection study in Bonneville and John Day reservoirs. This study was conducted on behalf of Grant PUD by Washington Department of Fish and Wildlife to collect larval White Sturgeon for subsequent hatchery rearing as an alternate source of juveniles for stocking in the Project area; the summary report for this study component is provided in Appendix B.

The follows sections summarize previous work conducted within the Project specific to juvenile White Sturgeon supplementation and monitoring, White Sturgeon spawn monitoring, and in situ egg incubation.

Juvenile White Sturgeon Releases: 2011 (2010BY), 2013 (2012BY), and 2014 (2013BY)

Juvenile White Sturgeon releases in the Project area have been conducted annually since 2011, with the exception of 2012 (2011BY) when fish became infected with White Sturgeon Iridovirus. Implementation of the juvenile White Sturgeon supplementation program has been inconsistent, with differences in annual release numbers, genetic origin of the juveniles, rearing facility, fish health, size at release, and release location. Prior to 2014, release timing had been relatively consistent in that all fish were released either in late April or by early May in each release year.

In 2014, the juveniles were released in two groups and at different times, with the first release in early May and a second release in September. Excluding 2010, the first year of the M&E program, the majority (~95%) of broodstock used to produce each release group have been captured below McNary Dam and supplemented with a smaller number of mature fish (e.g., ~5% of total broodstock) captured from either the Project area in Wanapum Reservoir below Rock Island Dam or in the tailrace of McNary Dam.

Table 1 Summary of hatchery White Sturgeon juveniles released in 2011 (2010BY), 2013 (2012BY), and 2014 (2013BY) 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		

Brood Year	Reservoir	Release Location	River Mile	Brood Source	Release Date	Number Released	Fork Length (cm)		Weight[4] (g)	
							Mean	SD	Mean	SD

[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 the Project area 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

White Sturgeon Spawn Monitoring: 2000 to 2002, 2010, and 2013

Under the WSMP, resumption of successful natural recruitment is an underlying assumption of the long-term recovery objectives. The objective of the spawn monitoring program is to determine seasonal timing of spawning events and annual variation of spawning intensity in relation to environmental variables such as flow and water temperature. Within the Project area, spawning assessments were conducted below both Wanapum and Rock Island dams in 2000, 2001, 2002, and 2010 (Golder 2003 and 2011). In 2013, monitoring efforts were limited to below Rock Island Dam due to the larger number of spawning adult fish in Wanapum Reservoir and historically larger catch in that area compared to results below Wanapum Dam in Priest Rapids Reservoir (Golder 2014). In all years, the same sampling locations below Rock Island Dam have been used. Monitoring duration was longer during the 2000, 2001, 2002, and 2010 study years, and based on these data, the monitor effort in 2013 was refined to a two-week period from late June to mid-July when peak spawning was expected to occur. With the exception of 2001 (i.e., a near record low flow year), first spawning has occurred in late June with the last event detected in late July. Across all study years, the number of eggs captured in a given year has varied substantially (Table 2).

Table 2 Summary of White Sturgeon spawning events below Rock Island Dam in Wanapum Reservoir.

Year	Number of Spawning Events Detected	Date of First Spawning Event	Date of Last Spawning Event	Number of Eggs/Larvae Captured
2000	5	29 June	24 July	129
2001	1	26 July	-	29
2002	6	29 June	19July	1,907
2010	6	27 June	17 July	161
2013	6	29 June	10 July	455

The goal of *in situ* incubation of White Sturgeon prior to the 2013 study was to confirm viability of spawned eggs as verification that lack of natural recruitment was not due to non-viability of adult gametes or mortality due to errors in cellular replication that leads to tissue and organ deformities. In 2013, a custom incubator was tested to determine if sufficient number of wild-spawned eggs could be captured and incubated *in situ* to provide larvae for hatchery rearing as part of the annual juvenile supplementation program (Golder 2014). Lessons learned during the 2013 incubation program were applied to the current monitoring effort.

Adult White Sturgeon Population Indexing: 1999 to 2002, 2010, and 2012

Under the WSMP, White Sturgeon adult population indexing is conducted every three years to estimate the number of adults White Sturgeon remaining in the Project area. Previous population assessments conducted from 1999 to 2001 used setlines and baited circle hooks, with lines deployed in pairs systematically at each river mile (Golder 2003). Catch was typically low, but seasonally, more fish were captured during the fall. Due to low number of recaptures, confidence limits of these early adult sturgeon population estimates were widely distributed.

In 2003, the Columbia River Intertribal Fisheries Commission (CRITFC) released approximately 20,600 juvenile White Sturgeon into Rock Island Reservoir, located immediately upstream of the Project. A large proportion of the CRITFC hatchery fish released were entrained into Wanapum Reservoir. When adult indexing was conducted in 2010 using the same methods and level of effort as the previous studies, substantially more White Sturgeon were captured, the majority of which were CRITFC hatchery fish. As recapture rates of wild fish were too low to allow meaningful analysis, the wild fish population was estimated based on CRITFC fish population estimate (i.e., modified Schnabel and Bayes estimates from intersession and intrasession recaptures) and the catch proportion of wild fish to CRITFC fish. Adult indexing at a level of effort similar to previous years was conducted again in 2012, but set line locations in 2012 were selected using a general random tessellation stratified (GRTS) design, which is a spatially balanced random sampling strategy (Stevens and Olsen 2004). Bayesian analysis abundance estimates based on recaptured fish marked in 2010-2012 indicated that the abundance of CRITFC hatchery White Sturgeon in Wanapum Reservoir was almost double that of the Priest Rapids Reservoir, with mean population estimates of 3,740 individuals (95% CI = 2,340 to 5,830) in Wanapum Reservoir and 1,729 individuals (95% CI = 889 and 3,181) in Priest Rapids Reservoir.

1.1 Consultation

Pursuant to the reporting requirements, Grant PUD provided a complete draft of the WSMP Annual Report to the PRFF on February 10, 2016 for review. Written comments were received from Colville Confederated Tribes (CCT) on March 1, 2016. A summary of comments by the PRFF as received by Grant PUD on the draft PLMP Comprehensive Annual and Biological Objectives Status Report have been compiled along with responses from Grant PUD (Appendix C). The Washington Department of Ecology approved the WSMP Annual report on March 10, 2016 (Appendix D).

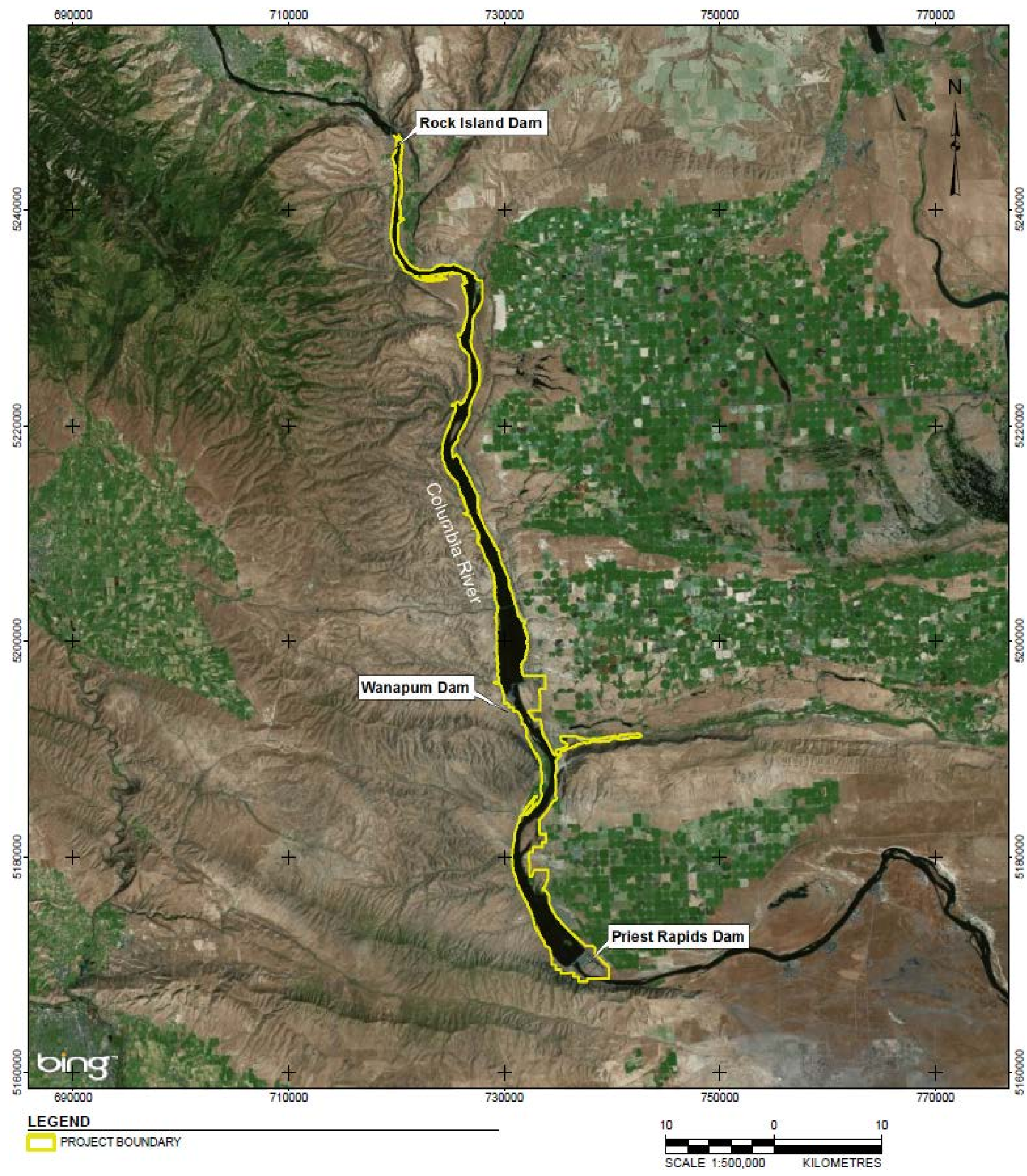


Figure 1 The Priest Rapids Project area.

2.0 METHODS

The methods used in completing work in 2015 closely followed those used in previous studies conducted in the Project area. These methods are described in detail in the previous reports (Golder 2011, 2012, 2013, 2014, and 2015). 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 was recorded in the tailwater of Rock Island Dam to document these environmental variables within the Project area. Changes in discharge and water temperature below Rock Island Dam were relevant to the study efforts, such as spawning monitoring and *in situ* egg incubation, that are conducted immediately downstream of the dam. Mean hourly total river discharge and water temperature data from January 1 to November 16, 2015 were obtained from the Columbia River Data Access in Real Time webpage (DART 2015).

2.2 2014BY Marking and Release

Working in conjunction with staff from Marion Drain Hatchery (MDH), the combined 2014 broodstock capture efforts by Grant PUD and Public Utility District No. 1 of Chelan County, Washington (Chelan PUD) resulted in the production of 40 half-sib genetic families of juvenile White Sturgeon.

The goal in 2015, was to process and tag approximately 6,500 juvenile 2014BY White Sturgeon in mid-April for release in early May. As in previous tagging efforts, fish were tagged in equal proportion across all genetic families and, once tagged, sorted into specific holding pens based on release location. Of the 2014BY juveniles tagged, 77 percent of these fish were to be released in Wanapum Reservoir, with the remaining 23 percent released in Priest Rapids Reservoir.

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. In total, 65 Vemco V9 acoustic tags were purchased for implantation in the 2014BY juveniles (Table 3). The V9 tags weighed 4.7 g in air and were implanted in fish that weighed at least 235 g to ensure that the tag weight did not contribute more than 2 percent to total weight of the tagged fish. The intent was to acoustic-tag fish as close as possible to the mean fish size at release (i.e., mean = 157 g, SD = 82) and therefore, hypothesized to exhibit similar behavior, movement patterns, and survival rate. The 65 acoustic-tagged fish were distributed in the Project area in the same proportion used to determine the total fish released in each of the two reservoirs, with 50 acoustic tags (i.e., 77 percent) deployed in Wanapum Reservoir and the remaining 15 tags (i.e., 23 percent) deployed in Priest Rapids Reservoir.

Table 3 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

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 through the anterior insertion of the dorsal fin. Using standard procedures developed by Kootenay Trout Hatchery (Ron Ek, Freshwater Fisheries Society of British Columbia, March 8, 2011, personal communication), select fish received an acoustic tag, with the tag inserted into in the coelom through a horizontal incision in the lateral wall; the incision was closed with two interrupted single sutures (Figure 2).

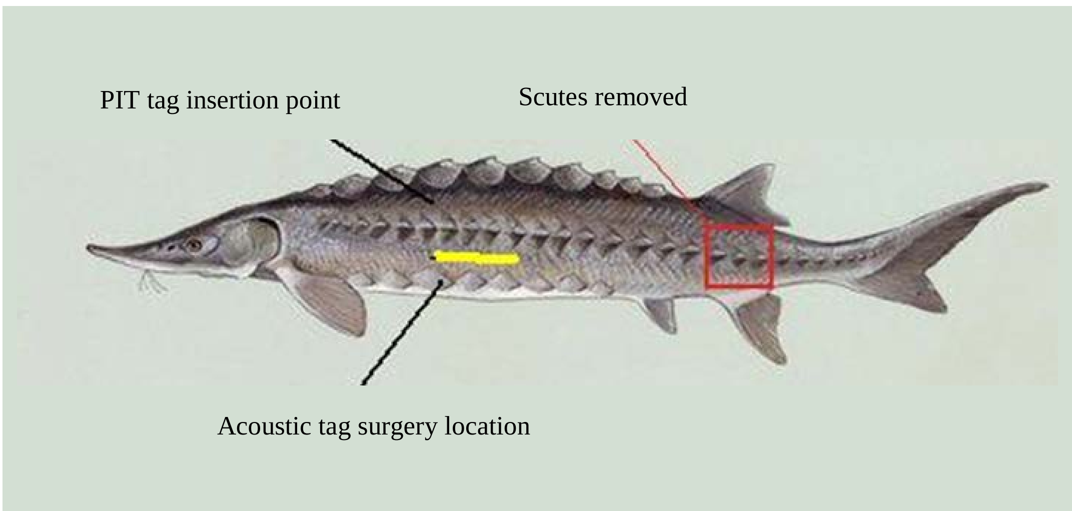


Figure 2 Juvenile White Sturgeon tag implantation and mark locations.

Tagging logistics and data collection was coordinated by LGL, assisted by Marion Drain Hatchery (MDH), Blue Leaf Environmental (BLE), and Golder staff during PIT-tagging, scute-marking, and surgical implantation of acoustic tags. Data were recorded electronically into the P3 data processing program to limit errors associated with manual data entry. The LGL 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 of each fish and the identifying tags and marks applied (Table 4).

Table 4 **Data recorded for the 2014BY White Sturgeon tagged and released in the Priest Rapids Project area in 2015.**

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	2014
Rearing Pen-Stock Id	See Table 5
Release Pen #	WP or PR
Scute removal	3 left lateral scute below dorsal, see work instructions provided
PIT-tag placement	left lateral, behind head
Notes	Record deformities and if fish are in poor health

2014BY Release

The 2014BY were held at MDH from 10 to 17 days post-tagging and allowed to recover from the tagging process. All 2014BY were tentatively scheduled to be released by May 1 to allow MDH staff time to clean and prepare the facility for receipt of 2015 broodstock captured in May. The release of 2014BY in the Priest Rapid Project area was coordinated by Golder and BLE, who worked with staff and equipment provided by MDH, Chelan PUD, and Grant PUD.

Of the fish processed, the majority (77%) fish were released in Wanapum Reservoir at the recently refurbished Frenchman Coulee boat launch (RM 424.5). During processing, fish destined for Wanapum reservoir were placed in approximately equal densities into two 20-foot diameter holding tanks. The remaining fish (23%) were released in Priest Rapids Reservoir at the Wanapum Dam tailrace launch (RM 415.6). During processing, fish destined for Priest Rapids reservoir were placed in approximately equal densities into two 10-foot diameter holding tanks.

The majority of the fish were transported using the large Chelan PUD transport truck. Based on previous experience, the Chelan transport truck was capable of transporting up to 3,500 fish at a time; however, the actual number of fish per trip was dependent on the size of the fish and total axle weight determined at the time of transport. Total transport time to the release site was estimated at approximately three hours and, as such, transporting the fish at higher densities was considered possible as long as sufficient oxygen was provided. To allow direct release of fish from the transport chambers via the release blade valves and prevent damage to the fish, the Chelan PUD transport truck was equipped with 30.5 cm (12”) diameter valve fittings and a canvas flume to eliminate the vertical drop between the transport chamber and river surface. Buckets of water and nets were used to evacuate any remaining fish from each transport chamber. An effort was made to chase any fish away from around the wheels of the transport truck before the truck was driven from the water.

BLE assisted in the release by transporting up to 600-700 fish with the Grant PUD transport trailer. The maximum number of fish that could be held in the Grant transport trailer was determined by BLE and MDH staff based on density estimates, water temperature, and oxygen consumption rates. Fish were released from the Grant trailer by backing the trailer into water and opening the 20.3 cm (8”) diameter blade valve at the rear of the chamber. Additional water was provided by a gas-power water pump to flush any remaining fish from the transport chamber. Released fish that settled around the wheels of the transport trailer were chased away before the trailer was removed from the water.

During loading and transport, BLE field staff monitored and recorded 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.
- 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 arrival, release, and departure times.

2.3 Broodstock Capture

As in previous years, White Sturgeon broodstock capture was conducted in 2015 as part of a collective broodstock program conducted in the mid-Columbia basin in support of White Sturgeon conservation aquaculture efforts at MDH. Unlike previous years, all broodstock capture efforts in 2015 were conducted outside the Project area, with the majority of effort conducted below McNary Dam in John Day Reservoir and additional effort below John Day Dam. Broodstock capture efforts below McNary Dam were coordinated by BLE and were conducted over 12 days from May 7 to 18, 2015. This capture effort consisted of guide-assisted angling conducted by BLE biologists, Chelan and Grant PUD personnel, and volunteers. Additional broodstock angling capture efforts were also conducted by Grant PUD funded MDH staff at the John Day Dam tailrace in The Dalles Reservoir from May 8 to 16, 2015 (Donella Miller, MDH, February 1, 2016, personal communication).

2.4 Pilot White Sturgeon Larvae Drift Capture

Sampling for White Sturgeon larvae was conducted at locations downstream of The Dalles Dam in Bonneville Reservoir and downstream of John Day Dam in The Dalles Reservoir. These locations were selected based on previous larvae-drift capture efforts conducted in the area. Depending on site conditions, single or double-frame plankton nets were deployed. The double-frame nets were provided by the Colville Confederate Tribes (CCT) and were deployed in manner consistent with the sampling methodology developed by the CCT. Drift sampling was conducted opportunistically at both locations from May 28 to June 24. A detailed description of the sampling methodology used is provided in Appendix B.

2.5 Spawn Monitoring and Egg Incubation

2.5.1 Egg Collection Mats

Previous studies have identified the left downstream bank below Rock Island Dam as a high-use White Sturgeon spawning and egg incubation area (Golder 2003, 2011, and 2014). From June 12 to June 29, 2015, egg collection mats were deployed below Rock Island Dam to capture wild-spawned White Sturgeon eggs and determine the timing and number of spawn events. An earlier start date of spawn monitoring was selected due to below average total river discharge and above average water temperature that could result in an earlier start to the spawning season. As in previous studies, metal framed egg collection mats were deployed at locations where White Sturgeon eggs were collected or mature adults were detected in previous study years. The design and deployment method of egg collection mats used in 2015 was identical to the method used during the 2010 and 2013 spawning assessments (Golder 2011 and 2014).

In 2015, paired mats were deployed at eight shore locations and a single mat at three mid-channel locations along the left downstream riprap bank between the Rock Island Dam boat hazard sign and upstream of Haystack Eddy (Figure 3). The locations sampled and numbers of mats deployed were determined by channel configuration, water elevation, and flow hazards. Unlike in previous monitoring efforts, permanent eye-bolts attachment points were installed at each site with a rock drill to facilitate ease of gear deployment and allow relocation and consistent sampling at the same monitoring sites in future studies. Site names and UTM locations are provided in Table 5.

Table 5 Locations of egg collection mats deployed below Rock Island Dam, 2015.

SiteName	UTMZone	UTMEasting	UTMNorthing
RI-1	10T	720088	5247189
RI-2	10T	720184	5247088
RI-2A	10T	720222	5247025
RI-3	10T	720273	5246952
RI-4	10T	720326	5246859
RI-4A	10T	720365	5246780
RI-5	10T	720413	5246655
RI-6	10T	720455	5246499
RI-M1	10T	720035	5247142
RI-M2	10T	720130	5247072
RI-M3	10T	720046	5247101

Egg collection mats were retrieved daily and visually inspected for White Sturgeon eggs. Eggs observed on the mats were enumerated and a representative sub-sample examined with a hand lens to determine developmental stage. Egg developmental stage was also documented using a microscope and USB camera on board the research vessel, to record a digital image of the egg. Developmental stages were based on classifications outlined in Beer (1981). All eggs captured were used in an ongoing pilot *in situ* incubation study to determine if sufficient numbers of wild spawn eggs can be captured and incubated to provide larvae for hatchery rearing and juvenile stocking (see Section 2.2.3).

Figure 3 **Location of egg collection mats in the Wanapum Reservoir downstream of Rock Island Dam during the White Sturgeon spawning assessment surveys conducted from June 12 to June 29, 2015.**

2.5.2 Spawning Events

The number and timing of discrete sturgeon spawning events in Wanapum Reservoir were inferred based on the spatial distribution of egg captures, examination of developmental stages, and back calculation from the time of egg collection to spawning date based on developmental rates at the measured water temperature (calculated based on Wang et al. 1985; Parsley et al. 2004).

2.5.3 Egg Incubation

Based on lessons learned from the 2013 study and the first test of an *in situ* incubator (Golder 2014), a modified version of the *in situ* incubation was deployed in 2015 (Figure 4). The incubator consisted of a square 76 cm wide floating chamber 120 cm deep, designed to allow eggs to develop and hatch on the mat material within the incubator.

If an egg collection mat captured only a few eggs, these eggs were carefully removed from the mat using tweezers and kept in a water-filled cooler until transferred to the incubator. These loose eggs were incubated in one of two MacDonald jars affixed to the inside of the incubator, submerged below water. A submersible pump powered by batteries and two solar panels was used to circulate water in the MacDonald Jars. If a large number of eggs (e.g., > 30 eggs) were present on the mat, the mat frame was dismantled and the mat fiber material removed and transferred to the incubator. Individual fiber sheets of egg-laden mat material were suspended vertically in the incubator, eliminating the need to manually remove eggs from the mat fiber. This approach was intended to reduce handling time and the exposure of the eggs to desiccation, high temperature, UV radiation, and mechanical damage from handling. During transport to the incubator, egg collection mat material with adhered eggs was kept shaded and routinely saturated with water to reduce desiccation and thermal stress.

In the hatchery, newly hatched White Sturgeon yolk sac larvae, referred to as free-embryos, typically swim to the bottom of the hatching jar and seek cover (Golder 2014). However, observation of free-embryos in the *in situ* incubator tested in 2013 suggested that the free-embryos tend to swim up to the surface and will follow along a smooth surface until they hit an obstacle (e.g., a protruding edge, corner, etc.). The incubator tested in 2015 attempted to exploit this behavior with an internal chamber that opened at an inside corner, through a narrow vertical slot, into a second capture chamber. Within this capture chamber, Pentair Bio-balls® (3.8 cm diameter; sinking- type) were added to simulate the cover provided by natural substrate on a river bed and encourage the fish to remain in the capture chamber. Free embryos hatched in the incubator were allowed to develop into free-swimming larvae and left until they absorbed most of their yolk sac. The capture chamber was accessible from the top so that free-swimming larvae could be removed as they accumulated. Both the incubator and rearing chamber were moored in an eddy approximately 3.5 km downstream of Rock Island Dam, near RM 451 (Figure 5). All larvae that survived were collected from the incubator by mid-July and transported to WDFW Wells Hatchery for rearing.

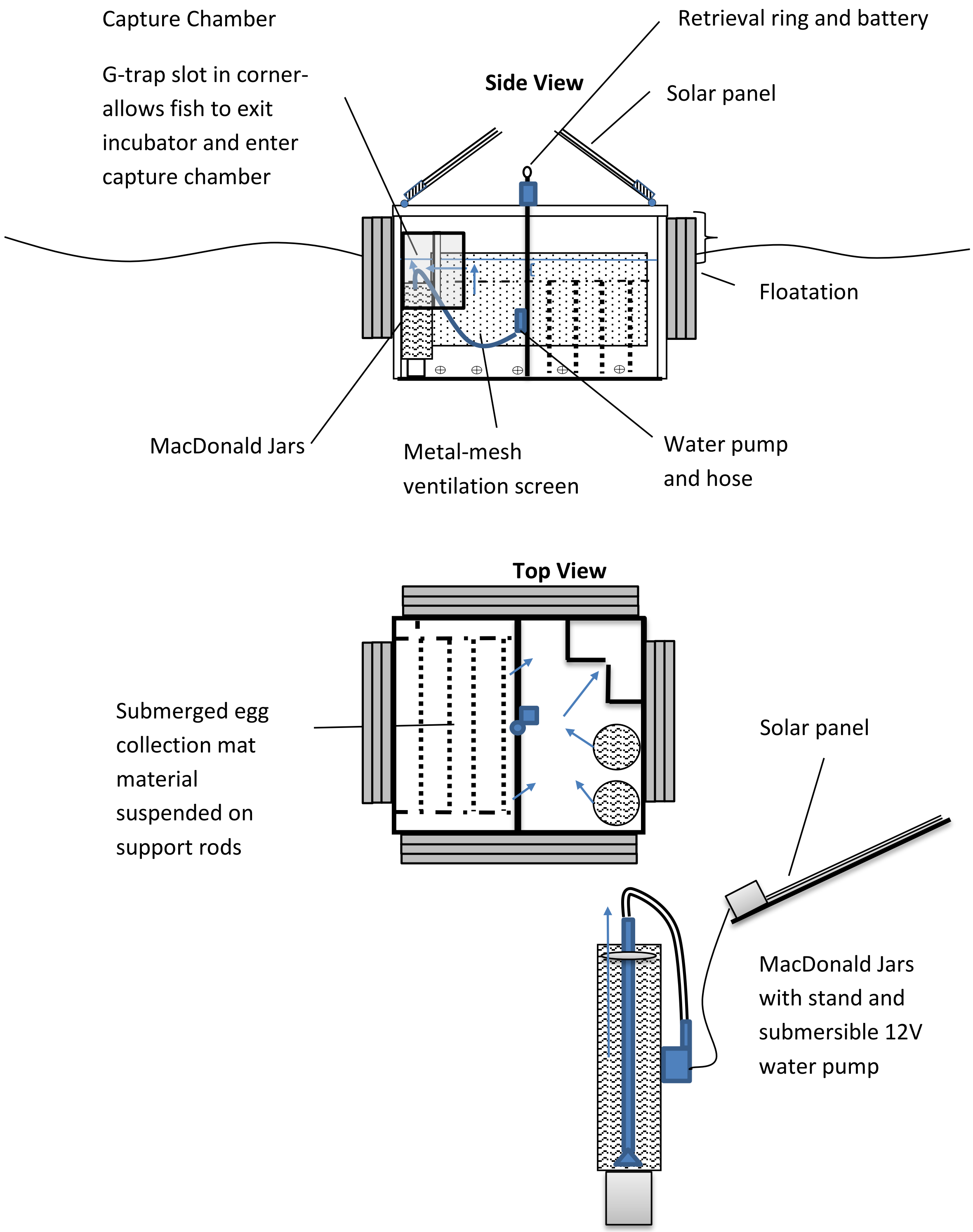


Figure 4 **Design of the prototype in situ White Sturgeon egg incubator used to incubate White Sturgeon eggs captured in Wanapum Reservoir below Rock Island Dam, June 12 to July 10, 2015**.

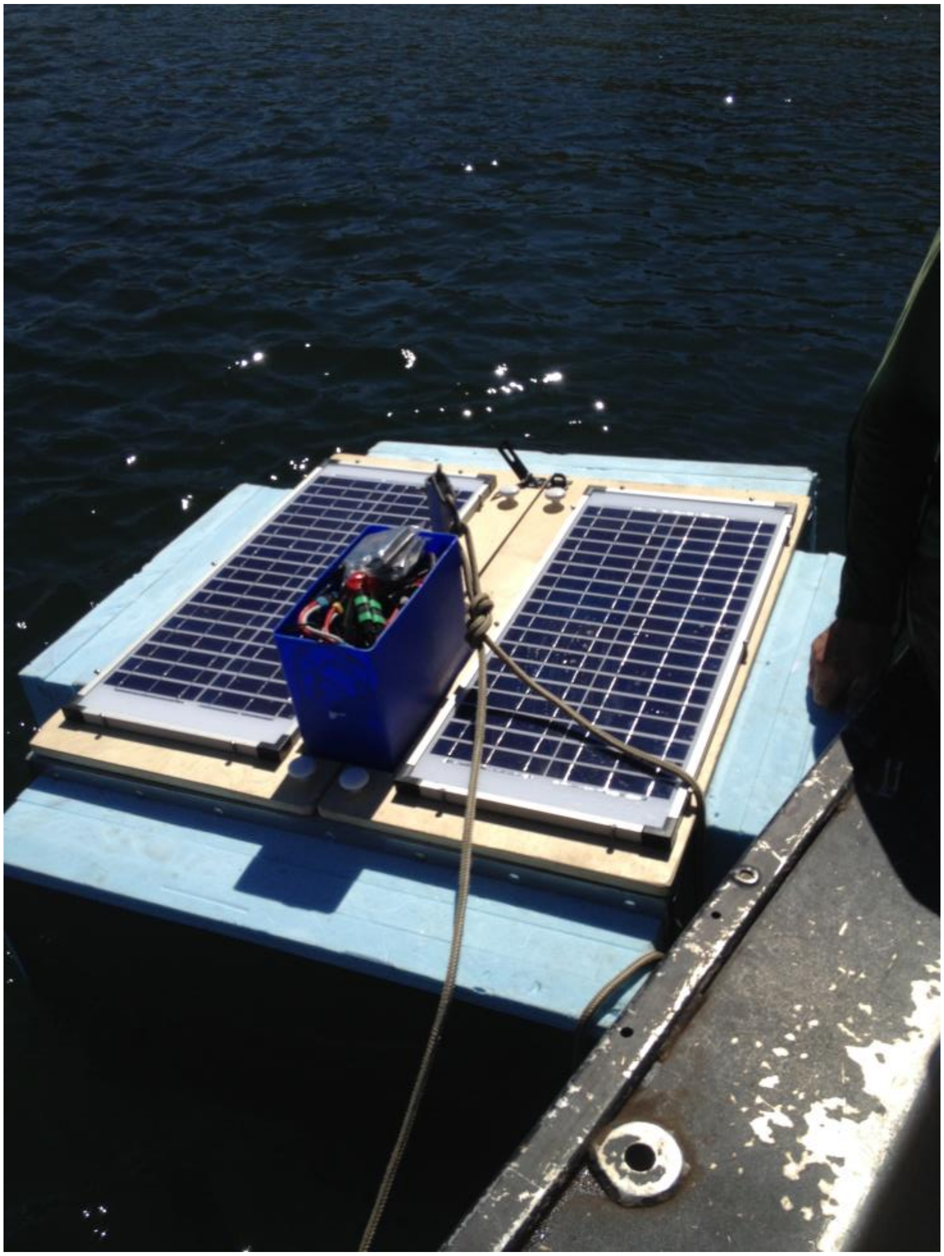


Figure 5 Egg incubator deployed in Wanapum Reservoir near RM 451, June 13 to July 10, 2015.

2.6 White Sturgeon Adult Population Indexing

A White Sturgeon mark-recapture study was conducted in fall 2015 from September 8 to September 18 (Session 1), and from October 5 to October 14 (Session 2), to obtain life history and population data on adult and sub-adult White Sturgeon in Wanapum and Priest Rapids reservoirs. The survey timing was selected based on previous capture and telemetry data that indicated White Sturgeon were more broadly dispersed throughout the reservoir from late summer to early fall and were moving more and actively feeding (Golder 2011). In previous studies when seasonal sampling was conducted, the highest White Sturgeon capture rates were recorded in early fall from September to October (Golder 2003).

Sampling was conducted by Golder and BLE field crews using two Golder research vessels to deploy gear and process fish. Golder set line deployment gear and methods were essentially identical to the set line methodology used during the 2010 adult indexing program (Golder 2011). Long set lines with 30 baited gangions per line were used during the population assessment program. Set lines were approximately 183 m long and consisted of 0.64 cm diameter nylon mainline, anchored at both ends with 25 kg piece of metal rail attached to float retrieval lines. Up to 30 gangions baited with pickled squid were attached to the ground line at 4.6 m intervals. Hook gangions were 0.7 m in length and consisted of a swivel-snap, a length of round-tarred ganging, and a single circle hook. Three sizes of circle hooks [i.e., small hooks #7 (12/0), medium size hooks #5 (14/0), and large hooks #3 (16/0)] were used to allow capture of a wide range of size classes. For all previous adult indexing studies in the Project area, the barbs on all hooks were removed to facilitate fish release and reduce the severity of hook related injuries. In 2015, the effect of barbed versus non-barbed hooks on catch efficiency was examined. Ten gangions of each hook size (i.e., 30 gangions total) were placed in random order on each line and for each size group; five hooks with barbs and five without. Gangions were baited with commercially available pickled squid. Set lines were set overnight and pulled approximately every 24 hours.

Set line locations were selected using a general random tessellation stratified (GRTS) design, which is a spatially balanced random sampling strategy (Stevens and Olsen 2004). The GRTS sample locations were determined with the SPSURVEY package (Kincaid 2007) developed for the R statistical program (The R Development Core Team). Shallow areas of Wanapum and Priest Rapids reservoirs with abundant aquatic macrophytes were excluded from the survey. In Priest Rapids Reservoir, site selection was constrained to the area encompassed within 6 m bathymetric contour; in the larger and deeper Wanapum Reservoir, site selection was constrained to the area encompassed within the 10 m bathymetric contour. Shape files based on these areas were generated for use by SPSURVEY.

The sample design divided the Project area into two main sample strata by reservoir. Based on reservoir area, 66 GRTS sample locations were generated for Wanapum Reservoir and 30 sample locations for Priest Rapids Reservoir. Wanapum Reservoir was further stratified into two substrata north of the I-90 Bridge crossing to Rock Island Dam (WR_N) and south of the bridge crossing to the face of Wanapum Dam (WR_S). Strata WR_S was considered the least riverine and more lake-like in terms of hydrology and consisted of a broad inundated area of former terrestrial habitat. Due to the areal extent of WR_S, the area encompassed almost half of the GRTS sample and oversample sites. Telemetry data and previous capture efforts in WR_S during the 2010 adult population indexing captured few fish, which suggested a low use of this area by White Sturgeon (Golder 2011); consequently, only 12 of the 66 sample sites were allocated to WR_S, with the remainder of the sample effort allocated to WR_N. However, the primary motivation to limit sample effort in WR_S was the risk of high wind and wave conditions, common to this section of reservoir. Under such conditions, the difficulty of gear deployment, retrieval, and fish processing increases substantially and data quality can be compromised.

In total, 192 GRTS sites were sampled over two sample sessions in fall 2015 (i.e., 96 sites sampled per session). This effort was comparable to that expended during the 2010 and 2012 indexing studies (Golder 2011and 2013). The GRTS sites generated for Session 1 were not reused and a new set of GRTS sites were generated for Session 2 to eliminate sampling bias and ensure complete randomization of sample locations for each session.

Fish were handled and processed in a similar manner as during previous indexing capture programs (Golder 2011 and 2012). 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. Other measurements recorded in previous studies (e.g., total length, girth, etc.) were not recorded in 2015, as these data were not used in any subsequent analysis and increased processing time per fish. Sex and maturity of wild fish were assessed by surgical examination and visual inspection of the gonads with an otoscope. The assessment of sex and maturity followed the methods used in the upper Columbia River White Sturgeon Recovery Program (Table 6; UCWSRI 2006). Nine mature (i.e., Females - maturity F3 or greater; Males - M2; see Table 6) wild White Sturgeon were implanted with ten-year Vemco® V16 acoustic tags to allow the fish to be tracked to identify seasonal movements. All data were entered in the field, directly into Golder's White Sturgeon capture database. DNA samples were obtained and preserved for all first-time captured wild fish. When required, a canopy was deployed over the rear half of the Golder research boats to protect fish from direct sunlight and reduced overall thermal stress and exposure to UV radiation during processing.

Table 6 Sexual maturity codes for White Sturgeon (adapted from Bruch, et al. 2001).

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

2.7 Population Abundance Estimates

Mark-recapture data from all sampling conducted during the September-October adult sampling programs in 2010, 2012, and 2015 were used to construct a POPAN model of combined Wanapum and Priest Rapids data. The analysis was implemented using the statistical environment R, v. 3.1.0 (R Development Core Team, 2014), 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 marked as loss-on-capture (i.e., the fish were removed from the system due to emigration) when analyzing the data. Only wild and CRITFC fish were included in the analysis.

A total of three POPAN models were constructed. All three included the following parameters:

1). a constant survival term;
2). year-specific recapture parameters;
3). a group-specific super-population parameter (N), modeled separately for each reservoir and hatchery-reared and wild sturgeon.

The three models differed in their specifications of probability of entry into the system (combined birth and immigration), which were constructed as follows:

1). Model 1 – constant probability of entry, identical for both hatchery and wild fish
2). Model 2 – constant probability of entry, by group – different for hatchery and wild fish
3). Model 3 – probability of entry fixed at zero for hatchery fish, and modeled as constant for wild fish. This simulated lack of entrainment from upstream reservoirs after 2010 (zero entry for hatchery fish), while allowing for natural recruitment (constant entry for wild fish).

The models were evaluated using Akaike's Information Criterion corrected for small sample size (AICc), where a lower value indicates better support for the model. In addition to AIC values, the output also included AICc weights (as proportions), which indicate the probability that the model is the best among the entire set of candidate models. For instance, an AICc weight of 0.9 for a model, indicates that given the data, that model has a 90% probability of being the best one among all examined candidate models.

Following the estimation of survival (Phi), the super-population (N) and the probability of entry (pent), occasion-specific population estimates and their 95% confidence intervals were calculated using the "popan.derived" function. These calculations of derived parameters were performed using model-averaging, where the estimates (and variability) from all three models were taken into account, using the AICc weight given to each model during the initial model fitting.

2.8 VR2W Telemetry Array Download and Maintenance

In total, between ten and twelve VR2W station telemetry receivers (model VR2W, Vemco-Amirix Systems Inc., Halifax, NS) have been deployed on an annual basis since 2010 to monitor movements of acoustic-tagged White Sturgeon in the Project area. In 2014, cumulative metal fatigue at critical connections in nearly all VR2W mooring systems resulted in the displacement of several receivers. Although all the displaced VR2W's were eventually recovered, all stations were removed and refurbished in April 2015. Retrieval of the cable and heavy anchors required additional safety precautions. In several cases, the anchor connection broke during retrieval and new anchors were deployed. Prior to redeploying the moorings, the following measures were taken to strengthen and reinforce the moorings:

- replaced all galvanized steel components with stainless steel components at all connection points;
- replaced all aluminum crimp with copper crimps;
- replaced worn or frayed cable;
- use of two separated sections of chain to connect anchor pieces (1 m lengths of steel railway rail);
- installed a new LD2 buoy if existing buoy connection was worn; and
- removed all secondary bullet foam floats as these floats interfered with the upright orientation of the primary LD2 float and increased wear on connection points.

At both the Priest Rapids Dam forebay station (i.e., VRRM 398.1) and the Wanapum Dam forebay station (i.e., VRRM 416.1), strong wave action at these locations was the cause of station failure and will likely result in future failures even with the reinforced systems. Permission was obtained from Grant PUD to deploy the VR2W's on the safety boom above each dam. The safety boom stations consisted of a single 4 m length of 3/16" diameter stainless steel cable attached to a one of the boom's primary steel buoys by a locking carabineer, with the VR2W securely attached to the steel cable with cable clips. Range testing was conducted at both proposed forebay locations to estimate tag detection range. During testing, substantial acoustic noise was evident in the vicinity of Priest Rapid Dam safety boom, likely produced by dam operation, and this noise interfered with VR2W signal reception and greatly reduced tag detection range. Consequently, the Priest Rapids Dam forebay station was redeployed on a float mooring at the original station location, further away from the dam. Acoustic noise near the Wanapum Dam safety boom was low and the forebay safety boom station was successfully deployed.

As a pilot, a new deployment approach was tested at two stations located near shore and in strong back eddies in Priest Rapids Reservoir (i.e., VRRM 413.5) and below Priest Rapids Dam in McNary Reservoir (i.e., VRRM 396.1). Previous float mooring systems at these location experienced substantial wear on connection points due to constant rotation by changing eddy currents. The new deployment system entailed mounting the VR2W upright in a metal frame situated on the river bottom and cabled to shore (Figure 6).

A second station was deployed downstream of Priest Rapids Dam (i.e., VRRM 384.1) near the upstream-most water intake for the Hanford site to improve detection of entrained acoustic-tagged fish from Priest Rapids Reservoir. Selection of this site was based on expectation that sturgeon may hold temporarily in the large back eddy at this location. The VR2W previously deployed at VRRM 404.0 (i.e., serial number 109732), which was displaced and later recovered in 2014, was deployed at the new station. Station VRRM 404.0 was not re-deployed in 2015 due to sufficient coverage in Priest Rapids Reservoir, but may be considered for re-deployment in 2016 depending on the amount of data recorded at VRRM 384.1.

The location and deployment information of the twelve active VR2W station in the Project, as well as the location of previously deployed stations, are provided in Table 7. All stations received new batteries in April 2015 and each station was downloaded and serviced in June, July, and October, as well as in August and September in conjunction with Grant PUD lamprey studies.

Figure 6 Metal VR2W deployment frame used in 2015 at acoustic monitoring station VRRM 413.5 and VRRM 396.1.

Table 7 Current and historic acoustic receiver stations location, deployment date, and status in the Project area as of October, 2015.

Station Name	River Mile	Zone	UTM		Reservoir	Deployment Date	Lost Date	Removal Date	Refurbished / Redeployed	Station type [a]	Station Status	VR2W Serial No.
			E	N								
VRRM384.1	384.1	11	296939	5168295	McNary	16-Jun-15			16-Jun-15	LD2	Active	109732
VRRM392.0	392.0	11	284680	5167847	McNary	18-May-12		15-Apr-15		LD2	Removed	109733
VRRM396.1	396.1	11	278151	5168309	McNary	20-Sep-10	14-May-12			LD2	Lost	109734
VRRM396.1	396.1	11	278151	5168309	McNary	15-Apr-15			15-Apr-15	Frame	Active	109733
VRRM398.1	398.1	11	276897	5170976	Priest	22-Jun-10		9-Oct-15		LD2	Removed	109728
VRRM398.1	398.1	11	276803	5170825	Priest	22-Jun-10			15-Apr-15	LD2	Active	122200
VRRM404.0	404.0	11	272861	5180011	Priest	22-Jun-10		24-Aug-14		LD2	Removed	109732
VRRM410.5	410.5	11	276891	5188323	Priest	23-Jun-10			17-Apr-15	LD2	Active	109731
VRRM413.5	413.5	11	274578	5192176	Priest	23-Jun-10		13-Jun-14	17-Apr-15	LD2	Removed	109729
VRRM413.5	413.5	11	274578	5192176	Priest	23-Jun-10			17-Apr-15	Frame	Active	109729
VRRM415.5	415.5	11	274044	5195579	Priest	19-Sep-10		17-Apr-15		LD2	Removed	109735
VRRM415.5	415.5	11	274065	5195645	Priest	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
VRRM416.1	416.1	11	273719	5196719	Wanapum	7-Oct-10		30-May-14		LD2	Removed	109738
VRRM418.5	418.5	11	275059	5200077	Wanapum	24-Nov-10	1-Mar-11			LD2	Lost	109726
VRRM421.0	421.0	11	273966	5203545	Wanapum	20-Jun-10	1-Aug-10			LD2	Lost	109727
VRRM426.5	426.5	10	727342	5211924	Wanapum	23-Jun-10			16-Apr-15	LD2	Active	109730
VRRM432.5	432.5	10	725538	5220726	Wanapum	20-Jun-10	1-Mar-11			LD2	Lost	109736
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		12-Jun-14	14-Apr-15	LD2	Active	109737
VRRM449.5	449.5	10	720138	5242290	Wanapum	21-Jun-10	21-Jun-10			LD2	Lost	109724
VRRM452.4	452.4	10	720484	5246202	Wanapum	20-Sep-10		25-Jun-14	14-Apr-15	LD2	Active	109725
VRRM452.4	452.4	10	720484	5246202	Wanapum	13-Jun-14		1-Jun-15		LD2	Removed	120241

[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; Frame – VR2W oriented upward and deployed in a metal frame on the river bottom, typically in a back eddy near shore, with the frame attached to shore with a retrieval cable.

2.9 Juvenile Movements

Telemetry data from acoustic tagged 2014BY juveniles released in 2015 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.

The screened data were analyzed as presence/absence data. If a fish was detected at a receiver more than once in a day (i.e., the detection was defined as non-spurious), it was considered to be present near that receiver on that day. This approach allowed the examination of temporal patterns of presence/absence rather than simply reporting the numbers of detections recorded at each VR2W station. Daily presence/absence data were then used to estimate: 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. All data analyses were performed in the statistical environment R, v. 3.1.0 (R Development Core Team 2014). Plots were created in R using the package ggplot2 (Wickham 2009).

2.10 General Data Recording and Analysis

Custom task-specific field databases were designed and used to record field data. Within these databases, queries were used to extract and process White Sturgeon capture, spawning, and telemetry data, as well as screen for data entry errors. Broodstock and egg capture CPUE calculations, summary tables, and simple figures were produced in Excel® using pivot tables and data filters. More complicated figures were created in R using the package ggplot2 (Wickham 2009). Customized datasheets and manifests were used to record information during the juvenile release, broodstock transport, VR2W download and servicing, and mobile telemetry tracking.

3.0 RESULTS

3.1 Discharge and Temperature During Study Components

Due to low snow pack and reduced precipitation, 2015 Columbia River total discharge was the lowest recorded since the start of monitoring efforts in 2010 and was comparable to the near record low flow year recorded in 2001. In conjunction with below average discharge, mean daily water temperatures were above seasonal normal values observed in previous study years (Golder 2011, 2012, 2013, 2014, 2015).

In 2015, peak mean daily flows were recorded on February 23 (5,017 m^3/s). This atypical occurrence was due to unseasonably warm temperatures in February as well as volitional releases from large upstream storage reservoirs (Figure 7). After the peak in February, the Columbia River hydrograph in the Project exhibited a gradual and continual decline, with substantial daily and weekly fluctuations in response to changing flow inputs and power requirements. Such fluctuations were evident during the 2014BY juvenile White Sturgeon release, with low mean daily flows during the first release day on April 30 (2,784 m^3/s), followed by substantially higher flows during the second and final release on May 1 (3,544 m^3/s). The average of mean daily water temperature during the 2014BY release was 9.7°C.

Atypical fluctuations in discharge were also evident during spawn monitoring, during which peak flows were recorded on June 15 (3,824 m^3/s), followed by a substantial decrease in flows by June 21 (2,205 m^3/s), and return to higher flow conditions near the end of monitoring on

June 29 (3,327 m^3/s). The average of the mean daily water temperatures over the entire monitoring period (16.6°C) was slightly above the optimum temperature for sturgeon egg development (i.e., 14 to 16°C) and ranged between 16.0 and 17.5°C.

Large variations in discharge were evident during both session 1 (September 9 to 19) and session 2 (October 6 to 15) of the White Sturgeon adult population indexing program. During session 1, mean daily discharge peaked on September 11 (2,596 m^3/s) and declined over the remainder of the session, with the lowest flows during the final sample day on September 19 (1,593 m^3/s). Flow varied during session 2 as well, with higher flows near the start (October 6; 1,858 m^3/s) and end (October 15; 2,173 m^3/s) and the lowest flows during the mid-point of the session on October 10 (1,097 m^3/s).

The average of mean daily water temperature during session 1 (18.8°C) was less than the seasonal summer peak (20.2°C), but still very warm for mid-September. During session 2, average mean daily water temperature was lower (16.7°C).

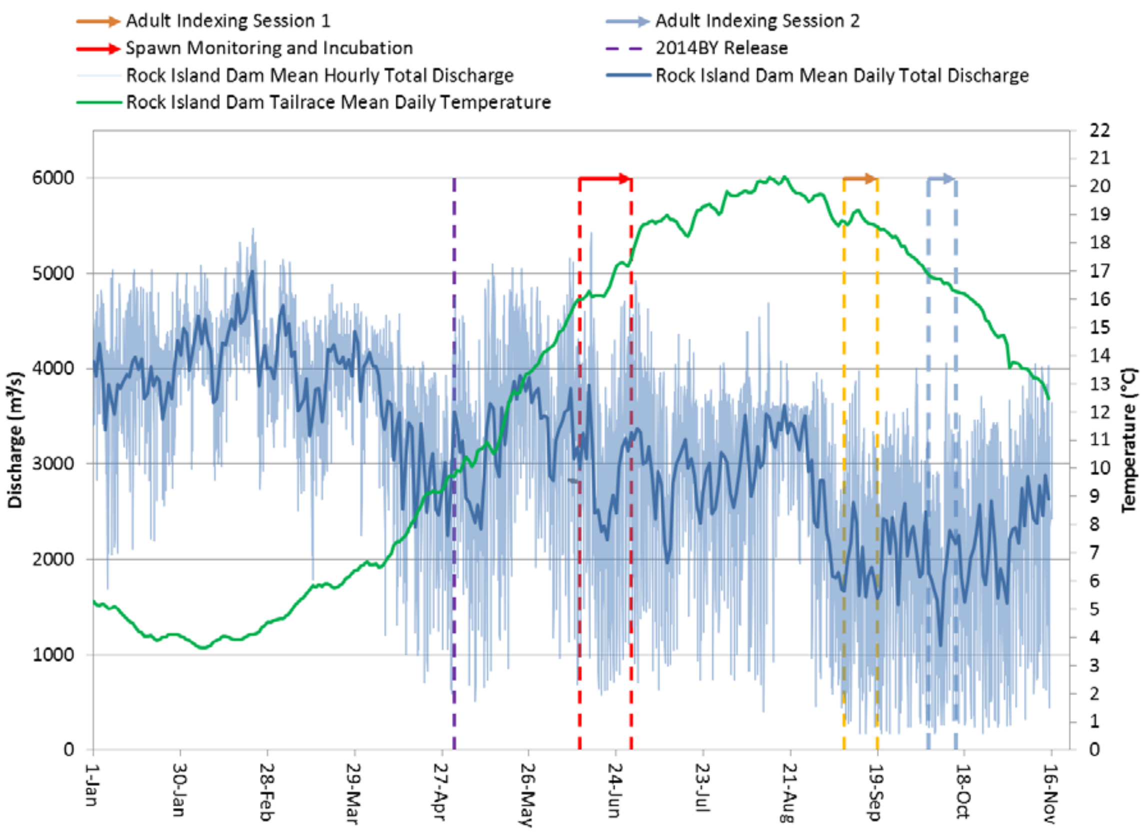


Figure 7 **Mean daily discharge (dark blue line), mean hourly discharge (light blue ribbon), and mean hourly water temperature (green line) of the Columbia River below Rock Island Dam. Horizontal arrows between the dotted vertical lines indicate spawn monitoring (red) and adult indexing session 1 (yellow) and session 2 (blue). Vertical purple dashed line denotes the final 2014BY juvenile White Sturgeon release date.**

3.2 2014BY Juvenile Marking and Release

In 2015, the Grant PUD juvenile White Sturgeon program entailed the marking and release of 2014BY brood reared at the Marion Drain Hatchery (MDH). The 2014BY brood release represented eight maternal families and resulted in 40 genetic crosses achieved with a 5F X 5M cross and a 3F X 5M cross using a combination of McNary fish and one male from the Project area. All 2014BY fish were PIT-tagged and scute marked over eight days from April 13 to 20, 2015. In total 6,502 fish were tagged, marked, and released over two days from April 30 to May 1, with 5,007 fish (77%) of the fish released in Wanapum Reservoir at the Frenchman Coulee Launch (RM 426.5) and remaining 1,495 fish (23%) in Priest Rapids Reservoir at the Wanapum Dam tailrace launch (RM 415.6; Table 8). Mean fork length and weight of the 2014BY release was 313 mm (S.D. +/- 30 mm) and 198 g (S.D. +/- 56 g), respectively.

In total, 63 fish of the 2014BY release possessed an acoustic tag, with 48 acoustic-tagged fish released in Wanapum Reservoir and 15 released in Priest Rapids Reservoir. Two shed acoustic tags were recovered from the holding pens and were reserved for future tagging efforts. Shed PIT-tags were not found in the holding pens or the transport tanks after fish were released and the pens drained and cleaned. During each release, all fish were released alive; dead or moribund fish were not observed.

Table 8 Release number and mean fork length and weight of the 2014BY juvenile White Sturgeon released in the Priest Rapids Project area, 2015.

	Project area 2015 White Sturgeon 2014BY Release		
Release Location Reservoir (River Mile)	**No. of Fish (acoustic-tagged)**	**Mean FL (+/- SD) mm**	**Mean Weight (+/- SD) g**
Wanapum (424.5)[1]	5,007 (48)	313 (29)	199 (55)
Priest Rapids (415.6)[2]	1,495 (15)	315 (35)	194 (57)
Total	**6,502 (63)**	313 (30)	198 (56)

[1] Frenchmen Coulee Launch

[2] Wanapum Tailrace Launch

During tagging, a large proportion of the 2014BY (i.e., 78.5% or 5,104 of 6,502 fish) exhibited evidence of one or more fin abnormalities primarily pertaining to deformation or damage to the pectoral fins and caudal fin (Table 9).

Table 9 Fin deformity type and occurrence noted during processing of 2014BY juvenile White Sturgeon released in the Priest Rapids Project area, 2015.

2014BY Primary Fin Deformity	Fin Deformity Sub-type	No. of fish with Primary Deformity	No. of fish with Sub-type Deformity
Caudal deformity only		**571**	
	curled		465
	split or damaged		106
Both caudal and pectoral deformity		**2,208**	
	curled or damage pectoral and caudal		2,031
	missing pectoral and caudal deformity		143
	missing both pectorals and deformed caudal		34
Pectoral deformity only		**2,313**	
	curled, short or damaged		2,023
	missing pectoral		240
	missing both pectorals		50
Dorsal or anal fin deformity		**12**	
Total		**5,104**	

3.3 Broodstock Capture and Juvenile Production

Broodstock capture efforts in 2015 below McNary Dam in John Day Reservoir resulted in the capture of 149 individuals, with four of these fish captured twice, for a total of 153 sturgeon capture events (Blue Leaf 2015). A more detailed description of broodstock capture results is provided in Appendix A. Based on evidence of milt expression and surgical inspection of gonads, 15 ripe female and 13 ripe male White Sturgeon were transported to MDH. From these fish and one fish captured at The Dallas, the eggs from nine females (i.e., 8 from John Day Reservoir; 1 from The Dalles) were obtained during two induced spawning events on May 28 and 29. These eggs were fertilized with the milt from 10 males (all from John Day Reservoir) to produce 85 half-sibling families.

3.4 Drift-sampling Larva Collection

Plankton nets were deployed either overnight or throughout the day on 80 separate occasions from 28 May through 24 June. Total sample effort in both reservoirs combined was 1,150 hours, with 675.4 hours of sampling effort in Bonneville Reservoir and 474.4 hours of sampling effort in The Dalles Reservoir; however, only six White Sturgeon larvae were captured in total. A detailed description of drift sampling results is provided in Appendix B.

3.5 2014BY Juvenile White Sturgeon Movement

Acoustic telemetry positional data from the 2014BY juveniles recorded from April 30 to October 12, 2015 were analyzed to determine the post-release dispersal of juvenile White Sturgeon from the release locations in each reservoir.

In Wanapum Reservoir, all of the 48 acoustic-tagged fish released at RM 424.5 were subsequently detected during the study. All fish initially exhibited upstream movement after release (mean movement = 53 km, S.D. = +/-37 km; [33 miles +/- 21 miles]); however, the amount of upstream movement varied considerably, with approximately half the acoustic-tagged fish (n = 25) detected at least once at the upstream-most monitoring station below Rock Island Dam near RM 452.4, approximately 45 km (28 miles) from the release site. The remaining fish exhibited less upstream movement and were detected between stations located near RM 437.1 and RM 446.9 (n = 12), or remained in the vicinity of the release site and were detected by the station near RM 426.5 (n = 11) (Figure 8).

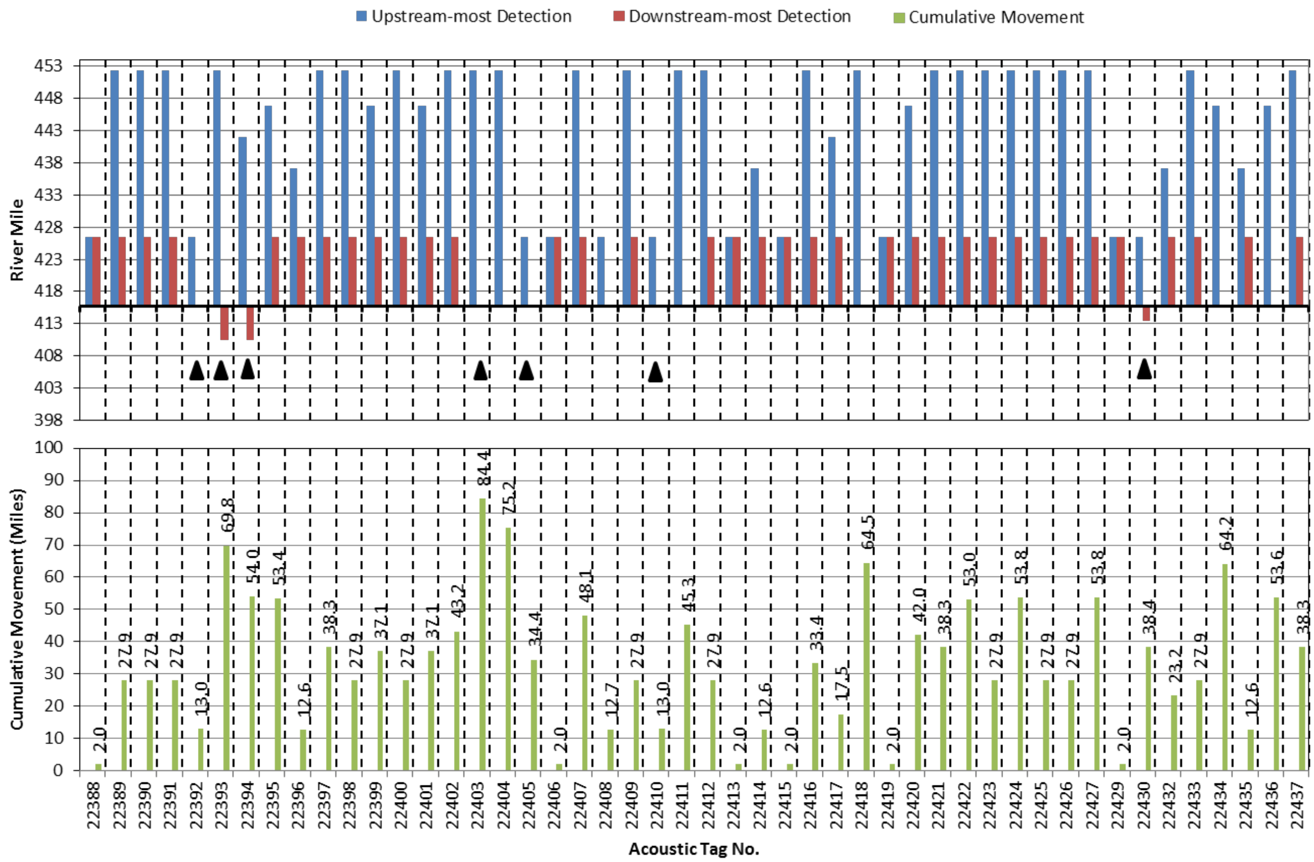


Figure 8 Upstream-most and downstream-most detection location (upper panel) and cumulative movement (bottom panel) of acoustic-tagged 2014BY White Sturgeon released in Wanapum Reservoir from April 30 to October 12, 2015. Horizontal black line in upper panel represents Wanapum Dam location. Fish without 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 2014BY from Wanapum Reservoir into Priest Rapids Reservoir was detected for 7 of 48 fish released (14.6%; Figure 9). Entrained fish exhibited a range of movement patterns, with some fish moving substantial distances (e.g., tag 22403) or remaining in Wanapum Reservoir for a prolonged period (e.g., tag 22430) before entrainment, while other fish essentially moved downstream and were entrained soon after release (e.g., tag 22392). The earliest entrainment detected was on May 5 after approximately 10 days at large (i.e., tag 22393); the latest entrainment detection was on October 2 after 155 days at large.

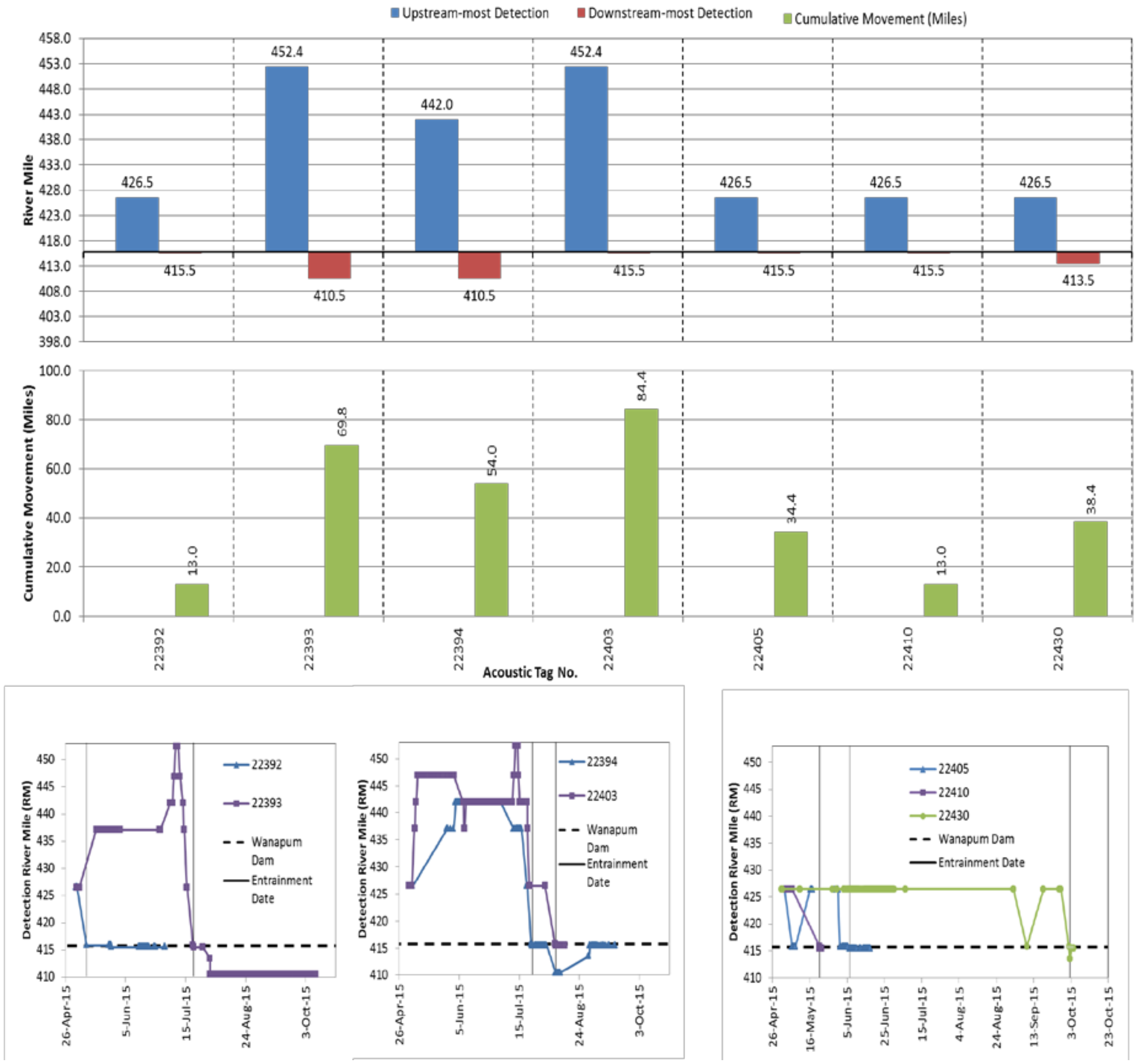


Figure 9 **Upstream-most and downstream-most detections (upper panel), cumulative movement (middle panel), and movement plots showing date of entrainment (bottom panel) of 2014BY White Sturgeon entrained from Wanapum Reservoir into Priest Rapids Reservoir.**

Changes in the daily fish detection counts at each monitoring station in Wanapum Reservoir indicated that post-release, the 2014BY dispersed rapidly throughout the reservoir from the release site at RM 424.5. On the day of release, many of the acoustic-tagged fish were detected at the nearby upstream monitoring station located at RM 426.5 (Figure 10). By the end of the first week in May, detections at RM 426.5 had declined and detections at the upstream and downstream monitoring stations increased, with more detections recorded at upstream stations.

By mid-May, less than two weeks after release, acoustic-tagged 2014BY were detected below Rock Island Dam near RM 452.4. Although some use of the large Wanapum Dam forebay area downstream of the I-90 bridge is suspected, especially within the deeper portions of the original river channel, detection data indicate that the majority of the 2014BY (i.e., 37 of 48 fish) remained primarily upstream of the release site and were detected more in the middle and upper sections of Wanapum Reservoir.

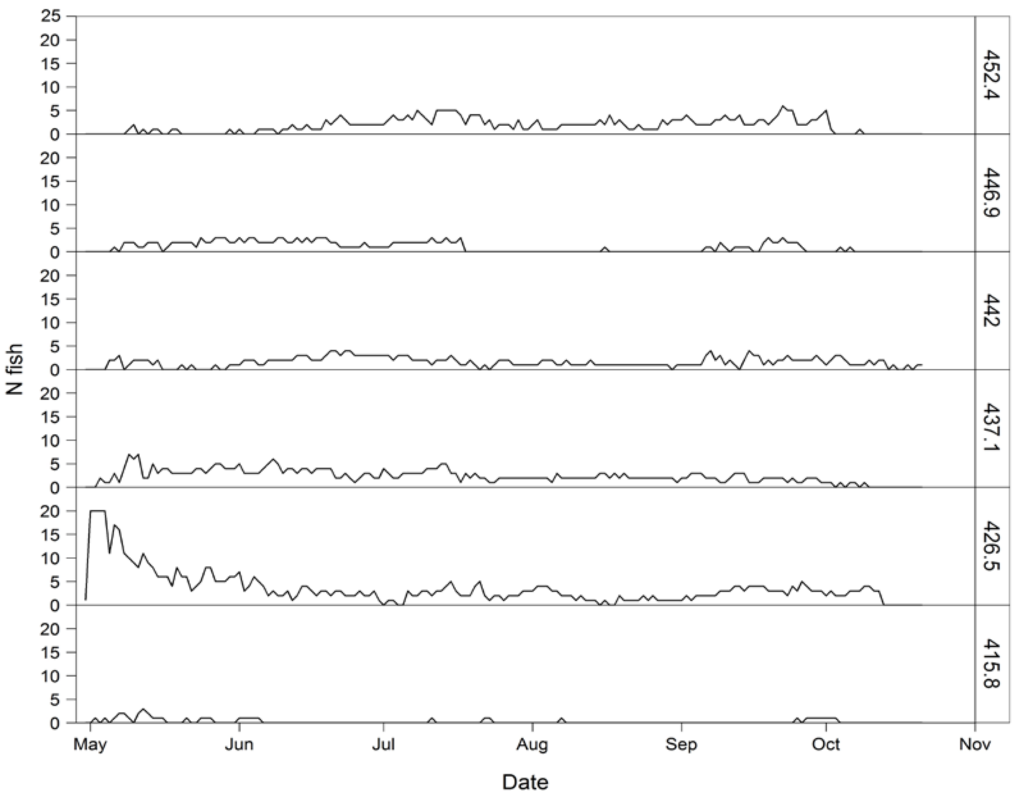


Figure 10 Number of acoustic-tagged 2014BY White Sturgeon detected at acoustic monitoring stations (on right Y-axis) in Wanapum Reservoir from April 30 to October 12, 2015.

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 RM 442.0 and RM 446.9. Station RM 442.0 is located near a known overwintering and holding area for White Sturgeon where high residency would be expected, whereas the RM 446.9 station is located at constriction in the river where fish generally pass through and do not hold for extended periods, so high residency by juvenile White Sturgeon was not expected. Substantial seasonal variation in residency was also recorded at these sites and suggest that fish move around and investigate their new environment in their first year after release. In the middle and upper sections of the reservoir near stations RM 426.5, RM 437.1, and RM 452.4, mean daily residency indicated moderate use with lowest use in the Wanapum Dam forebay area at RM 415.8 (Figure 11).

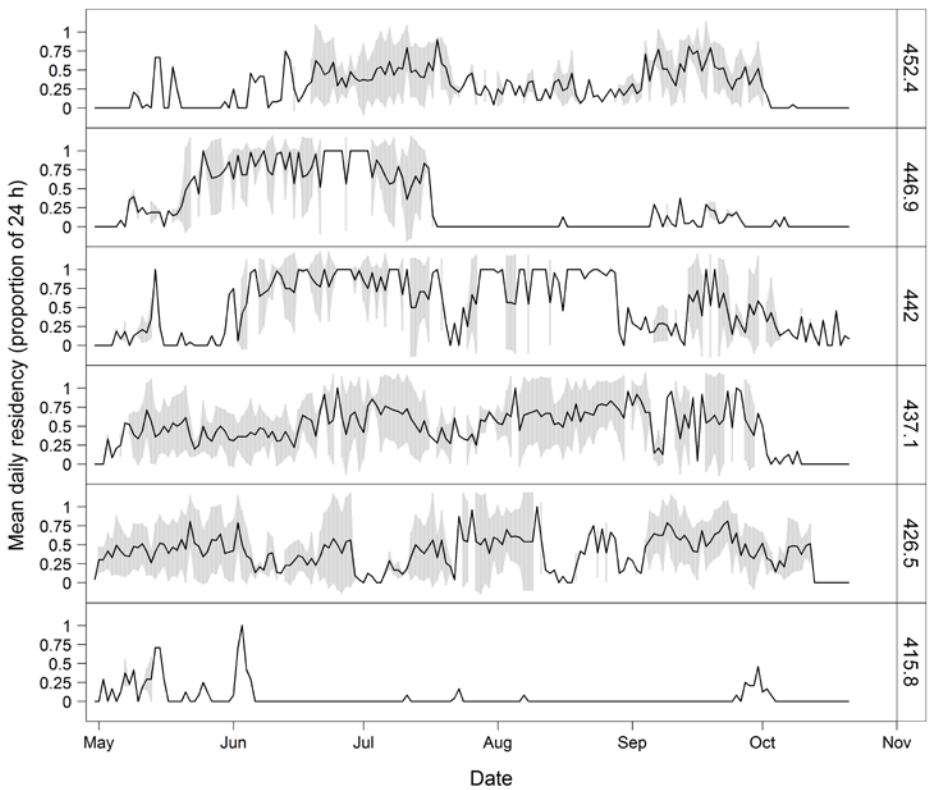


Figure 11 Mean daily residency (black line; S.D. grey ribbon) of 2014BY White Sturgeon at Wanapum Reservoir acoustic monitoring stations (on right Y-axis) from April 30 to October 12, 2015.

In Priest Rapids Reservoir, fish were released in the Wanapum Dam tailrace at RM 415.6; acoustic-tagged juveniles were detected in the tailrace area and the upper section of the reservoir (Figure 12). All 15 acoustic-tagged fish were detected at the tailrace station and 11 of these were detected at downstream reservoir stations. Of the four fish only detected at the Wanapum Dam tailrace station at RM 416.5, two were only detected on the day of release and not after, while the remaining two were detected on the day of release and intermittently over the monitoring period, which suggests that these fish were active and moving in and out of detection range in the general tailrace area. Movement into the Priest Rapids Dam forebay or entrainment through the dam was not detected. Cumulative movement of individual fish ranged between less than 1 km (0.6 miles) and 25 km (15 miles) over the April 30 to October 12, 2015 monitoring period. The downstream-most detection was at RM 410.5. Almost immediately after release, fish dispersed downstream and were detected downstream of the release site (Figure 13). Even after dispersal, more 2014BY fish (e.g., 4 to 6 fish) were recorded near the Wanapum Dam tailrace area than at downstream receivers (e.g., 1-2 fish).

Mean daily residency rate of fish detected in the Wanapum Dam tailrace ranged between 1.0 and 0.25, which suggested that some fish may stay within the detection range of the receivers but others frequently move out of receiver range (Figure 14). Fish that dispersed downstream exhibited higher than expected mean residency once established and remained in the vicinity of the downstream receivers for extended durations.

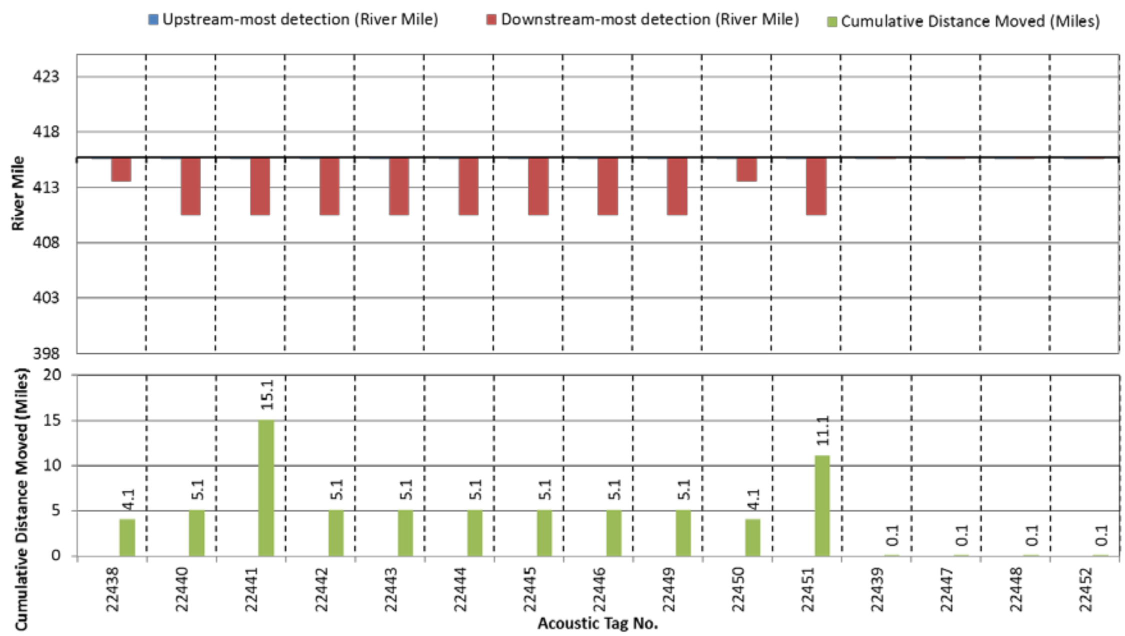


Figure 12 **Upstream-most and downstream-most detections (upper panel) and cumulative movement (middle panel) of 2014BY White Sturgeon in Priest Rapid Reservoir from April 30 to October 12, 2015.**

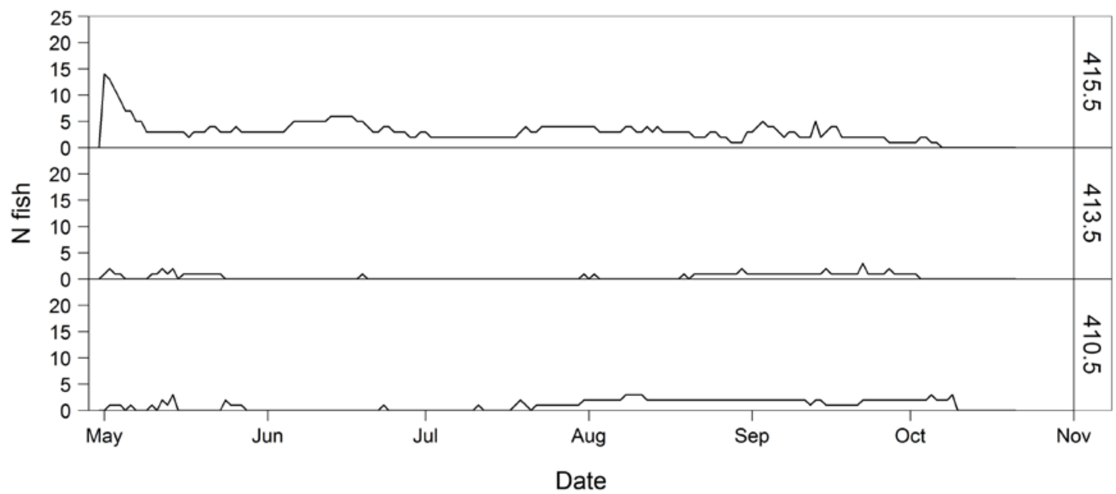


Figure 13 **Number of individual 2014BY White Sturgeon detected at acoustic monitoring stations (on right Y-axis) in Priest Rapid Reservoir from April 30 to October 12, 2015.**

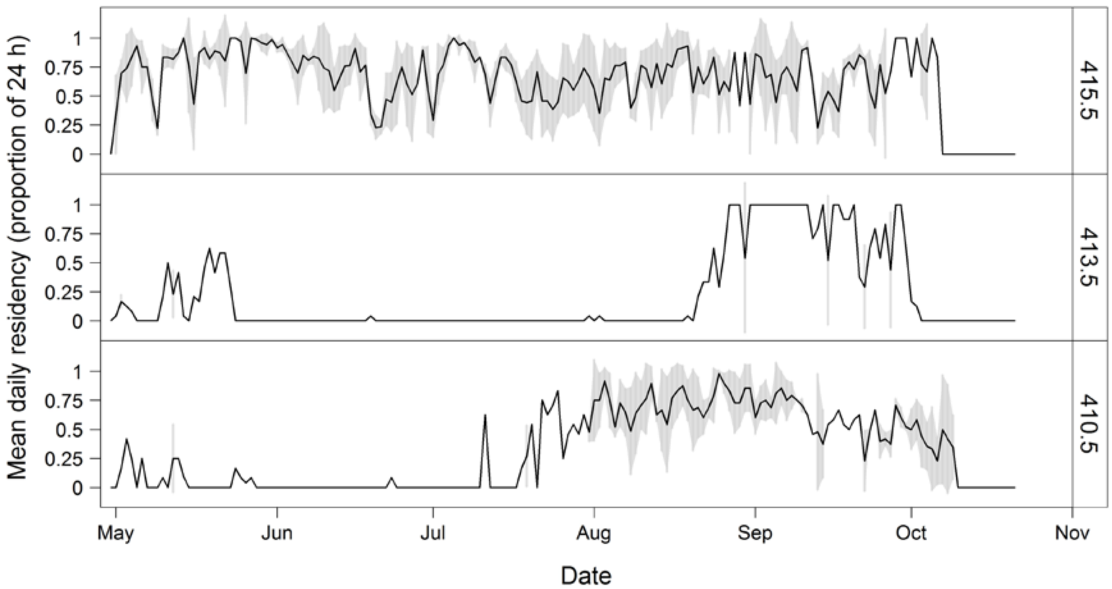


Figure 14 Mean daily residency (black line; S.D. grey ribbon) of 2014BY White Sturgeon at Wanapum Reservoir acoustic monitoring stations (on right Y-axis) from April 30 to October 12, 2015.

3.6 Spawning Investigations

3.6.1 Egg and Larval Collection

White Sturgeon spawning activity was monitored in Wanapum Reservoir below Rock Island Dam from June 12 to June 29, 2015. In total, 916 White Sturgeon eggs were captured during 7,320 mat-hours of sample effort (Table 10).

Mean daily water temperature had already exceeded 16.0°C at the start of spawn monitoring on June 12, 2015. Water temperature increased gradually over the monitoring period and attained a maximum temperature of 17.2°C by the end of monitoring on June 29. Mean daily discharge ranged from 2,205 m^3/s to 3,327 m^3/s during monitoring. In previous spawning assessments in 2010 and 2013, water temperatures were cooler than 16°C in June and only exceeded 16°C in July (Golder 2011 and 2014).

Eggs were first captured on June 20, ten days after initial deployment of the egg mats. The three largest egg capture events, by site and date of capture, were at RI-6 (106 eggs; June 21), RI-2A (87 eggs; June 28) and RI-5 (83 eggs; June 29; Figure 15). The capture of large number of eggs at the end of the monitoring period suggests that spawning activity likely continued into July after monitoring ended.

Overall CPUE was 3.0 eggs/24 mat-hours and eggs were captured at all sites, with the largest total number of eggs captured at site RI-2a (233 eggs; CPUE = 7.0 eggs/24 mat-hours), RI-6 (139 eggs; CPUE = 4.1 eggs/24 mat-hours), and RI-5 (120 eggs; CPUE = 3.6 egg/24 mat-hours; Table 10). The second highest CPUE (5.2 eggs/24 mat-hours) was recorded at site RI-M3, which was deployed mid-way through the monitoring period. Spatially, the egg catch was broadly distributed, with large number of eggs capture at both the upstream end of the monitoring area near the Rock Island Dam tailrace (e.g., RI-2a), as well as a sites located further downstream near Haystack Eddy (e.g., RI-6; Figure 16).

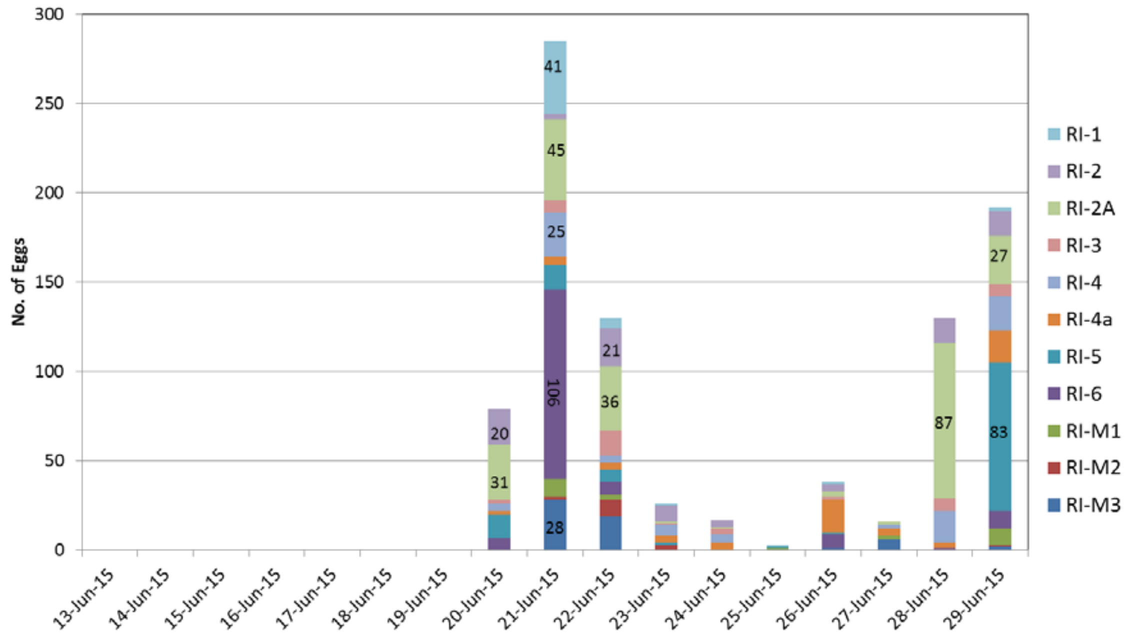


Figure 15 **White Sturgeon egg catch distribution by capture location and date of capture. Only capture events with greater than 20 eggs are shown.**

Table 10 **The total White Sturgeon egg capture effort, number of eggs captured, and catch-per-unit-effort at each capture location in Wanapum Reservoir, 2015.**

Station	Total Effort (mat-hours)	Total Egg Catch	CPUE/24 mat-hours
RI-1	804	52	1.6
RI-2	805	89	2.7
RI-2A	800	233	7.0
RI-3	808	43	1.3
RI-4	807	83	2.5
RI-4a	709	61	2.1
RI-5	810	120	3.6
RI-6	811	139	4.1
RI-M1	354	25	1.7
RI-M2	352	15	1.0
RI-M3	260	56	5.2
Total	**7320**	**916**	**3.0**

Figure 16 White Sturgeon egg catch number and distribution by capture location in Wanapum Reservoir, 2015. Highest egg catch identified by filled-circle outlined in red; lowest egg catch identified by open circle outlined in green.

3.6.2 Egg Development Staging and Spawning Events

At the time of capture, a subsample of eggs were photographed and examined to determine developmental stage based on stage descriptions and the amount time required to attain the developmental stage at a given water temperature (Beer 1981). Using this developmental information, the number of White Sturgeon spawning events and approximate date of each event was estimated. A single spawning event was assumed to represent one or more females releasing their entire egg mass within a 24-hour period. On this basis, seven discrete spawning events were detected below Rock Island Dam in 2015. The back-calculated spawn times for each event are provided in Table 11. These spawning events were estimated to have occurred on June 20, 21, 22, 26, 27, 28, and 29 (Figure 17). Mean daily water temperature during all of the estimated spawning events ranged between 16.1°C and 17.4°C, which was at or slightly above the upper optimum temperature range for White Sturgeon egg development (14°C to 16°C; Wang et al. 1985).

Table 11 Estimated number and timing of White Sturgeon spawning events in Wanapum Reservoir below Rock Island Dam, 2015.

Spawning Event	Egg Collection Date/Time	Water Temp. at Capture (°C)	Egg Stage at Capture	Estimated Spawning Date/Time	Water Temp. at Spawning (°C)	Mean Daily Discharge at Spawning (m^3/s)
1	20-Jun-15 10:01	16.1	12	20-Jun-15 10:01	16.1	2,356
2	21-Jun-15 11:00	16.3	12	21-Jun-15 11:00	16.3	2,205
3	22-Jun-15 12:29	16.4	14	22-Jun-15 07:29	16.4	2,490
4	26-Jun-15 08:24	17.3	12	26-Jun-15 08:24	17.3	3,173
5	28-Jun-15 08:34	17.2	19	27-Jun-15 12:34	17.2	3,270
6	28-Jun-15 11:47	17.2	14	28-Jun-15 07:47	17.2	3,135
7	29-Jun-15 07:56	17.4	12	29-Jun-15 07:56	17.4	3,327

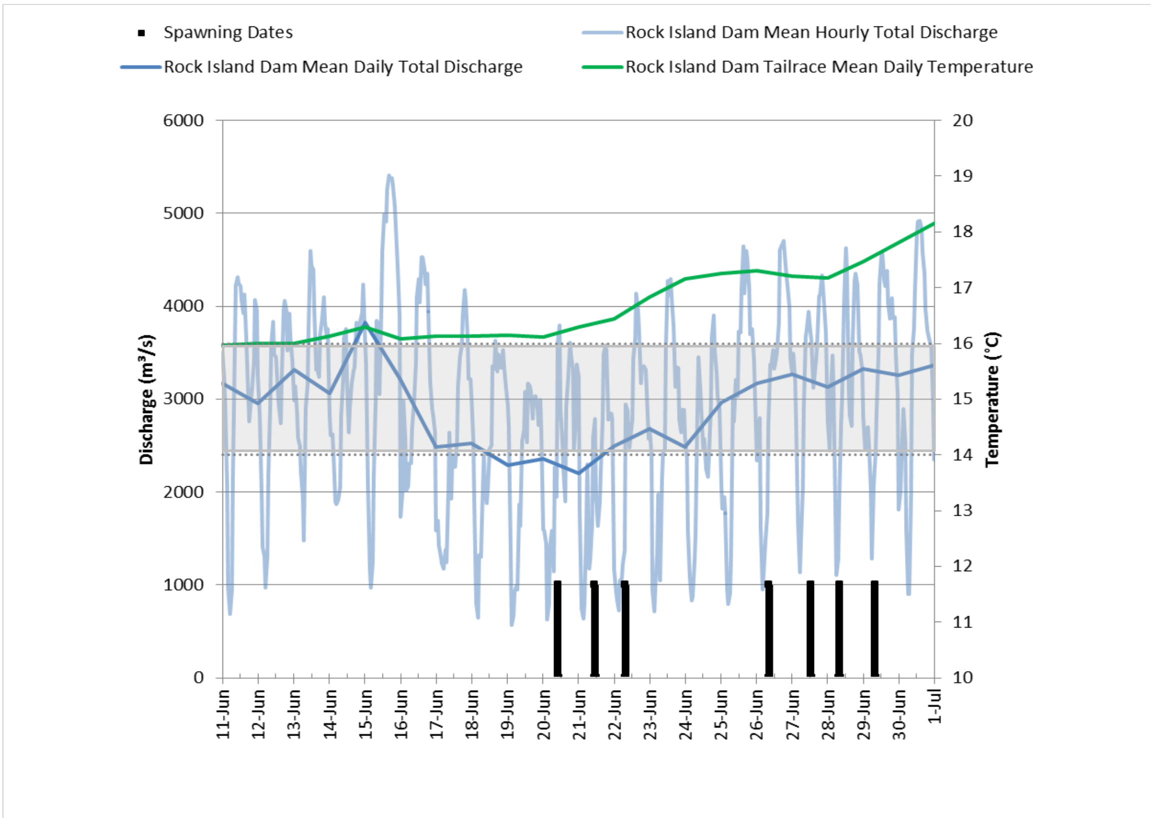


Figure 17 **Mean daily water temperature and discharge of the Columbia River in Wanapum Reservoir below Rock Island Dam from June 11 to July 1, 2015. Vertical black bars indicate estimated dates of White Sturgeon spawning events. Horizontal lines represent the optimal egg incubation temperature range for White Sturgeon egg development (14-16 °C).**

3.6.3 White Sturgeon Egg Incubation

All 916 eggs captured were transported to the *in situ* incubator. Egg incubation duration was dependent on time of egg capture and egg stage at capture, and as a result, larvae collected from the incubator on July 10 varied in developmental stage and remaining yolk reserves. Approximately 90 of the 916 eggs incubated were left adhered to the egg collection mats and were not physically handled. These eggs were placed in the incubator on the egg collection mats, with the mats suspended inside the incubator. The remaining eggs (n = 826 eggs) were manually removed from the mats and then placed in one of two incubation jars over the course of monitoring.

Field crews noted that the water circulation system used to provide continual flow though the MacDonald jars was only partially effective. Power demand by the pump was greater than expected and the two 40W solar panels were unable to keep the deep cycle battery powering the pump fully charged. In response, batteries were exchanged every two days; however, periods of reduced power and circulation still occurred and likely reduced egg survival and hatch success. Fungus infection of eggs was identified as the primary cause of egg mortality within the incubation jars and to a lesser extent, fungus even affected eggs left adhered to the suspended mat material. Apparently healthy eggs added to the incubation jar typically exhibited signs of fungus within 24-hours. Removal of obviously fungus-infected eggs prior to the addition of new eggs did not curb the spread of fungal infection in the jars. As incubation at high egg density was identified as a factor in the spread of fungal contamination among eggs, use of the incubation jar was eventually abandoned and the remaining eggs were placed into the body of the incubator and biospheres added to the bottom incubator in an attempt to reduce fungal infections. Microscopic images of eggs, taken for the purpose of developmental staging, also indicated that most eggs at capture have some amount of filamentous material that adheres to the egg gel coat. These filaments are generally not visible to the unaided eye. Although the fungal origin of this filamentous material could not be confirmed, the presence of this material in nearly all the microscopic images recorded suggests that most of the eggs captured in 2015 may have had some base level of fungal infection.

Until June 29, the capture chamber portion of the incubator (see Figure 4) was routinely examined for free-embryos and larvae as eggs were captured and incubated, but larvae were never observed in the chamber. After the end of spawn monitoring, the incubator was deployed until July 10 to allow all eggs to hatch and free-embryos to develop prior to transfer to WDFW Wells Hatchery. Upon removal of the incubator, 126 live larvae were produced from the 916 eggs placed in the incubator for a 13.7% egg-to-larvae survival rate. A few older dead eggs were recovered, but dead larvae were not found.

Some of the larvae from later spawning events (e.g., June 29) were less developed with obvious large yolk sacs, while larvae from earlier events were more developed and with only residual amounts of yolk evident. Of the 126 larvae, 36 larvae were recovered from the capture chamber that was designed with the intention to collect and concentrate late-stage larvae that exhibit dispersal behavior and tend to swim more rather than seek cover. Based on qualitative observation and photos, the 36 larvae recovered from the collection chamber all appeared to be well-developed late stage larvae, whereas larvae from the main incubation chamber were at an earlier developmental stage.

3.7 Adult White Sturgeon Population Assessment

Sample site distribution within the two main sampling areas, the Wanapum Reservoir North stratum and the Priest Rapid Reservoir stratum, was consistent with expectations of areal-based GRTS equal probability design, with a greater number of sites located in the larger lower section of each reservoir and fewer sites in the smaller middle and upper sections. Limiting site selection to the area encompassed within the >10 m and >6 m depth stratum for Wanapum and Priest Rapids reservoirs, respectively, combined with pre-field office-based screening efforts, eliminated most areas and sites not suitable for sampling and reduced the need to use oversamples based on decisions in the field. Stratification and reduced sample effort allocated to the Wanapum Reservoir South area between the I-90 bridge and Wanapum Dam was considered prudent from a safety perspective, as this section of the reservoir is often characterized by high winds and waves. This occurred during session 1 on September 12 and prevented retrieval of one set line (WRS2015-S1-1) within 24-hours, hampered effective processing of fish, and impeded boat movement between the remaining sites. Of note, eight fish (7 CRITFC fish, 1 Wild) were captured at site WRS2015-S1-1 upon retrieval of the set line after 41 hours.

For Wanapum Reservoir North GRTS samples, sample density was 4.1 samples/100 Hectares and mean water depth sampled was 19.6 m (range = 4.0 to 39 m; n = 24). For Wanapum Reservoir South GRTS samples, sample density was 1.9 samples/100 Hectares and mean water depth sampled was 19.7 m (range = 9.5 to 40 m; n = 24). For Priest Rapids Reservoir GRTS samples, sample density was 3.0 samples/100 Hectares and mean water depth sampled was 12.2 m (range = 2.1 to 27 m; n = 60; Table 12).

Table 12 Details of GRTS sample site distribution, areal extent of reservoir sections, estimates of sampling intensity, and setline sample depths in the Priest Rapids Project area, September 9 to October 15, 2015.

	Reservoir		
	Wanapum North	**Wanapum South**	**Priest Rapids**
Number of sample sites	108	24	60
Sampled area (Ha)	2,604	1,243	1,983
Samples/100Ha	4.1	1.9	3
Sample depths (m)			
Mean	19.6	19.7	12.2
Minimum	4	9.5	2.1
Maximum	39	40	27

Flow fluctuations during both sample sessions 1 (September 9 to 19) and session 2 (October 6 to 15) occurred (see Figure 7), but the average of mean daily flow for each session was similar (session 1, 1,965 m^3/s; session 2, 1,842 m^3/s). During session 1, mean daily discharge peaked on September 11 (2,596 m^3/s) and declined over the session, with the lowest flows during the final sample day on September 19(1,593 m^3/s). Flow varied during session 2 as well, with higher flows near the start (October 6; 1,858 m^3/s) and end (October 15; 2,173 m^3/s) and the lowest flows during the mid-point of the session on October 10 (1,097 m^3/s).

The average mean daily water temperature during session 1 was 18.8°C, which although less than the seasonal summer peak (20.2°C), was unseasonably warm for mid-September. These elevated temperatures may have potentially delayed recovery of sturgeon after capture and processing. Fortunately, nearly all fish captured during session 1 recovered quickly, although a few (e.g., less than five) CRITFC fish required additional time to recover and volitionally swim to depth. During session 2, average mean daily water temperature was lower (16.7°C) and sturgeon were less stressed and recovered more quickly.

In total, 121,879 hook-hours of set line sample effort was expended during the mark-recapture sessions conducted in the Project area (Priest Rapids and Wanapum reservoirs) during the two GRTS population sample sessions in 2015 (Table 13). The combined sample effort from both sessions resulted in the capture of 532 White Sturgeon (includes fish captured twice) composed of 60 wild fish, 75 MDH hatchery fish, and 397 CRITFC hatchery fish for an overall CPUE of 0.44 fish/100 hook-hours. Overall catch composition of wild fish to hatchery fish was 14.1% in Wanapum Reservoir (57 of 405 fish caught) and 2.4% in Priest Rapid Reservoir (3 of 127 fish caught).

Table 13 **Total set line sample effort, catch, and CPUE in the Priest Rapids Project area during the adult White Sturgeon population assessment program, September 9 to October 15, 2015.**

Session[a]	Reservoir	Sample Effort	Catch (No. of fish)				CPUE (fish/100 hook-hours)			
		(hook-hours)	Wild	MDH	CRITFC	Total	Wild	MDH	CRITFC	Wild &Hatchery
1	**Wanapum**	42,640	24	31	183	238	0.06	0.07	0.43	0.56
	Priest Rapids	18,788	2	8	55	65	0.01	0.04	0.29	0.35
		61,428	**26**	**39**	**238**	**303**	**0.04**	**0.06**	**0.39**	**0.49**
2	**Wanapum**	41,305	33	20	114	167	0.08	0.05	0.28	0.40
	Priest Rapids	19,146	1	16	45	62	0.01	0.08	0.24	0.32
		60,451	**34**	**36**	**159**	**229**	**0.06**	**0.06**	**0.26**	**0.38**
Total by Reservoir	**Wanapum**	83,945	57	51	297	405	0.07	0.06	0.35	0.48
	Priest Rapids	37,934	3	24	100	127	0.01	0.06	0.26	0.33
Overall Total		**121,879**	**60**	**75**	**397**	**532**	**0.05**	**0.06**	**0.33**	**0.44**

[a] Sample Session 1, September 9 to 19, 2015; Sample Session 2 , October 6 to 15, 2015;

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

Overall, catch distribution corresponded with effort, with more fish captured at locations where more effort was expended (Figure 18). However, CPUE distribution plotted by river mile identifies some sites in the mid and upper portions of each reservoir (e.g., RM 409 in Priest Rapids; RM 449 in Wanapum Reservoir) with higher CPUE, as likely the result of chance deployment of sampling gear near a location where sturgeon aggregate. These aggregations occur throughout each reservoir, but more notably in the upper portion each reservoir. Using GRTS sample site selection, only few samples sites were located in the upper section of each reservoir due to the small areal extent these sections. That said, even when sites were selected at upstream locations in each reservoir, they were usually dropped in favor of an oversample (selected in order) at downstream sites, as sites in the upper portion of each reservoir were difficult (dangerous) to sample with conventional long-line gear due to high water velocity and obstructions.

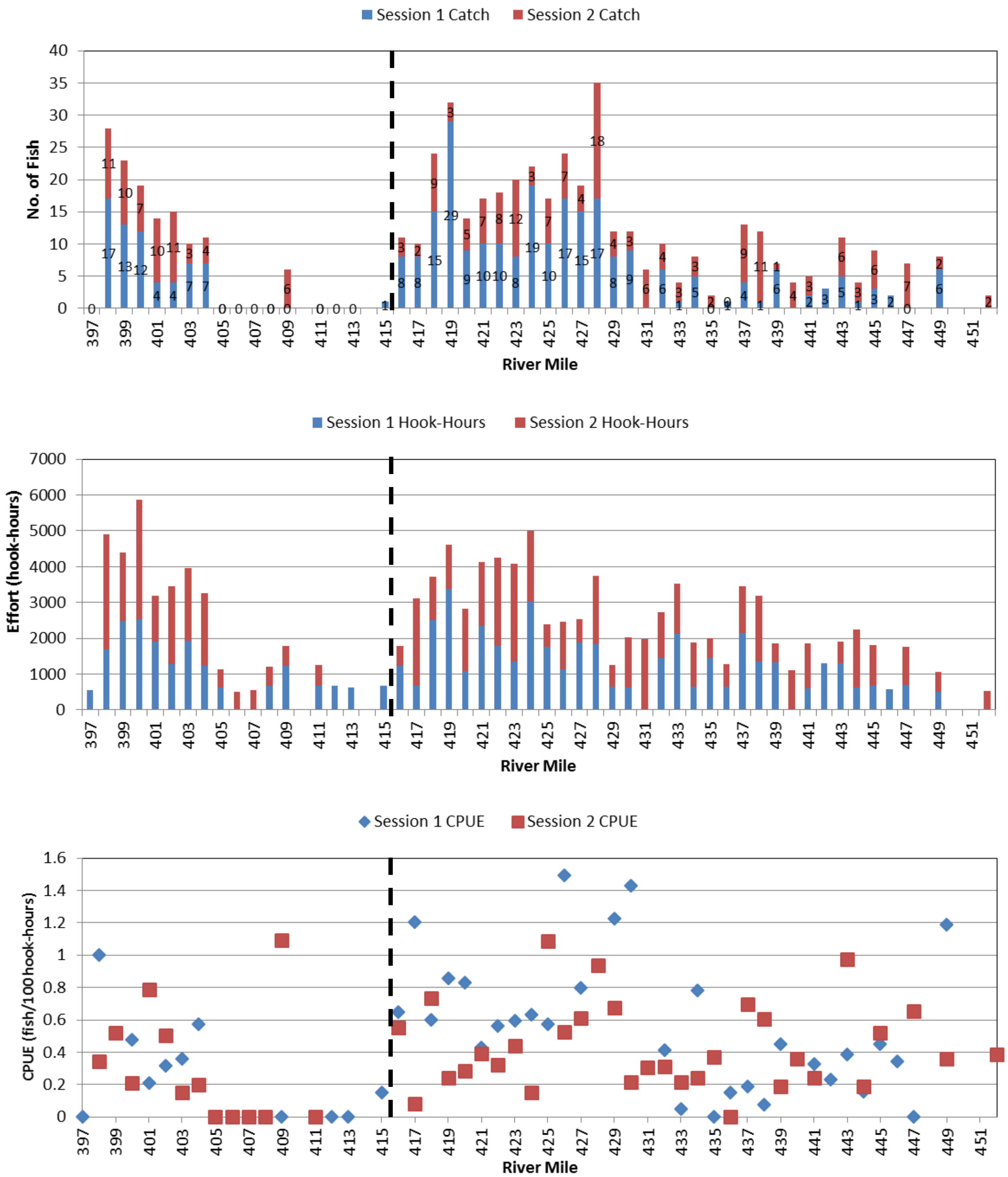


Figure 18 White Sturgeon setline sampling catch, effort, and CPUE distribution by river mile for session 1 (September 9 to 19) and session 2 (October 6 to 15), 2015. Dash vertical line represents the location of Wanapum Dam.

3.7.1 White Sturgeon Size Distribution-Wild

The mean fork length (FL) of the 54 wild fish captured during the 2015 adult population indexing program in Wanapum Reservoir was 198.4 cm FL and ranged from 81.0 cm to 256.0 cm FL (Table 14). Wild fish captured in 2015 were on average larger than fish captured in previous indexing studies in 2010 and 2012; however, length frequency distributions essentially overlap across all study years (Figure 19). The total number of wild fish captured in 2010 (n = 53) was comparable to 2015, but fish captured in 2010 were on average smaller (169.8 cm FL; range = 116.0 cm to 241.0 cm FL). Substantially fewer wild fish were captured in Wanapum Reservoir during the 2012 indexing program (n = 30) and fish were slightly smaller (190.3 cm FL; range = 60.5 cm to 258.0 cm FL) than fish captured in 2015.

Compared to Wanapum Reservoir, very few wild fish have been captured in Priest Rapids Reservoir during indexing studies in 2010 (n = 5), 2012 (n = 3), and 2015 (n = 3; Table 14; Figure 19). In 2015, the average length of wild White Sturgeon captured in Priest Rapids Reservoir was 139.3 cm FL (range = 65.5 cm to 190.0 cm FL). For comparison, the average lengths of wild White Sturgeon captured in Priest Rapids Reservoir in 2010 and 2012 were 166.4 cm FL (range = 137.5 cm to 205.0 cm FL) and 162.8 cm FL (range = 118.0 cm to 205.5 cm FL), respectively.

Table 14 Fork length of wild White Sturgeon captured during the 2010, 2012, and 2015 adult indexing studies in Wanapum and Priest Rapids reservoirs.

Adult Indexing Study Year	Wanapum Catch FL (cm)					Priest Rapids Catch FL (cm)					All Catch FL (cm)				
	n	mean	SD	min	max	N	mean	SD	min	max	n	mean	SD	min	max
2010	53	169.8	31.3	116.0	241.0	5	166.4	34.4	137.5	205.0	58	169.6	31.3	116.0	241.0
2012	30	190.3	41.8	60.5	258.0	3	162.8	43.8	118.0	205.5	33	187.8	42.0	60.5	258.0
2015	54	198.4	36.9	81.0	256.0	3	139.3	65.4	65.5	190.0	57	195.3	40.3	65.5	256.0
All	137	185.6	38.0	60.5	258.0	11	158.0	43.1	65.5	205.5	148	183.5	38.9	60.5	258.0

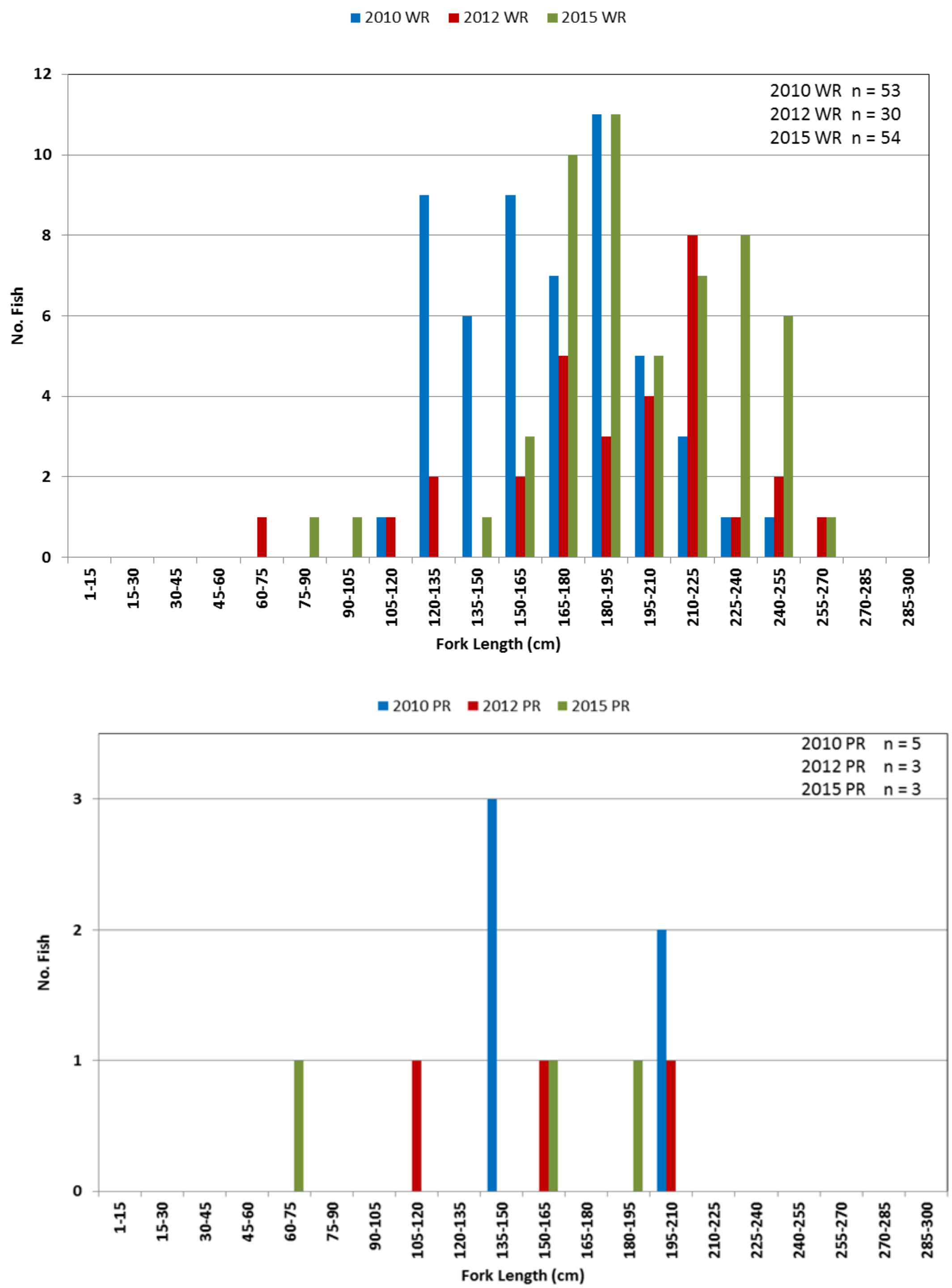


Figure 19 Length-frequency distributions of wild White Sturgeon captured in Wanapum Reservoir (WR) and Priest Rapids Reservoir (PR) during the 2010, 2012, and 2015 adult indexing programs.

Of the combined catch of 60 wild fish, 14 were recaptures previously marked in indexing studies from 1999 to 2002 (n = 5), 2010 and 2012 (n = 5), and broodstock capture efforts in 2012 (n =3) and 2014 (n = 1; Table 15). As expected, the general trend in annual growth varied in relation to the size of fish at first capture, with large fish (e.g., greater than 180 cm FL) exhibiting less growth than small and medium size fish. Of note, a small, young wild fish (FL = 53.0 cm) captured during the 2000 indexing study and recaptured in 2015, had developed into a large mature male adult (i.e., 2015 maturity code =M2; 184.0 cm FL) in 15 years.

3.7.2 White Sturgeon Size Distribution-CRITFC Hatchery Fish

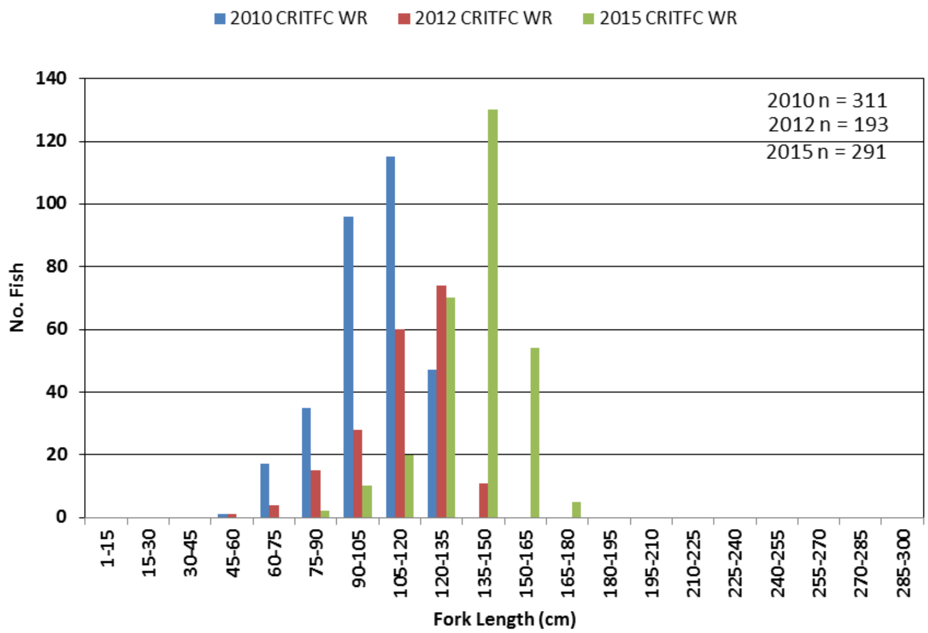
The CRITFC fish, which were released in Rock Island Reservoir in 2003 and subsequently entrained downstream into the Priest Rapids Project area, have been captured in high numbers in both Wanapum and Priest Rapids reservoirs during the previous indexing studies, in 2010 and 2012, and again during the 2015 study (Table 16). Since 2010, mean fork length of the CRITFC fish has increased by approximately 34 cm in both Wanapum and Priest Rapids reservoirs and an obvious shift in CRITFC length-frequency distribution is evident in the length-frequency distribution of fish collected to date (Figure 20). In total, 91 CRITFC fish have been captured twice or more since 2010 during the adult indexing studies and broodstock capture programs. Of these recaptures, 86 fish were at large for more than 1,000 days between first and last capture events; annual growth of these fish was 7.3 cm/year. Of note, 14 of the 91 recaptured CRITFC fish (15%) were initially captured in Wanapum Reservoir and were later recaptured in Priest Rapids Reservoir. Date of entrainment of each fish is unknown; mean days at large between capture and recapture was 1,652 days (4.5 years).

Table 15 Growth of wild White Sturgeon, previously captured and tagged in the Priest Rapids Project area during studies in 1999, 2000, 2001, 2010, 2012, and 2014, and recaptured during the 2015 adult indexing study.

	First Capture			Second Capture			Years at Large	ΔFL	ΔWt	Growth FL	Growth Wt
PIT-tag	Date	FL (cm)	Wt (kg)	Date	FL (cm)	Wt (kg)		(cm)	(kg)	(cm/year)	(kg/year)
985121021206405	23-Sep-10	194.0	66.2	15-Sep-15	196.5	72.1	4.98	2.5	5.9	0.5	1.2
985121021197959	12-Oct-10	205.5	70.3	13-Oct-15	218.0	92.7	5.01	12.5	22.4	2.5	4.5
985120030512761	05-Oct-12	135.0	18.2	14-Oct-15	159.5	29.0	3.02	24.5	10.8	8.1	3.6
985120030405316	13-Sep-12	130.5	22.4	14-Oct-15	150.0	28.1	3.08	19.5	5.7	6.3	1.8
985120021743750	25-Sep-10	125.5	13.6	15-Sep-15	166.0	33.1	4.98	40.5	19.5	8.1	3.9
985120017184741	23-Jun-12	134.0	16.5	19-Sep-15	154.0	27.7	3.24	20.0	11.2	6.2	3.5
985120021749486	20-Jun-12	187.0	57.2	18-Sep-15	193.0	48.1	3.25	6.0	-9.1	1.8	-2.8
985120018705716	23-Jun-12	247.0	127.5	12-Oct-15	256.0	-	3.30	9.0	-	2.7	-
985120021743750	31-May-14	157.0		15-Sep-15	166.0	33.1	1.29	9.0	33.1	7.0	-
4110652906	07-Oct-01	180.0	49.1	18-Sep-15	210.5	70.8	13.96	30.5	21.7	2.2	1.6
4203606567	21-Sep-99	215.0	-	13-Oct-15	232.0	104.8	16.07	17.0		1.1	0.0
41105D7E20	23-Sep-00	223.0	-	14-Oct-15	240.0	117.9	15.07	17.0	-	1.1	-
4110647A02	04-Oct-00	53.0	1.2	14-Oct-15	184.0	56.2	15.04	131.0	55.0	8.7	3.7
4203422D28	22-Sep-99	203.0	-	12-Oct-15	226.5	100.2	16.07	23.5	-	1.5	-

Table 16 Fork length of CRITFC hatchery White Sturgeon captured during the 2010, 2012, and 2015 adult indexing studies in Wanapum and Priest Rapids reservoirs.

Adult Indexing Study Year	Wanapum Catch FL (cm)					Priest Rapids Catch FL (cm)					All Catch FL (cm)				
	n	mean	SD	min	max	n	mean	SD	min	max	n	mean	SD	min	max
2010	311	104.1	15.1	58.0	132.5	158	101.3	14.3	64.5	132.5	469	103.2	14.9	58.0	132.5
2012	193	114.8	16.7	57.5	144.0	87	113.3	15.5	56.5	141.0	280	114.3	16.3	56.5	144.0
2015	291	137.7	15.6	77.0	170.0	98	135.4	16.1	57.5	165.0	389	137.1	15.7	57.5	170.0
All	795	119.0	21.6	57.5	170.0	343	114.1	20.8	56.5	165.0	1,138	117.5	21.5	56.5	170.0



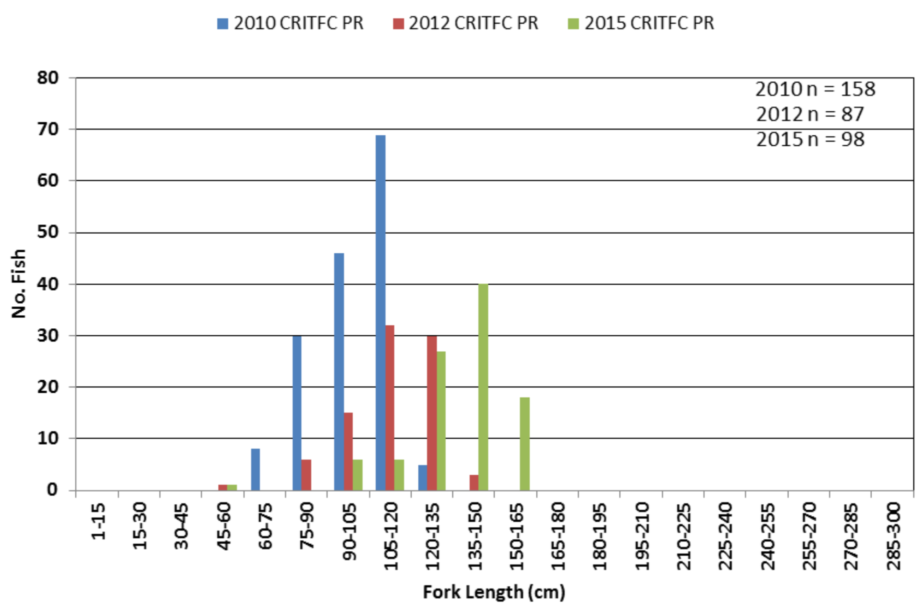


Figure 20 **Length-frequency distribution of CRITFC hatchery White Sturgeon captured in Wanapum Reservoir (WR; top) and Priest Rapids Reservoir (PR; bottom) during the 2010, 2012, and 2015 adult indexing programs.**

3.7.3 White Sturgeon Size Distribution- Marion Drain Hatchery (MDH) Fish

In 2015, Marion Drain Hatchery (MDH) juvenile White Sturgeon from brood years (BY) 2010BY, 2012BY, 2013BY, and 2014BY contributed 14% (n = 75 of 532) to the total adult indexing catch. This was a substantial increase from the adult indexing study in 2013, when only two MDH hatchery fish (<1% of the total catch) were captured (Golder 2013). Using small-hook set line sampling, the 2014 juvenile indexing study captured 231 MDH fish and verified that the hatchery fish were growing and healthy (Golder 2015). This finding is supported by the growth data obtained for MDH hatchery fish catch during the 2015 adult indexing program.

The 2010BY captured in 2015 were large (mean = 77.7 cm FL; range = 54.0 to 100.0 cm FL; Table 17) and have grown rapidly since release (mean = 9.9 cm/year; SD = 2.5 cm/year; Table 18). Three 2015 recaptures of 2010BY first captured during the 2014 juvenile indexing study confirmed substantial annual growth (mean = 14.2 cm/year; SD = 2.4 cm/year). Similar strong growth rates were recorded for the other brood year juveniles (see Table 17 and 18).

A portion of the 2015 adult indexing MDH hatchery fish total catch (12.0%; n = 9 of 75 fish) were 2010BY that had been released upstream in Rocky Reach Reservoir and entrained into the Project. A similar proportion of the 2014 juvenile indexing catch also were 2010BY entrained from Rocky Reach Reservoir (8.6%; n = 20 of 232 MDH fish). To date, of all the brood years released in Rocky Reach Reservoir, only 2010BY MDH fish have been captured in Wanapum and Priest Rapids reservoirs.

Table 17 Fork length (cm) summary for MDH hatchery White Sturgeon captured during setline sampling in Wanapum and Priest Rapids reservoirs during the White Sturgeon adult indexing effort, September 9 to October 15, 2015.

Stocking Entity	Brood Year	Wanapum Catch FL (cm)					Priest Rapids Catch FL (cm)					All Catch FL (cm)				
		n	mean	SD	min	max	n	mean	SD	min	max	n	mean	SD	min	max
Chelan PUD	2010	9	86.3	12.2	63.5	99.0	-	-	-	-	-	9	86.3	12.2	63.5	99.0
Grant PUD	2010	30	72.1	13.0	54.0	96.5	21	85.6	11.9	54.0	100.0	51	77.7	14.1	54.0	100.0
	2012	8	54.4	6.5	48.0	69.0	1	66.5	-	-	-	9	55.7	7.3	48.0	69.0
	2013	3	48.5	5.5	43.0	54.0	2	53.8	8.1	48.0	59.5	5	50.6	6.3	43.0	59.5
	2014	1	38.0	-	-	-	-	-	-	-	-	1	38.0	-	-	-
All sturgeon	All	51	69.8	16.3	38.0	99.0	24	82.2	14.8	48.0	100.0	75	73.8	16.8	38.0	100.0

Table 18 Growth as change in fork length (FL; cm) and growth rate (FL; cm/year) of MDH hatchery fish captured during setline sampling in Wanapum and Priest Rapids reservoirs during the White Sturgeon adult indexing effort, September 9 to October 15, 2015.

Reservoir	Stocking Entity	Brood Year	n	Time at Large (Years)				Growth (cm)				Growth Rate (cm/year)			
				mean	SD	min	max	mean	SD	min	max	mean	SD	min	max
Wanapum	Chelan PUD	2010	9	4.44	0.04	4.40	4.49	57.1	12.4	38.5	72.4	12.9	2.8	8.7	16.4
	Grant PUD	2010	30	4.41	0.03	4.38	4.47	43.5	11.1	25.0	63.5	9.9	2.5	5.7	14.5
		2012	8	2.39	0.04	2.34	2.42	24.1	5.3	18.3	34.6	10.1	2.2	7.6	14.3
		2013	3	1.41	0.03	1.37	1.43	21.7	5.6	15.6	26.6	15.3	3.6	11.4	18.6
		2014	1	0.46	-	0.46	0.46	4.7	-	4.7	4.7	10.2	-	10.2	10.2
Priest Rapids[1]	Grant PUD	2010	21	4.43	0.04	4.37	4.46	57.3	12.4	29.0	71.5	12.3	3.8	1.6	16.1
		2012	1	2.40	-	2.40	2.40	38.4	-	38.4	38.4	16.0	-	16.0	16.0
		2013	2	1.43	0.00	1.43	1.43	23.0	9.9	16.0	30.0	16.1	7.0	11.2	21.0
All	Chelan PUD	2010	9	4.44	0.04	4.40	4.49	57.1	12.4	38.5	72.4	12.9	2.8	8.7	16.4
	Grant PUD	2010	51	4.42	0.04	4.37	4.47	49.1	13.4	25.0	71.5	10.9	3.3	1.6	16.1
		2012	9	2.39	0.03	2.34	2.42	25.7	6.9	18.3	38.4	10.7	2.8	7.6	16.0
		2013	5	1.42	0.03	1.37	1.43	22.2	6.4	15.6	30.0	15.6	4.4	11.2	21.0
		2014	1	0.46	-	0.46	0.46	4.7	-	4.7	4.7	10.2	-	10.2	10.2

Gear performance

Gangions composed of 50% barbed and 50% barbless hooks of each size type (i.e., 12/0, 14/0, and 16/0) were deployed to determine the effect of barbed hooks on fish retention and ultimately on catch (Table 19). Barbed 12/0 hooks captured 50% more fish than barbless 12/0 hooks, and in particularly, increased the capture and retention of smaller fish less than 100 cm FL by 84%. A similar increase in the proportion of small fish (<100 cm FL) caught by barbed versus barbless 14/0 hooks was also recorded (17 fish on barbed 14/0 hooks compared to 6 fish on barbless). As expected, the large 16/0 hooks were not effective at capturing the smaller MDH hatchery fish. As hook size and fish size increased, the number of fish captured by both barbed and barbless hooks was approximately equal, with the exception of the largest hook size (16/0) and the largest fish, where barbless hooks outperformed barbed hooks (i.e., 11 fish on barbed 16/0 hooks compared to 24 fish on barbless; Table 19).

Table 19 Total catch and mean fork length by hook size (12/0, 14/0, and 16/0) and type (barbed and barbless) during the 2015 adult indexing study.

	MDH Hatchery		**CRITFC Hatchery**		**Wild**		**Grand Total**	
Hook Size	**No. of Fish**	**mean FL (cm)**	**No. of Fish**	**mean FL (cm)**	**No. of Fish**	**mean FL (cm)**	**No. of Fish**	**mean FL (cm)**
12/0 Barbed	38	70.2	55	136.5	6	156.8	99	111.8
12/0 Barbless	7	75.0	41	136.7	4	165.5	52	130.6
14/0 Barbed	17	78.9	76	138.6	8	180.6	101	131.8
14/0 Barbless	6	80.5	82	137.8	5	202.3	93	137.6
16/0 Barbed	3	81.0	70	134.3	11	206.3	84	142.0
16/0 Barbless	4	68.3	71	135.9	24	208.9	99	150.3
Grand Total	**75**	**73.8**	**395**	**136.5**	**58**	**195.3**	**528**	**133.9**

3.7.4 Adult Indexing White Sturgeon Abundance Estimates

A total of 1,231 individual White Sturgeon, wild and CRITFC fish, were captured during the three years of adult index sampling at Wanapum and Priest Rapids reservoirs. At Wanapum, 917 individual fish were captured, whereas at Priest Rapids, 327 individual White Sturgeon were recorded. The annual captures of hatchery-origin and wild sturgeon are detailed in Table 20. Of the fish initially captured in Wanapum Reservoir, 13 fish were entrained at some point between 2010 and 2015 and later recaptured in Priest Rapids Reservoir. Of these entrained fish, 12 were entrained from Wanapum Reservoir after 2010, and one fish after 2012.

Table 20 Number of individual sturgeon (wild and CRITFC), captured in each sampling year in each reservoir in the Priest Rapids Project area, 2010, 2012, and 2015.

Reservoir	Year	Number of Hatchery[a]	Number of Wild	Total
Wanapum	2010	379	53	432
	2012	189	30	219
	2015	293	55	348
Priest Rapids	2010	155	5	160
	2012	84	3	87
	2015	96	3	99

[a] CRITFC fish (2002BY) only

Of the three POPAN models, Model 3 (probability of entry zero for hatchery fish, constant for wild fish) had the lowest AICc value (807.6) and the highest AICc weight (0.66), suggesting this model had 66% chance of being the best of the examined three models, given the dataset. Model 2 (constant probability of entry, differs by hatchery and wild populations) had the second lowest AICc value (809.5) and the second highest AICc weight (0.25). Model 1 (constant probability of entry across all populations) had the highest AICc value (811.6) and the lowest AICc weight (0.09). All estimates provided below were derived using model averaging.

The POPAN model estimated survival at 0.796 (95% CIs of 0.604-0.909), and recapture probability ranging from 0.08 in 2012 to 0.221 in 2015 (Table 21). The estimates had high uncertainty, with survival 95% CIs spanning from 0.604 to 0.909, and the 95% CIs of the 2015 recapture probability spanning from 0.088 to 0.455. This uncertainty was reflected in the derived population estimates.

The wide 95% CI of survival estimates of both reservoirs, coupled with convergence difficulties for any more complex models (not shown), strongly suggest that the current dataset is not sufficient for a reliable mark-recapture population estimate. The occasion-specific abundance estimates were calculated based on the model's estimates of super-population, survival, and probability of entry. The decreases in abundance estimates between sampling occasions therefore reflect the model's low mean survival rate.

The estimates of Wanapum hatchery population decreased from 3,767 fish in 2010 to 1,251 fish in 2015 (Table 22). However, the uncertainty associated with survival and super-population estimates (Table 21) was high, indicating the need for collection of additional data. This is reflected in the estimated 95% CIs; for example, 2015 hatchery estimate had 95% CIs spanning from 204 to 2,298 fish. The wild fish in Wanapum were estimated to decrease from 536 sturgeon in 2010 to 249 sturgeon in 2015. However, as with the hatchery population estimates, these values reflect a high uncertainty.

In Priest Rapids, the hatchery population was estimated at 1,514 fish in 2010, 972 fish in 2012, and 503 fish in 2015, with wide confidence intervals throughout the three sampling years. The wild population was estimated at 45 fish in 2010, 33 fish in 2012, and 21 fish in 2015.

Table 21 Estimates of POPAN parameters for White Sturgeon, from reservoir-specific rmodels.

Reservoir	Parameter	Estimate Mean	Lower 95% confidence limit	Upper 95% confidence limit
Shared by both Wanapum and Priest Rapids	Survival (Phi)	0.796	0.604	0.909
	Recapture, 2010	0.101	0.069	0.146
	Recapture, 2012	0.080	0.052	0.121
	Recapture, 2015	0.221	0.088	0.455
	Probability of entry, hatchery	0.008	Fixed parameters	
	Probability of entry, wild	0.080	0.018	0.294
Wanapum	Super population, hatchery	3,040	2,232	4,142
	Super population, wild	507	366	705
Priest Rapids	Super population, hatchery	1,222	884	1,689
	Super population, wild	42	20	87

Table 22 Estimated White Sturgeon population abundances in the Priest Rapids Project area; values in parentheses are 95% confidence intervals.

Reservoir	Year	Abundance estimate		
		Hatchery	**Wild**	**Total**
Wanapum	2010	3,767 (2,447-5,087)	536 (306-767)	4,303 (2,753-5,854)
	2012	2,419 (1,471-3,366)	391 (222-561)	2,810 (1,692-3,927)
	2015	1,251 (204-2,298)	249 (36-462)	1,500 (240-2,759)
Priest Rapids	2010	1,514 (971-2,057)	45 (15-74)	1,559 (986-2,132)
	2012	972 (584-1,360)	33 (11-54)	1,005 (595-1,415)
	2015	503 (80-925)	21 (0-41)	524 (80-967)

The analyses detailed here use data from all three sampling years. This is an improvement to the closed population estimates presented previously (Golder 2011 and 2013). However, the current dataset is still too sparse to provide reliable estimates of survival or population abundance. The preferred POPAN mod included fixed parameters, which is likely to bias parameter estimates. Fixing parameters was necessary to get the models to converge.

4.0 DISCUSSION

The following sections provide a brief discussion of the Year 8 M&E program results for the Project area. Activities included tagging and release of 2014BY juvenile White Sturgeon, broodstock capture and 2015BY production, White Sturgeon larvae drift capture, White Sturgeon spawn monitoring and *in situ* egg incubation, and telemetry monitoring of 2014BY movements after release. Discussion of the 2015 adult White Sturgeon indexing study will consist of a general overview of the study approach to identify strengths and limitations and the ability of the program to estimate adult sturgeon population and adult survival.

Juvenile White Sturgeon Processing and Release (2014BY)

With the return to full-pool and repair of Wanapum Dam in 2015, the 2014 release location (i.e., Rocky Coulee Launch near RM 421.5) was permanently closed. After consideration of a number of alternative release sites in Wanapum Reservoir, the recently refurbished Frenchman Coulee boat launch (RM 424.5) was selected as the juvenile sturgeon release site in 2015. This proved to be an excellent choice, both in terms of ease of access and reduced risk of avian predation due to deep water habitat located immediately near the release site. As the Frenchman Coulee Launch site is approximately 14.4 km (9 mi) upstream of Wanapum Dam, the risk that fish released at this site will be quickly entrained through Wanapum Dam was assumed to be low in normal flow years.).

The fin deformity rate recorded during processing of the 2014BY (i.e., 78.5%; n = 5,104 of 6,502) was much higher than expected and had increased compared to the rate recorded for the 2013BY (i.e., approximately 64%; n =4,246 of 6,594; Golder 2014). The effect of fin deformity on juvenile White Sturgeon survival is unknown and would be difficult to quantify; however, variation in the amount and severity of fin deformity in future hatchery release likely introduces another variable that may affect juvenile survival rates, and indirectly, the juvenile stocking rate necessary to achieve program objectives. A review by the PRFF of aquaculture techniques available to reduced fin deformity rate is strongly suggested.

Broodstock Capture 2015

Broodstock collection efforts primarily below McNary Dam, and to a lesser extent at The Dalles, were the most successful to date in terms of the total number of viable female and male fish transported to Marion Drain Hatchery for spawning (i.e., 15 ripe females and 13 ripe males). This success was reflected in the number of 2015BY genetic crosses produced (i.e., 85 genetic crosses). Collaboration between Grant and Chelan PUD to fund a high intensity-short duration broodstock capture program below McNary Dam in May 2015 proved to be an efficient and effective approach, and if continued, will likely yield similar results during future broodstock capture efforts.

White Sturgeon Larvae Drift Capture

The low number of White Sturgeon larvae captured during the 2015 drift capture program in Bonneville and The Dalles reservoirs was attributed in part to site specific sampling conditions (e.g., high wind and waves) and difficulty associated with gear deployment. A detailed description site conditions and the effect on sampling is provided in Appendix B. Based on captured efforts in Lake Roosevelt, larvae drift sampling has been demonstrated as a highly effective approach to obtain live larvae for hatchery rearing (Howell and McLellan 2010); however, the success of such a program tends to be site specific to local conditions and dependent on the identification of specific locations with high larvae-catch probability. This is illustrated by the results of a 2013 USGS larval capture pilot study where sampling at one of the same sites sampled by WDFW in 2015 captured more than 100 larvae with less than 1/4 the effort (Parsley and Kofoot 2013). Based on the pilot larvae drift sampling study conducted in the Project area (Golder 2014), one conclusion reached was that an effective larvae drift capture program requires that reconnaissance sampling first be conducted to identify high-probability catch locations.

Movements of 2014BY Acoustic Tagged Juveniles

In Wanapum Reservoir, the majority 2014BY (i.e., 77%; n = 37 of 48 fish) exhibited a substantial amount of movement after release, with these fish detected at least once upstream of RM 437.1. A large portion of fish that moved upstream (67%; n = 25 of 37) were detected at least once in the upper reservoir near the Haystack Eddy monitoring station (RM 452.4) within two weeks after release. A smaller portion of the 2014BY release moved less (i.e., n = 11 fish) and remained in the lower portion of the reservoir. In the 2013BY released in the lower section of Wanapum Reservoir near RM 421.5, a similar tendency for initial upstream movement in the first month after release was also observed. This tendency to dispersal upstream after release reduced the risk of entrainment through Wanapum Dam; however, fish that approach Rock Island Dam were exposed to a higher risk of avian predation from the cormorants nesting colony located in the Rock Island Dam forebay.

During the 2010BY Wanapum released in 2011, fish were released in the upper portion of reservoir near Columbia Siding Road (RM 451.0). A large portion of the fish released remained in shallow water and were exposed to avian predators near Rock Island Dam for a prolonged period. Based on previous releases, new sturgeon release sites were selected in the lower section of Wanapum Reservoir at locations where released fish could quickly sound to depth and evade avian predators.

During the initial analysis of 2015 acoustic telemetry data of 2014BY White Sturgeon with acoustic tags, the rapid and volitional movement of some fish into Rock Island tailrace area, although unexpected, was not initially considered detrimental as this movement suggested that these fish were likely healthy, had acclimated quickly to their new environment, and possibly more likely to evade avian predators.

However, an inspection of the cormorant colony for PIT-tags by Chelan PUD staff in October 2015 found evidence of avian predation on the 2014BY fish. In total, 39 PIT-tags from 2014BY fish were detected at the cormorant rookeries in the Rock Island Dam forebay, including a PIT-tag from one fish that was also implanted with an acoustic tag (Table 23). As a percentage of the total hatchery release, the amount of detected avian predation on 2014BY (0.78%) was comparable to avian predation rates observed on the 2010BY (0.97%) and 2012BY (0.88%), which were released at upstream locations, closer to the rookeries. Overall, the 2013BY juveniles had the lowest observed avian predation (0.14%). The 2013BY were released in two groups in May and September 2014 near RM 421.5 at Rocky Coulee Launch, the only access point to Wanapum reservoir when reservoir elevation was reduced to facility repair of Wanapum Dam. At this low pool elevation, flow conditions in the Rock Island Dam tailrace were shallow and fast and likely not conducive for diving cormorants. Across all brood years and PIT-tags recovered, mean fork length was 295 mm and ranged between 235 mm and 308 mm (Table 23).

The unique low reservoir conditions under which the 2013BY were released likely resulted in reduced avian predation on the 2013BY by cormorants in the vicinity of Rock Island Dam. Excluding the 2013BY, the 2014BY experienced the least amount of avian predation compared to the 2010BY and 2012BY, albeit by a small margin. Therefore, use of the downstream Frenchman Coulee Launch site for future hatchery juvenile releases is preferred.

Table 23 PIT-tags from MDH hatchery White Sturgeon (2010BY to 2014BY) subject to avian predation based on PIT-tag detected at Rock Island Dam cormorant rookeries as of October 2015.

Brood year	Wanapum Reservoir Hatchery Release No.	Release Date	PIT Tags recovered	Percent of Wanapum Release	No.of PIT-tagged fish with V9 Pinger	Pinger Code	Downstream Release RM	Upstream Release RM	Mean Fork Length (mm)	SD of Fork Length (mm)
2010	7,016		68	0.97			450.6	450.6		
		-	58		1	44537	450.6	450.6	259	31
		26-Apr-11	4				450.6	450.6	235	21
		29-Apr-11	6				450.6	450.6	274	27
2012	2,264		20	0.88			442	450.6	288	22
		14-May-13					442	450.6		
2013	5,093		7	0.14			421.5	421.5	290	47
		6-May-14	2				421.5	421.5	259	8
		15-Sep-14	1				421.5	421.5	257	-
		18-Sep-14	4				421.5	421.5	314	52
2014	5,007		39	0.78			424.5	424.5		
		30-Apr-15	39		1	22398	424.5	424.5	308	26
Grand Total	**19,380**		**134**	**0.69**	**2**				**295**	**32**

Movement of acoustic-tagged 2014BY White Sturgeon released in Priest Rapids Reservoir was similar to previous releases, with fish generally remaining in the upper portion of the reservoir and gradually dispersing downstream to RM 410.5, before return upstream. Use of the Priest Rapids forebay area by 2014BY was not detected. Entanglement of the tailrace monitoring station at RM 415.5 with fishing gear was a problem in 2015 and the station was displaced into deeper water after the encounter. Although the scope of the cable system was reduced to limit the movement of the station, future encounters with anglers in this area will likely occur. Re-deployment of the VR2W near RM 404.0, removed in 2014, is recommended. Detection frequency by original station at RM 404.0 was better than at the downstream Priest Rapids forebay station at RM 398.1 and the new station would provide additional movement and seasonal use information in the lower Priest Rapids Reservoir.

2014BY Juvenile Entrainment

In total, 7 of 48 (14.6%) acoustic-tagged 2014BY White Sturgeon released in Wanapum Reservoir were entrained into Priest Rapids Reservoir. Entrainment events occurred from May to October 2015, with additional entrainment events in June, July, and August. In 2015, Columbia River flows were exceptionally low and water temperatures high; however, an obvious relationship between entrainment and these environmental conditions was not apparent.

The acoustic-tagged 2014BY White Sturgeon entrained in 2015 exhibited movement patterns prior to entrainment that could be categorized into two general groups based on the amount initial upstream and downstream movement exhibited by the fish. One group of fish moved either initially downstream of the release site or were only detected in the vicinity of the release site, sometimes for an extended period of time. Three of the entrained fish (i.e., tags 22392, 22405, and 22410) that exhibited this behavior were entrained within approximately one month after release (range 10 to 37 days), while a fourth fish (i.e., tag 22430) that behaved in a similar manner was entrained in October, 155 days after release. The second group was different in that these fish (i.e., tags 22393, 22394, and 22403) initially moved a substantial distance upstream from the release site (i.e., up to Rock Island Dam) and subsequently returned downstream to the Wanapum forebay, after which the fish were entrained. After entrainment, movements of five of the seven entrained fish notably decreased.

Overall entrainment percentage (all releases in all years combined) from Wanapum Reservoir into Priest Rapids Reservoir increased from 8.2% in 2014 to 9.8% in 2015 (Table 24). Out of all brood year hatchery releases, the 2014BY experienced the highest entrainment rate (14.6%). Based on preliminary data, fish released at downstream release sites are subject to higher entrainment rates than fish released at upstream sites. At these downstream release sites, entrainment rate also appears to depend on which river bank (i.e., east or west bank) the fish are released. Located on the east bank, the Frenchman Coulee Launch is nearer to the original river channel where water depth and velocity are greater. In contrast, the Rocky Coulee Launch (now closed) where the 2013BY were released is located on the west bank and is surrounded by expansive shallow mud flats. The physical release site attributes at Frenchman Coulee (i.e., proximity to deep fast moving water) may have resulted in increased entrainment of the 2014BY if a portion of these fish had a behavioral propensity to move downstream after release; however, in the absence of additional entrainment data to support this finding, Frenchman Coulee remains the preferred release location in Wanapum Reservoir.

The overall percentage of fish (all releases combined) entrained from Priest Rapids Reservoir into McNary Reservoir decreased from 4.9% in 2014 to 3.6% in 2015. This low entrainment rate may reflect the low detection probability of the receiver station below Priest Rapids Dam, due in part to the shallow and fast flowing riverine conditions below the dam. Re-deployment of a monitoring station below Priest Rapids Dam at RM 396.1 and deployment of a second monitoring station further downstream at RM 384.1 may increase future detections of entrained fish. Acoustic range testing at these new stations was conducted; however, the amount of data recorded below Priest Rapids Dam to date has been limited and the detection efficiency of these new shallow water stations under all seasonal flow conditions (e.g., high spring flows with elevated dissolved gas) remains uncertain.

Table 24 Entrainment rate for acoustic tagged juvenile White Sturgeon released into the Priest Rapids Project area between 2011 and 2015, detailed by release pool, year, and dam of entrainment.

Release Details				**Entraining Dam (RM)**	**Number Entrained**	**Percent Entrainment (%)**
Pool	**Year**	**N**	**Release RM**			
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
Subtotal		**56**			**2**	**3.6**
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
Wanapum	2014 (2013BY)	52	421.5	Wanapum (415.6)	3	5.8
Wanapum	2015 (2014BY)	48	424.5	Wanapum (415.6)	7	14.6
Subtotal		**194**			**19**	**9.8**

Spawn Monitoring and in situ Egg Incubation

Evidence of White Sturgeon spawning below Rock Island Dam was obtained during the 2015 spawn monitoring program by the collection of 916 eggs. Egg capture data based on the date of egg capture, developmental stage, and water temperature indicated that seven individual spawning events likely occurred during monitoring in 2015. Daily inspection of the egg collection mats facilitated the collection of early stage eggs and the identification of new spawning events, which would have been more difficult to identify if the interval between mat inspections were longer (e.g., 48 hours interval vs 24 hours). Use of a microscope camera to document egg developmental stage on the boat, rather that preserving a subsample of eggs for subsequent examination in the lab, proved to be an effective approach that also allowed all captured eggs to be incubated.

Spawn monitoring began on June 12, 2015 on the assumption that peak spawning would start earlier than normal (i.e., typically last week of June and first week in July) due to above average water temperatures and low flows. This assumption was incorrect as eggs were not captured during the first week of monitoring. Consequently, the spawn monitoring study ended early (June 29) and spawn monitoring was not conducted in July when additional spawning may have occurred.

Incubation success of wild spawned eggs (i.e., 13.7%) within the incubator was lower than other White Sturgeon in situ incubation experiments with more simple methods (e.g., suspended egg incubation cassettes) that have reported higher egg hatch success (i.e., 83%; Golder 2011), even though these approaches required manual handling of eggs and loading of incubation cassettes. In 2015, low egg hatch success was due to fungal infection of the eggs, as opposed to mortality of hatched larvae, specifically related to the use of MacDonald incubation jars. A portion of the eggs initially added to the jars likely had low-level fungal infection, but these infected egg were difficult to detect with the unaided eye. Contact between these infected eggs and healthy eggs, due in part to variable flow rates and reduced circulation within the jar, resulted in the spread of fungus within the MacDonald incubation jars and high egg mortality. Close contact of eggs incubated at high density within the jars was considered a primary factor that contributed to egg mortality. If *in situ* incubation efforts are used in the future, wild spawned eggs should only be incubated at low densities with MacDonald jars. Flow conditions within the jar and egg health should be monitored closely. As an alternative incubation approach, loose eggs removed from the mat material could be incubated in smaller groups within modified incubation cassettes, isolated from each other within the incubator, to limit the spread of fungal infection.

A second source of egg mortality was likely due to handling of eggs during mat processing and manual removal of eggs from the mat material, especially on hot days with high ultraviolent light indices. Egg handling should be reduced when possible. Effective overhead cover and a mat irrigation cooling system would also mitigate mortality associated with egg processing and handling. Assuming these proposed changes would reduce egg mortality during incubation, based on a conservative estimate, it is feasible that, in years with egg capture rates similar to 2015, future wild spawn egg capture programs below Rock Island Dam could provide between 500 and 800 live larvae for hatchery rearing.

Adult Indexing

A primary objective of the adult indexing program was to assess the remaining wild White Sturgeon population in terms of growth and abundance. Due to low numbers of wild fish recaptured, previous wild fish abundance estimates were based on CRITFC hatchery fish abundance estimates and catch proportion of wild fish of total catch (Golder 2011, 2013).

A strength of the adult indexing programs in 2010, 2012, and 2015 was that all three programs involved a similar level of effort applied at the same time of year (i.e. September and October each year). Bias in catch due to systematic sample site selection in 2010 versus GRTS sample site selection in 2012 and 2015 was likely not a large influence on catch; however, a minor change in gear type between the two field crews in 2012 (differences in ground line diameter and braid, set line anchor weight; Chi square = 6.647; p = 0.01) resulted in a large difference in catch-per-unit-effort (CPUE) between the two crews. Overall, the findings during the 2015 study were similar to previous indexing studies in terms of documented growth, catch rates, and distribution of wild fish and CRITFC hatchery fish. Substantially more MDH hatchery fish were caught in 2015, relative to the 2010 and 2012 efforts, as these fish grew and recruited to the set line gear. Catches of hatchery fish will continue to increase during future adult indexing studies as these fish grow and fully recruit to the gear. This will require more effort to obtain sufficient recaptures of wild adults upon which to develop reasonable population estimates. Key findings during the 2015 adult indexing study were as follows:

- Overall CPUE in 2015 (0.44 fish/100 hook-hours) was comparable to the 2010 adult indexing study (0.46 fish/100 hook-hours), while CPUE during the 2012 study was lower (0.26 fish/100 hook-hours). The lower CPUE in 2012 was likely related to difference in gear type between crews.
- The proportion of wild fish of the total catch for Wanapum Reservoir in 2015 (14.1%; 57 of 405 fish caught) was similar to 2010 (12.1%; 53 of 439 fish caught) and 2012 (13.5%; 30 of 223 fish caught). All three adult indexing studies captured only a few wild fish in Priest Rapids Reservoir, disproportionately much lower than the Wanapum catch given the size of Priest Rapid Reservoir. One explanation for the low wild fish capture rate in Priest Rapid Reservoir was that wild adults may be highly aggregated in a location near Wanapum Dam that cannot be readily sampled with set lines (e.g., spillway scour pools, scours adjacent to the fish bypass, etc.).
- Indexing catch distribution and CPUE by river mile was examined in 2015 for both Wanapum and Priest Rapids reservoirs. Area-based GRTS sample selection and CPUE data provided an indication of where high densities of sturgeon aggregate in the large lower and middle section of Wanapum and Priest Rapids reservoirs. Given that sturgeon can aggregate at high densities in relatively small areas, there are potentially aggregations of sturgeon at moderate densities in the upper sections of each reservoirs, but these areas were not sampled extensively using GRTS due to the smaller areal extent of the upper reservoir relative to the large lower sections. Flow and habitat conditions differ between the upper sections (i.e., more riverine) and lower sections (i.e., more lacustrine) of each reservoir. Although substantially smaller on an areal basis, the productivity and the resources available to sturgeon in the upper section of each reservoir are assumed to be considerable (e.g., extensive bivalve beds, entrained fish, etc.) and potentially could support moderate densities of sturgeon. In future studies, further stratification of the reservoirs should be considered, possibly based on previous catch data and acoustic telemetry, to refine GRTS sample selection to concentrate sample effort at areas where sturgeon aggregate in order to increase catch efficiency.

- The growth and length frequency distribution of wild fish captured in 2015 was consistent with previous studies; however, a comparison of 2015 catch data with pre-2015 catch data provided the most insight. Mature wild fish first captured 15+ years ago from 1999 to 2001 have grown relatively little in terms fork length. The relatively minimal increase in fork length of these fish likely reflects energetic demands associated gonad development and spawning. Weight of the older mature fish was variable and dependent on gonad maturity at time of capture. Small and medium sized juveniles and sub-adults wild fish captured 15+ years ago have exhibited high growth rates since their original capture. A comparison of 2010, 2012, and 2015 length- frequency data of CRITFC hatchery fish clearly indicates that annual growth of these fish is substantive. Some of the CRITFC fish captured in 2015 weighed in excess of 45 kg and several captured males were considered mature, based on gonad inspection, and likely have the potential to spawn. CRITFC fish have dominated catches in the past and will continue to do so during future adult and juvenile indexing programs. The presence of large numbers of aggressively feeding CRITFC fish has the potential to affect the ability of future indexing efforts to identify changes in the populations of MDH hatchery fish and wild fish.
- In total, 75 MDH hatchery fish were captured during the 2015 adult indexing study, with individuals captured from all brood years released to date. A comparison between 2015 capture data and size at release supports the 2014 juvenile indexing study results that the MDH hatchery fish continue to grow. As previously mentioned, the growth estimates generated from this survey are biased high due to gear selection for the largest, fastest growing hatchery fish.
- The Wanapum Reservoir 2015 CRITFC hatchery (n = 1,251-CI (204-2,298)) and wild (n = 249-CI (36-462)) sturgeon population estimates using R-Mark were highly uncertain and were considered unreliable because of assumptions needed for model convergence. These issues were primarily due to low recapture rates and uncertainty regarding emigration/loss of individuals from the population. Improvement of the population estimate would require increasing the total fish recapture rate.
- Harvest to reduce the CRITFC fish population has been proposed, and 49 CRTIFC were culled by Grant PUD biologists during 2015 indexing study, with an additional 20 fish culled post-study. Removal of the CRTIFC fish has the potential to increase captures and recaptures of target juvenile hatchery and adult wild sturgeon by reducing competition for the gear. In addition, if CRITFC fish were less abundant in the catch, the time required to process these fish would be reduced, which would allow more effort (e.g., possibly 25% more) to be applied to capture the target cohorts.

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Appendix A
2015 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: June 8, 2015

SUBJECT: Broodstock Collection Below McNary Dam in 2015

For the fifth consecutive year professional fishing guides were utilized to capture white sturgeon (*Acipenser transmontanus*) broodstock for the Mid-Columbia sturgeon recovery effort. As in the previous four years, beginning in 2012, fishing took place in the white sturgeon spawning sanctuary below McNary dam on the Columbia River. This year the effort was jointly supported by Chelan County PUD and Grant County PUD. Previous broodstock collection efforts are summarized in the report titled, White Sturgeon (*Acipenser transmontanus*) Broodstock Collection with Professional Fishing Guides in 2011 and 2012, submitted to Chelan PUD in July 2012. Please refer to this document for background information on the study site and methods used.

In 2015, fishing took place over 12 days from the 7th to the 18th of May. Fishing began 9 days earlier than any of the previous year's efforts due to the warm water temps that were approximately 13 days ahead of the ten year mean river temperature. Effort was increased this year with two boats fishing 8 of the 12 days and three boats fishing the remaining four days, for a total of 28 boat days. A total of 149 individual white sturgeon were captured and 4 of these fish were captured twice for a 153 sturgeon landings. Of the individuals captured, 92 were greater than 150 cm, or mature spawning sized sturgeon, and 57 were less than 150 cm. Length and girth relationship is shown in Figure 1. In total, 15 ripe females and 13 ripe males were transported to Marion Drain Hatchery. Four of the females were unable to be spawned because the polarization index (PI) value on their eggs was unsuitable. On the 28th and 29th of May 8x10 and 1x5 spawning matrices were performed producing 85 families of brood.

Due to the increased fishing effort, the mean number of fish captured per day went up from 6 in 2014 to 13 in 2015. Additionally the mean number of fish per boat per day also went up from 3.3 in 2014 to 5.5 in 2015, indicating fishing conditions were better overall in 2015. A complete summary of capture history and biometrics are found in Table 1.

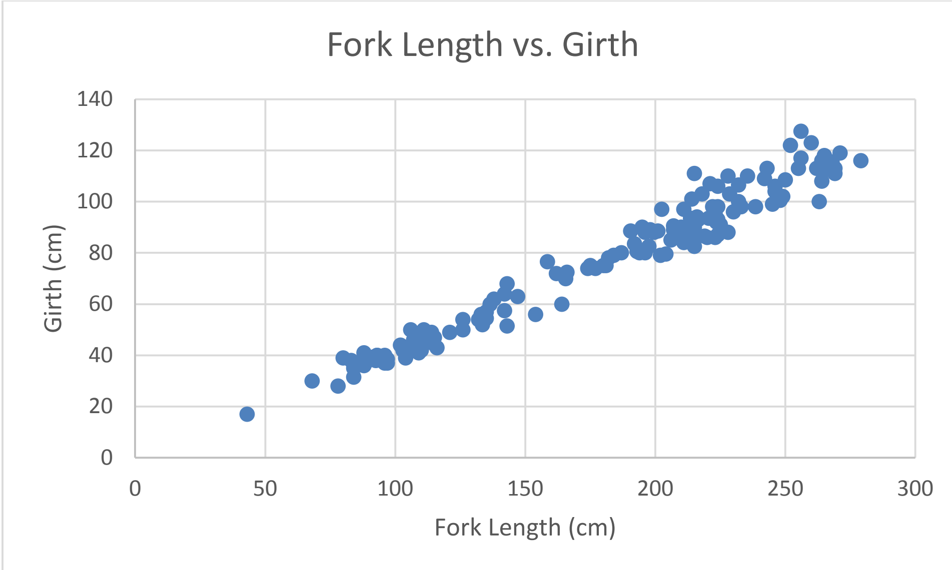

Figure1. Relationship of fork length to girth in cm.

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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, Stuart Hurd from Hurd's Guide Service, and Rob Curret 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	Total	Girth (cm)	Fate	Tagged	MARK @ Capture	PIT
1	5/7/2015	Female	224	253	93	hatchery		L2	3D9.1C2DCB541F
2	5/7/2015	UNK	126	145	54	released		L2	
3	5/7/2015	UNK	96.5		38.5	released	PIT		3DD.00775358A2
4	5/7/2015	Male	249	278	102	released	PIT		3DD.0077536116
5	5/7/2015	Female	264	278	116	released	PIT		3D9.1C2DF16AD0
6	5/7/2015	Female	246	270	106	released	PIT		3D9.1C2DF1299B
7	5/7/2015	UNK	138		62	released	PIT		3D9.1C2DECB4C9
8	5/7/2015	Male	210	228	90	released	PIT		3D9.1C2DF1943B
9	5/8/2015	Female	215	243	111	released		L2	
10	5/8/2015	UNK	133	156	56	released		L2	3D9.1BF1BB545A
11	5/8/2015	Female	262	294	113	hatchery			
12	5/8/2015	UNK	143	165	68	released			3DD.0077534980
13	5/8/2015	Female	263	292	100	released	PIT		3D9.1C2DF1A972
14	5/8/2015	UNK	93		40	released	PIT		3D9.1C2DECCFBC
15	5/8/2015	UNK	113		46	released	PIT		3D9.1C2DF1BFD4
16	5/8/2015	UNK	80		39	released	PIT		3D9.1C2DF19A4E
17	5/8/2015	Male	220.5	241.5	93.5	hatchery		L2	3D9.1C2D2F79CD
18	5/8/2015	Male	180	200	75	hatchery		L2	3D9.1BF139B6E0
19	5/8/2015	Male	214	236	84	released		L2	3DD.007753466E
20	5/8/2015	UNK	112		45.5	released	PIT		3D9.1C2DF142AE
21	5/8/2015	UNK	126		50	released	PIT		3D9.1C2DF12DCD
22	5/9/2015	Male	228	258	110	hatchery	PIT		3D9.1C2DF1AD04
23	5/9/2015	Male	215	244	90	hatchery	PIT		3D9.1C2DF18CBA
24	5/9/2015	Female	260	287	123	released	PIT		3D9.1C2DF15CCD
25	5/9/2015	UNK	68		30	released	PIT		3D9.1C2DF17E1F
26	5/9/2015	Female	250	299	108.5	released	PIT		3D9.1C2DF14FB4
27	5/9/2015	Male	195	220	90	hatchery	PIT		3D9.1C2DF1AC61
28	5/9/2015	Female	265	286	118	released		L2	3D9.1C2DCC40FF
29	5/10/2015	Male	199.5	229	88	hatchery	PIT	L2,3,8 R3,7,11	3D9.1C2DF1B788
30	5/10/2015	Female	230	256	96	released		L2	3D9.1C2DF5DEEA
31	5/10/2015	Male	228	253	88	released		L2	3D9.1C2CDA2ADC
32	5/10/2015	Female	252	281	122	hatchery	PIT		3DD.00775392EE
33	5/10/2015	Male	192	222.5	83.5	hatchery		L2	3D9.1BF101AC03
34	5/10/2015	Female	264	289.5	108	released			3D9.1C2DF15A41
35	5/10/2015	UNK	97		37	released		L2 R9	3D9.1C2E0ABD33
36	5/10/2015	UNK	43		17	released	PIT		3D9.1C2DF1BF41
37	5/10/2015	Male	209.5	233	86	hatchery		L2	3DD.00775330EB
38	5/10/2015	UNK	135		54.5	released		L2,11,12	3D9.1BF233DBC1
39	5/10/2015	Male	214	240	101	released		L2	3D9.1C2DF59FC2
40	5/11/2015	Male	225	249	91	released	PIT		3D9.1C2DF1C06C
41	5/11/2015	Male	193	217.5	80.5	released		L2	3D9.1BF2640BFC

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

No.	Date	SEX	Fork	Total	Girth (cm)	Fate	Tagged	MARK @ Capture	PIT
42	5/11/2015	UNK	164	188	60	released	PIT		3DD.0077530481
43	5/11/2015	Female	202.5	223	97	released	PIT	R7,8,9 L11,16,18	3DD.007752CF1E
44	5/11/2015	Female	238.5	271	98	hatchery	PIT		3DD.0077525EB8
45	5/11/2015	Female	190.5	216	88.5	hatchery	PIT		3D9.1C2DF1A9C8
46	5/11/2015	UNK	112	127	45.5	released		L2	3D9.1BF1C526A2
47	5/11/2015	UNK	109	124	45	released		L2	3D9.1BF10E9FBC
48	5/11/2015	UNK	84	96	31.5	released	PIT		3DD.0077535CA2
49	5/11/2015	Female	222	246	98	hatchery		L2	3D9.1C2DEC5E77
50	5/11/2015	UNK	147		63	released		L2, R7	3D9.1BF26401DA
51	5/11/2015	UNK	142		64	released	PIT	R3,10,11	3D9.1C2DEC4F28
52	5/11/2015	UNK	143		51.5	released	PIT		3D9.1C2DF14F18
53	5/11/2015	Female	224	254	87	released	PIT	L7	3D9.1C2DF1AD9F
54	5/12/2015	Male	232	260	106.5	hatchery	PIT		3D9.1C2DF1A62E
55	5/12/2015	Male				released		L2	3DD.0077536116
56	5/12/2015	UNK	114		45	released	PIT		3D9.1C2DF17D57
57	5/12/2015	Male	248	272	100.5	hatchery	PIT		3D9.1C2DECA63D
58	5/12/2015	UNK	97		38.5	released			3D9.1C2DF16234
59	5/12/2015	Male	201	225	88.5	released	PIT		3D9.1C2DF15C39
60	5/12/2015	UNK	135	154	57	released	PIT		3DD.007753582B
61	5/12/2015	UNK	115	129	47	released	PIT		3DD.00775321B9
62	5/12/2015	Male	206	236	85	released		L2,7 R11	3D9.1C2D8F4DFF
63	5/12/2015	Male	187	210	80	released		L2 R10,11	3D9.1BF268ED0E
64	5/12/2015	UNK	92.5	107	38	released	PIT		
65	5/12/2015	Male	158.5	182.5	76.5	released	PIT		3D9.1C2DEC50FA
66	5/12/2015	Female	218	250.5	103	released	PIT		3D9.1C2DF1A610
67	5/12/2015	Female	213.5	242	93.5	released		L2	3D9.1C2DCBB852
68	5/13/2015	Male	211	237.5	97	released		L2,9	3D9.1BF1023513
69	5/13/2015	Female	255	287	113	hatchery	PIT		3DD.00775350BB
70	5/13/2015	UNK	102	117	44	released	PIT		3DD.0077531C65
71	5/13/2015	Female	232	259	100	hatchery	PIT		3DD.0077532106
72	5/13/2015	UNK	166		72.5	released		L2	3D9.1BF1C5268A
73	5/13/2015	UNK	88		36	released		L2 R1,2,3,10	3D9.1C2DCBB792
74	5/13/2015	Male	196	219	80	hatchery	PIT		3D9.1C2DF129EF
75	5/13/2015	UNK	106		50	released			3D9.1BF1C759C6
76	5/13/2015	Male	219	242.5	86.5	hatchery		L2,9	3D9.1BF10E8892
77	5/13/2015	UNK	110		42	released		L1,8	3D9.1BF10E755D
78	5/13/2015	Female	256	293	117	released	PIT		3D9.1C2DEC5985
79	5/14/2015	UNK	133.5	150	52	released	PIT		3DD.00775340B4
80	5/14/2015	Male	223	248	95	released	PIT		3DD.0077533FF4

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

No.	Date	SEX	Fork	Total	Girth (cm)	Fate	Tagged	MARK @ Capture	PIT
82	5/14/2015	UNK	162	184	72	released		L2	3D9.1BF1C5268A
83	5/14/2015	Female	196	224	88	released	PIT	L2,7,9	3DD.007752733A
84	5/14/2015	UNK	96	109.5	37	released	PIT		3DD.0077529A4A
85	5/14/2015	Female	228.5	245	103	released	PIT	L13	3DD.007752A4A7
86	5/14/2015	Male	207	232.5	90.5	released	PIT	L17,24 R9,21,25,31,33	3D9.1C2DECDE53
87	5/14/2015	Female	221	250	107	hatchery	PIT	L2,7	3D9.1C2DF1A688
88	5/14/2015	Female	256	290	127.5	released	PIT		3D9.1C2DF1773A
89	5/14/2015	UNK	181	206.5	75	released	PIT		3D9.1C2DF16FF7
90	5/14/2015	Female	235.5	263	110	hatchery		L2,8,9	3D9.1BF10E1BDE
91	5/15/2015	UNK	84	95	35	released			
92	5/15/2015	UNK				released			3D9.1C2DF1C06C
93	5/15/2015	UNK	132	150	54	released			
94	5/15/2015	UNK	88	99	41	released			
95	5/15/2015	UNK	116	133	43	released			
96	5/15/2015	UNK	111		50	released		L2	3D9.1BF1D145F3
97	5/15/2015	Male	184	204	79	released		L2	3D9.1C2E0AAA13
98	5/15/2015	UNK	83		38	released	PIT		3DD.007752BA1C
99	5/15/2015	UNK	105		43	released		L2	3DD.007752A996
100	5/15/2015	UNK				released		L2	3D9.1C2DF7E2BD
101	5/15/2015	Female	212	240	86	released	PIT		3D9.1C2DF1BA07
102	5/15/2015	Female	246	278	104	released	PIT	R17,18,21	3DD.0077530EBA
103	5/15/2015	Male	224	256.5	106		PIT		3D9.1C2DEC9534
104	5/15/2015	UNK	92	105	39.5	released	PIT		3D9.1C2DF15AE5
105	5/15/2015	UNK	96.5	110.5	38	released		L2	3DD.007753235C
106	5/15/2015	UNK	88.5	102	37	released		L2	3DD.0077526FD2
107	5/15/2015	UNK	93	106	40	released		L2	3D9.1C2D2F7CCA
108	5/15/2015	Male	220	246	86	released	PIT		3D9.1C2DF12E18
109	5/15/2015	UNK	87.5	102	37	released	PIT		3D9.1C2DF141E0
110	5/16/2015	Male	224	254	98	released	PIT		3D9.1C2DECC830
111	5/16/2015	UNK	114	130	49	released	PIT		3D9.1C2DF1A7E1
112	5/16/2015	Male	233	254	98	released		L2 R20	3DD.0077537673
113	5/16/2015	Female	279	307	116	released	PIT		3D9.1C2DF167AD
114	5/16/2015	UNK	107	121	46	released		L2	3D9.1C2D674734
115	5/16/2015	UNK	142		57.5	released		L2,9 R9	3D9.1C2CDADD17
116	5/16/2015	Male	175	196	75	hatchery	PIT		3D9.1C2DF1A068
117	5/16/2015	Male	223	247.5	86	released	PIT		3D9.1C2DF1735D
118	5/16/2015	Female	264.5	292.5	112	hatchery	PIT		3DD.007752E04F
119	5/16/2015	Female	268	298	115.5	released	PIT		3DD.007752701B
120	5/16/2015	Male	182	207	78			L2 R11	3D9.1BF1B74A32
121	5/16/2015	Male	223.5	248	92	released	PIT		3D9.1C2DF14F1B

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

No.	Date	SEX	Fork	Total	Girth (cm)	Fate	Tagged	MARK @ Capture	PIT
123	5/16/2015	UNK	215	239.5	82.5	released	PIT	L2	3D9.1C2DF1ACF9
124	5/16/2015	Female	269	298	111	released	PIT		3D9.1C2DECDFA1
125	5/16/2015	UNK	165.5	188	70	released		L2	3DD.0077527D44
126	5/16/2015	Female	198	219.5	89	released		L2,9	3D9.1BF10E7FA2
127	5/17/2015	Male	202	225	79	released	PIT		3D9.1C2DECD347
128	5/17/2015	Male	194	211	80	released	PIT		3D9.1C2DF1A1AB
129	5/17/2015	Male	174	195.5	74	released			3D9.1BF2695FDE
130	5/17/2015	UNK						L2	3D9.1C2DF1ACF9
131	5/17/2015	Male	245	274	99	released		L2 R20	3D9.1C2DB99A6A
132	5/17/2015	UNK	106	114		released		L2	3D9.1C2CDA2B07
133	5/17/2015	Male	207	232	89	released	PIT		3D9.1C2DF15CC4
134	5/17/2015	UNK	109	124.5	41	released	PIT		3D9.1C2DF198FB
135	5/17/2015	Female	216	243.5	94	hatchery	PIT	L7	3D9.1C2DF162E8
136	5/17/2015	Female	269	301.5	113	released		L2	3DD.0077531486
137	5/17/2015	UNK	121		49	released	PIT		3DD.007752D57F
138	5/17/2015	UNK	154		56	released		L1,3,12 R9	3D9.1BF264B5D8
139	5/17/2015	UNK	104		43	released	PIT		3DD.007752BA1D
140	5/17/2015	Female	214	243	86	released	PIT	L2 R15	3D9.1C2DECBA0C
141	5/17/2015								3D9.1C2DEC50FA
142	5/17/2015	UNK	204	230.5	79.5	released	PIT		3D9.1C2DEC8B54
143	5/17/2015	Male	216.5	245	93	released	PIT		3D9.1C2DF1B651
144	5/17/2015	Male	211	223	84	released	PIT		3D9.1C2DF17787
145	5/17/2015	UNK	136.5	153	60	released	PIT		3D9.1C2DF1A6F1
146	5/18/2015	UNK	103	116	42	released	PIT		3D9.1C2DF1865C
147	5/18/2015	Female	242	270	109	hatchery	PIT	L2,7 R2,4	3D9.1C2DECBDC6
148	5/18/2015	UNK	109	120	44	released		L2,7,8,9 R2	
149	5/18/2015	Female	243	269	113	hatchery		L2,9	3D9.1BF10E81DC
150	5/18/2015	UNK	96	109.5	40	released		L2	3D9.1BF233B3EA
151	5/18/2015	UNK	104	119	39	released	PIT		3D9.1C2DEC8406
152	5/18/2015	Female	271	308	119	released	PIT		3D9.1C2DECE664
153	5/18/2015	Female	197.5	220	82.5	hatchery		L2,9	3D9.1BF10DE3E2
154	5/18/2015	UNK	177	199	74	released		L2	3D9.1BF1B5E6A1

Appendix B
Pilot White Sturgeon Larvae Collection in Bonneville and The Dalles Reservoirs, Columbia River, 2015

Pilot White Sturgeon Larvae Collection in Bonneville and The Dalles Reservoirs, Columbia River, 2015

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Abstract

Beginning in 2010, both the Chelan and Grant Public Utility Districts initiated White Sturgeon hatchery supplementation programs to produce juvenile fish for stocking into the Rocky Reach and Priest Rapids project areas. Initial efforts relied on direct gamete take from limited numbers of wild broodstock, however interest has increased in an alternative approach of using naturally produced larvae as an additional source of progeny for the programs. In 2015, the Washington Department of Fish and Wildlife (WDFW) initiated a one-year pilot study to investigate the potential of successfully capturing significant numbers of larvae produced from White Sturgeon populations spawning downstream of John Day and The Dalles dams for rearing in these hatchery supplementation programs. Specific objectives were to: 1) identify larvae collection sites within Bonneville and The Dalles reservoirs below known White Sturgeon spawning locations in 2015; 2) determine larvae capture rates by reservoir and collection site; 3) evaluate daytime versus overnight net sets; 3) measure debris loads for the different set types; 4) estimate collection effort required for future years; and 5) if feasible, experiment transporting and culturing larvae.

Drift-fishing plankton nets, comprised of a rigid frame supporting one or two nets with large 6-gallon collection buckets, were deployed on the riverbed to capture sturgeon larvae. Plankton nets were deployed either overnight or through the day on 80 separate occasions from 28 May through 24 June. The gear fished a total of 1,150 hours, but only six White Sturgeon larvae were captured. Two issues likely contributed to this result. First, we were challenged by the rough water and powerful upstream winds common to the Columbia River Gorge that limited the number of locations judged safe to successfully deploy nets without entangling in the vessels propeller. This issue is something that could be addressed through structural modifications to the vessel's davit arm. Second, river discharge and water temperatures during 2015 in this section of the Columbia River were unusually low and warm due to an ongoing drought. We suspect that this may have altered normal spawning activity, resulting in female sturgeon either delaying or abandoning spawning during the period sampled. Further prospecting under normal river conditions is warranted before eliminating this section of the Columbia River as a productive source of sturgeon larvae for supplementation programs.

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Introduction

Construction of dams on the Columbia River is believed to have negatively impacted White Sturgeon (*Acipenser transmontanus*) through river regulation, habitat alteration, and increases in predators due to flow and habitat manipulations. Populations of sturgeon isolated in the reservoirs between Priest Rapids and Chief Joseph dams contain low numbers of spawners and experience complete or frequent annual spawning and/or recruitment failures. Populations in these reservoirs have not experienced any significant increases in abundance for several decades.

As stipulated in the Washington Department of Ecology's 401 Water Quality Certifications, Public Utility Districts No. 1 and No. 2 of Chelan County (CPUD) and Grant County (GPUD), respectively, are required to develop and implement White Sturgeon Management Plans (WSMP) for the Rocky Reach and Priest Rapids project areas. Both WSMPs identify the use of hatchery supplementation to increase White Sturgeon populations to levels commensurate with available reservoir habitats.

In 2010, CPUD and GPUD initiated White Sturgeon hatchery supplementation programs to produce juvenile fish for stocking into the Rocky Reach and Priest Rapids project areas. Both hatchery supplementation programs were modelled off established programs on the Kootenai River in Idaho and the Upper Columbia River in British Columbia. Wild brood stock captured from select Columbia River reservoirs (primarily Wanapum and John Day) were transported to the Yakama Nation's Marion Drain Sturgeon Hatchery and then spawned in a full or partial factorial mating design. Progeny were raised in the hatchery environment for one year and then released into both project areas.

Recently, resource managers have raised concerns over the genetic risks of stocking yearling sturgeon produced from low numbers of parents. Genetic risks identified include low overall genetic diversity (i.e., number of alleles), high relatedness, common ancestry of hatchery progeny, and outbreeding depression. For sturgeon culture, an alternative to the conventional brood stock program is to collect the larval stage from the wild and raise them to yearlings in a hatchery. Post-hatch and yolk sac absorption (15-22 days) larval sturgeon drift downstream in fast flowing currents to colonize a variety of habitat types within a particular river system. Pioneering studies in the early 1980s on the Columbia River downstream of Bonneville Dam demonstrated that free-drifting sturgeon larvae could be captured using large cone-shaped plankton nets set on the river bottom (Kreitman 1983, Kreitman 1985, Kreitman and Bluestein 1985, Bluestein 1986, McCabe and McConnell 1988, McCabe et. al. 1989, McCabe and Tracy 1994). Similar work confirmed the gear could also successfully capture White Sturgeon larvae in Columbia River impoundments (Palmer et.al. 1988, Parsley et.al. 1989, Parsley et.al. 1993). More recently, the Washington Department of Fish and Wildlife (WDFW) refined techniques to scale up collection by constructing net frames featuring openings for two plankton nets and by incorporating large collection buckets (Howell and McLellan 2014).

The use of larvae for hatchery supplementation was first employed in the Great Lakes Basin to bolster Lake Sturgeon (*Acipenser fulvescens*) populations. This method was later adopted by resource managers to supplement White Sturgeon in Lake Roosevelt on the upper Columbia River. The benefits of using wild-origin larvae over progeny produced from a conventional brood stocking program is captured larvae were produced from randomized breeding, have gone through an initial phase of natural selection, represent significantly more adults, represent greater number of alleles, and have low rates of co-ancestry. Using wild caught larvae also eliminates some of the artificial hatchery selection (e.g., non-randomized breeding, max adult size, limited adult holding space, etc.) inherent in common hatchery practices.

While the benefits of using wild caught larvae for hatchery supplementation are obvious, there is currently no source of larvae for CPUD's and GPUD's stocking programs. Initiating pilot larvae collection in productive areas of the Columbia River is an important first step towards migrating away from conventional brood stock programs.

The Washington Department of Fish and Wildlife proposed to initiate a pilot White Sturgeon larvae collection study in Bonneville and The Dalles reservoirs in 2015. Bonneville and The Dalles reservoirs were selected because of their relatively large adult abundances (between 1,000-2,000 spawners) and potential of being able to capture significant numbers of larvae.

The WDFW proposed to collect free-drifting larvae over a three to four week time period between June and early July, and if feasible, experiment with transporting larvae and culturing them in a hatchery. The objectives of this pilot larvae collection study were to: 1) identify larvae collection sites within Bonneville and The Dalles reservoirs below known White Sturgeon spawning locations in 2015; 2) determine larvae capture rates by reservoir and collection site; 3) evaluate daytime versus overnight catch rates; 4) measure debris loads for the different set types; 5) estimate collection effort required for future years; and 6) if feasible, experiment transporting and culturing larvae.

Methods

Sampling for White Sturgeon larvae was focused in two general areas downstream of The Dalles Dam in Bonneville Reservoir and downstream of John Day Dam in The Dalles Reservoir (Figure 1). Specific deployment sites, shown in Figures 2 and 3, were identified from knowledge of previously reported capture locations of sturgeon early life stages (Parsley and Kofoot 2013, Duke et. al. 1990, Anders and Beckman 1993). Sites selected in Bonneville Reservoir were situated within one of the areas used for sturgeon larvae capture in 2013 by USGS researchers (Parsley and Kofoot 2013).

Site selection took into consideration the need to avoid conflicts with other river users, including barge and tour vessel use of the navigation channel and access to and from marked Tribal setnet fishing sites. Additional consideration was given to our capacity to safely deploy sample gear relative to wind and surface-wave conditions. In this last respect, we observed that locations downstream of Squally Point on the Oregon shore were too exposed to strong west-to-east winds and large waves generated within the long reach west of the point under atmospheric pressure patterns typical from May through August. However, gear was eventually deployed in a section of The Dalles Reservoir just downstream of the HWY97 Bridge known to be exposed to substantial waves under these same summer weather patterns (Figure 3).

Drift-fishing plankton nets were deployed on the riverbed to capture sturgeon larvae. A netting effort consisted of single or paired deployment of a plankton net. Nets were fitted with a large collection bucket specifically designed to minimize harm to fish that are collected. Collection gear, including net frames, plankton nets, collection buckets, and mooring systems, were patterned after those developed by Howell and McLellan (2014) and as described in Method ID 1027 in https://monitoringmethods.org.

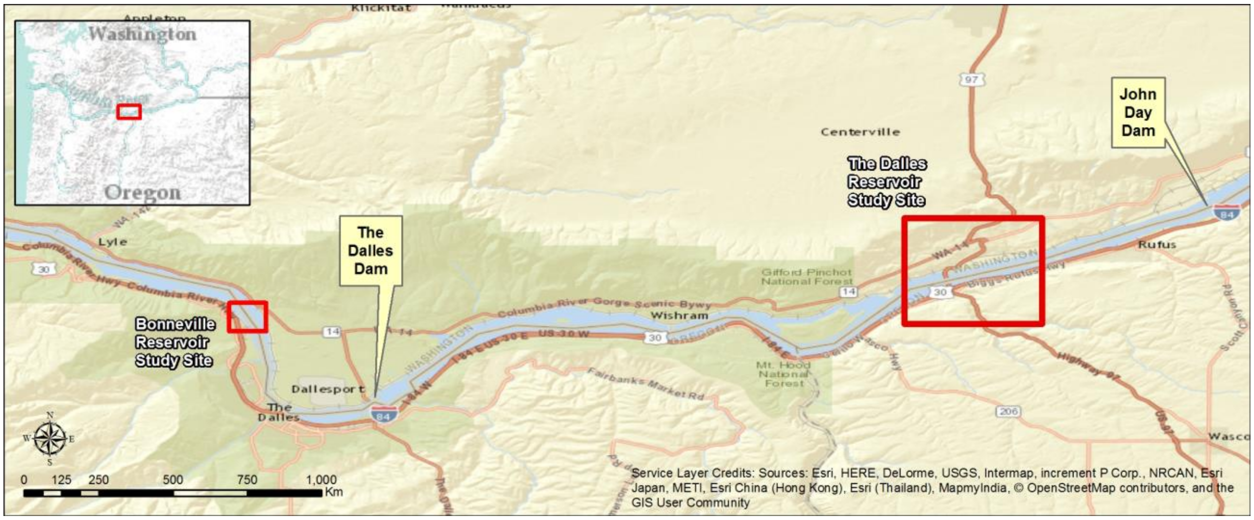

Figure 1. Map showing general locations within Bonneville and The Dalles reservoirs on the Columbia River sampled in 2015 for White Sturgeon larvae collection.

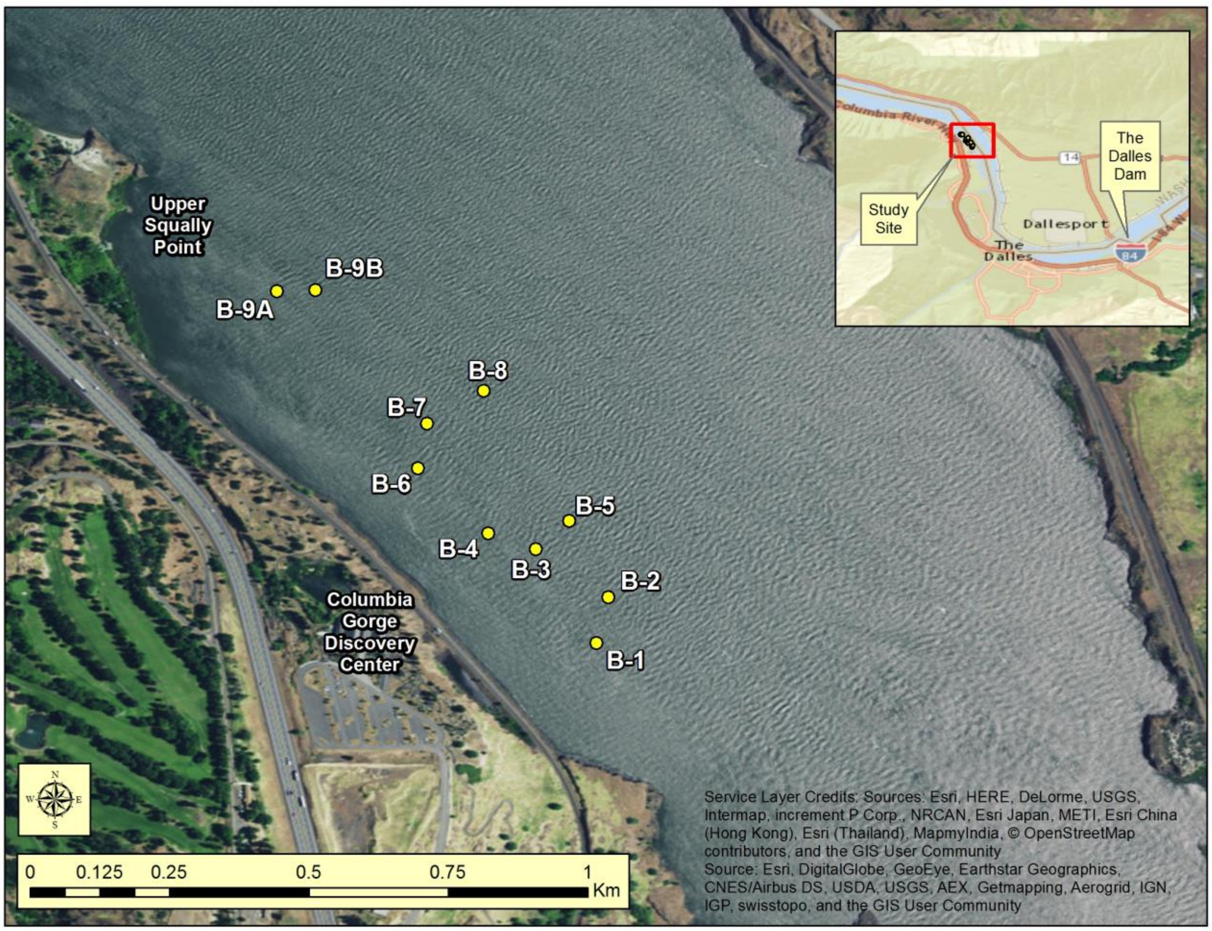

Figure 2. Image showing White Sturgeon larvae sampling station locations in Bonneville Reservoir.

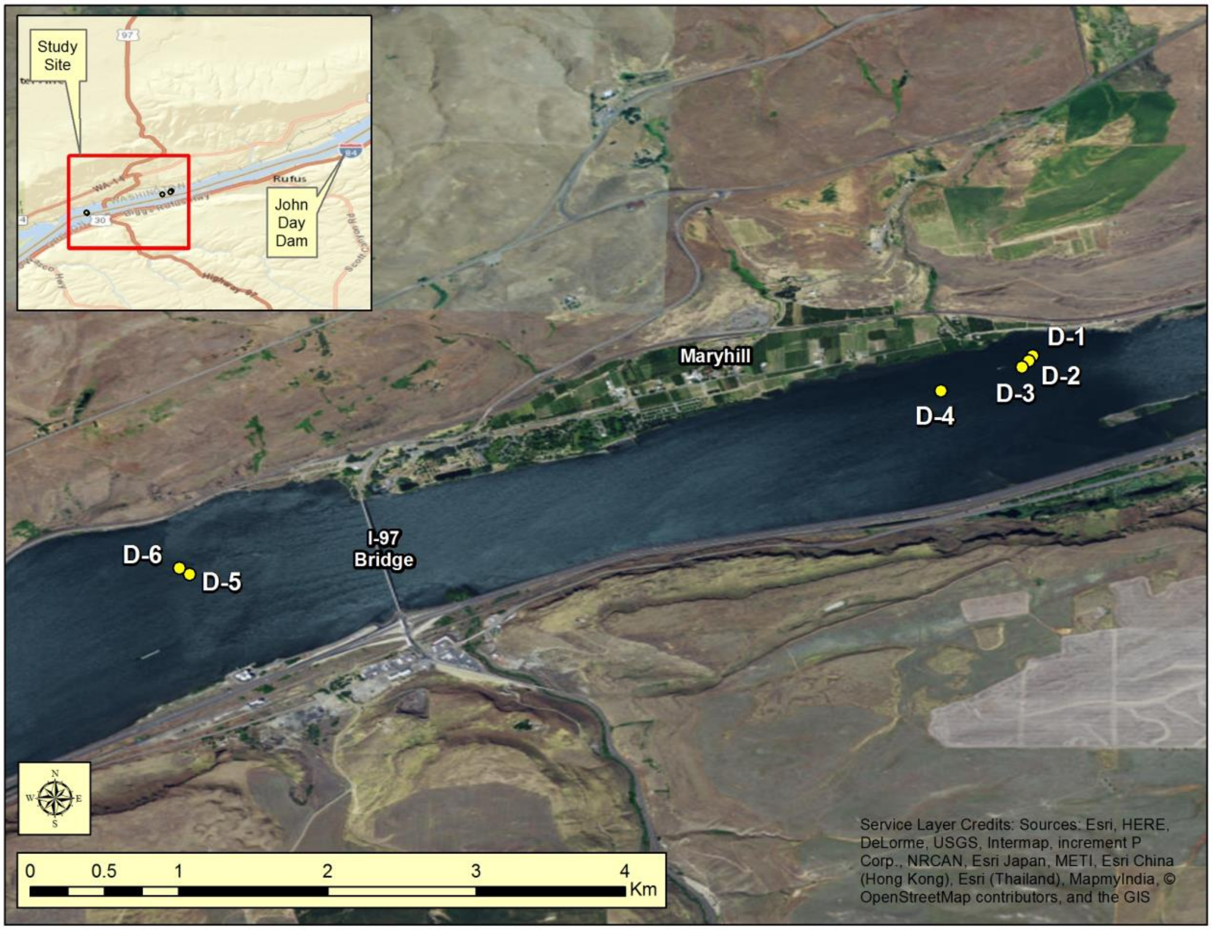

Figure 3. Image showing White Sturgeon larvae sampling station locations in The Dalles Reservoir.

Four net frames previously used elsewhere within the basin to capture sturgeon larvae were borrowed from the Colville Confederated Tribes. These contained two net-openings each (Figure 4). Frames were constructed of square steel tubing welded together to form the openings and incorporated a platform to ensure the frame stood upright. Openings were rectangular in shape, measuring 58 cm tall by 72 cm wide. Openings with nets attached were slightly smaller, by about 4 mm in each direction. We also fabricated two single-opening frames of 33 mm (1-5/16 inch) outside-diameter, 3.175mm (1/8 inch) thick, aluminum tubing (Figures 5 and 6). Straight sections were connected using Hollaender® aluminum structural fittings. Fittings were secured using stainless steel bolts. Openings measured 66.5 cm tall by 73 cm wide (again about 4mm less once nets were attached). The frames could be converted between single and double opening modes by coupling them together. This was done by replacing three of the horizontal members in each frame with tubes 155 cm in length.

Plankton nets were approximately 3.96 m long, tapering to a collar approximately 10.2 cm in diameter where it attached to the collection bucket. Nets were constructed of 1.6 mm knotless delta-mesh by H. Christiansen Company. Buckets consisted of a 22.7 liter capacity screw top type pail (M&M Industries, Inc. 24.6 liter Life-Latch® HDPE container) with five columns of 3.175 cm diameter ports (four per column) cut into sides for water flow. Each port was lined with 750µm Nitex® mesh screen glued to the inside wall of the bucket. The Nitex was further secured using a system developed by Phil Bates, Idaho Power. A plastic sleeve, cut from another bucket, and containing the same size openings, overlay the interior of the bucket and was secured using rivets.

Once suitable sites were identified, the nets were deployed and left to fish for 7 or more hours. General Oceanics model 30307 mechanical flowmeters were suspended at the opening of the nets to estimate water velocity and volume sampled (just one flowmeter was used on the double frames). GPS coordinates were recorded at all netting sites along with water depth and the date and time of net deployment, and retrieval. Nets were checked in both the morning and evening unless prevented by wind and wave conditions. Upon retrieval, the contents of the collection buckets were emptied into transfer buckets for examination at calm off-site locations. These ended up being The Dalles Marina boat basin in Bonneville Reservoir and the dock at the Maryhill boat ramp in The Dalles Reservoir.

The schedule for the field work was based on the estimated timing of spawning and initiation of downstream dispersal of larvae. White Sturgeon spawning normally peaks in Bonneville and The Dalles reservoirs when water temperatures reach 14-15°C (Parsley et.al. 1993). This typically occurs between the fourth week in May and first week in June. Downstream dispersal typically occurs at about 12 days of age (Parsley and Kofoot 2013), so we anticipated starting the first or second week in June to detect the onset of larvae drift. However, river water temperature warmed much sooner in 2015 than is typical. Procurement and construction of sampling equipment was completed in time for an initial test in Bonneville Reservoir on 28 May. This initial collection effort was prospecting in nature, to occur at a reduced rate until catch rates increased. One overnight multi-net set per reservoir was made the second week. Three to four multi-net overnight sets were made the third and fourth weeks in each reservoir, while two multi-net sets per reservoir were made the final week.

Results

Sampling site descriptions for Bonneville and The Dalles reservoirs are presented in Table 1. Ten stations were situated in Bonneville Reservoir within an area approximately 9.9 km to 10.9 km downstream of The Dalles Dam, from rkm 297.9 to rkm 298.9. All were situated off the Oregon side of the river between the navigation channel and shore. The ten stations were placed in the vicinity of the three most successful sites (C, D, and E) used in 2012 by USGS researchers (Parsley and Kofoot 2013). River depths ranged from 15.9 m to 20.1 m.

Six stations were situated in The Dalles Reservoir within two areas, one comprised of four stations approximately 8.7 km to 9.5 km downstream of John Day Dam from rkm 339.0 to rkm 339.7 (the Maryhill site), the second just downstream of the HWY 97 Bridge comprised of two stations approximately 13.0 km to 13.7 km downstream from the dam from rkm 334.8 to rkm 335.5. All were situated off the Washington shore adjacent to the navigation channel. River depths ranged from 8.2 m to 10.7 m.

Once deployed at the start of each week, collection gear was fished continuously unless moved, with a goal of checking it mornings and evenings to reduce accumulation of debris within collection buckets and within the net collar to prevent buildup of algae on the Nitex screens, conditions that compromised collection effectiveness. This schedule was modified when wind conditions were judged too strong to safely access the gear. This occurred twice in both Bonneville and The Dalles reservoirs when evening winds exceeded 30 mph with gusts exceeding 40 mph (real time wind speed data obtained from iWindsurf remote stations Doug's Club-Shred and Maryhill http://wx.iwindsurf.com/), resulting in set durations approaching 24 hours.

Plankton net sampling effort and catch within Bonneville Reservoir is summarized in Table 2. A total of 47 sets were made from 28 May through 24 June, two with the single-net configuration and 45 with the double-net configuration for a total of 92 net-sets. Set duration ranged from 7.7 hours to 23.4 hours with a mean of 14.4 hours for a season total of 675.4 hours of sampling. Overnight deployments comprised 74% of the sets. Water velocity ranged from 0.71 m/s to 1.38 m/s. Water temperature ranged from 16.3°C to 19.8°C. Accumulation of debris was a frequent problem with the sets in Bonneville Reservoir. The volume of debris ranged from 5% to 100% and averaged 24%. Twenty five percent of the time debris had clogged the opening into the collection bucket by the time the net was retrieved.

Only one larval White Sturgeon, a 9+ day old fish, was captured from Bonneville Reservoir (Table 2). That was on 23-24 June, the last day of sampling. Other catch included one juvenile White Sturgeon, juvenile lamprey, cottid species, and other larval and juvenile fish of undetermined species, in addition to numerous aquatic insects and Siberian prawn (*Exopalaemon modestus*).

Plankton net sampling effort within The Dalles Reservoir is summarized in Table 3. A total of 33 sets were made from 3 June through 24 June, 22 with the single-net configuration and 11 with the double-net configuration, for a total of 44 net sets. Set duration ranged from 9.5 hours to 25.6 hours with a mean of 14.4 hours for a season total of 474.4 hours of sampling effort. Overnight deployments comprised 72.7 % of the sets. Water temperature ranged from 17.5°C to 20.2°C. Accumulation of debris was not a problem with the sets in The Dalles Reservoir. The volume of debris ranged from 0% to 15%.

White Sturgeon larvae were captured on two occasions, one 9+ day-old fish on 15-16 June and four 9+ day-old fish from two net-sets on 16-17 June (Table 3). The catch of the single larvae came from one of the stations upstream of the HWY97 Bridge, as did one of the four larvae caught on 16-17 June. The other three came from stations downstream of the bridge. Other catch included one adult White Sturgeon, juvenile lamprey, cottid species, and other larval and juvenile fish of undetermined species, in addition to numerous aquatic insects and Siberian prawn.

Discussion

Past sampling for White Sturgeon larvae by researchers in Lake Roosevelt has demonstrated that catch improves significantly at night. Frequent clearing of collection buckets may even improve catch efficiency if it negates effects of debris and algae buildup. For us, the time of day and how frequently gear was worked was influenced by the on-water conditions we encountered. The section of the Columbia River chosen to prospect for White Sturgeon larvae is frequented by strong west-to-east winds from late spring through summer. Most of the time we encountered wind speeds that ranged from 10-20 mph with gusts to 35 mph, sometimes even stronger. Winds were greatest from afternoon on into late evening. Strong west-to-east winds presented issues for safe operation the boat during deployment and retrieval of gear. The typical approach to accessing deployed gear is to tie off to the anchor line and let the current keep the boat clear of lines and the net as it nears the surface. However, the east-to-west current where we worked was insufficient to overcome prevailing west-to-east winds, which blew the boat upstream over the anchor and float lines and over the net as it neared the surface. To prevent entanglement in the propeller, the boat was continuously powered in reverse to remain clear of lines and net. Clear sight of gear in the water was essential. Because of this, the risk of entanglement of ropes and nets in the prop was judged too great a risk to safely access gear at night.

In light of the safety concerns, we eventually adopted a routine where gear was deployed in the evening before dark and the contents retrieved after first light. We took advantage of the morning and evening trips by leaving gear in place to fish through the day. Timing of evening collection/deployment and morning collection/deployment was affected by travel time between reservoirs (i.e. evening sets in one reservoir may have been placed earlier than preferred in order to get to the sites in the other reservoir before dark).

We learned early on that to safely and efficiently deploy and retrieve plankton net gear in such windy and rough conditions required a three-member crew, with one person dedicated to running the boat at all times while the other two members focused on working the gear. This was a necessary departure from the two person crew we originally intended to use.

Wind and waves also impacted where we were able to examine collection bucket contents. Our samples had to be examined off-site at locations out of the wind and away from waves. This introduced travel time between stations and work-up sites.

Accumulation of debris was an issue at times, especially for near-shore stations which were close to beds of aquatic macrophytes. Debris presence increased following periods of the roughest weather. Volume within collection buckets ranged from 5% to 100%. On 23 occasions (25% of sets), the entrance into the bucket had clogged by the time the net was retrieved. It was unknown how long the gear fished effectively before being clogged. Substantial accumulation of macrophytes within the cod end of the net would suggest a slowing or maybe even a lack of flow through the collection bucket, a consequence of algae obstructing the Nitex screen. If this were occurring, flow of larvae into the bucket may have ceased at some point during the deployment period.

We relied on Parsley and Kofoot (2013) for guidance on scheduling our sampling relative to timing of spawning and larvae dispersal. Initiation of sampling was based on the expectation that White Sturgeon spawning downstream of John Day and The Dalles dams would begin once water temperature reached 12°C and begin to peak once water temperature reached 15°C. The presence of fish approximately 12 days of age, the age that downstream dispersal reportedly occurs, was anticipated to increase about a week after water temperature reached 15°C. In 2015, ambient Columbia River temperature, measured at The Dalles Dam, reached 15°C on 21 May (Figure 7). We were able to complete fabrication of sampling gear in time to deploy some of it on 28 May.

Columbia River flows were exceptionally low during late May and June 2015, while water temperatures were warmer than average during that period (Figures 7 and 8). This combination of warming water minus high flows may have negatively affected the behavior of pre-spawning fish. White Sturgeon reproduction and early life history characteristics and spawning habitat requirements between Bonneville and McNary dams was investigated from 1987 through 1991 (Palmer et. al. 1988, Parsley et. al. 1989, Duke et. al. 1990, Miller e. al. 1991). Sampling conducted downstream of John Day Dam in 1987 resulted in some interesting observations (Palmer et. al. 1988). Eggs were collected from 21 May through 17 July and larvae were collected from 28 May through 2 July. Egg deposition was estimated to have occurred on three occasions, 20-21 May, 26-30 June, and 11-12 July (Figure 9). The majority of eggs collected (87%) were dead and covered with fungus. Eggs were initially encountered in late May and the first larvae were taken a few days later. Then, after a hiatus of a month, numerous eggs and larvae were captured from late June thru mid-July. The authors concluded that survival was poor and speculated that this was a result of water temperatures during the last two or three weeks of the spawning period being within lethal limits for developing sturgeon embryos. Wang et al. (1985) found that water temperatures of 18°C to 20°C may cause substantial mortalities during the sensitive embryonic stages, and temperatures above 20°C are clearly lethal. The majority of eggs and larvae collected in 1987 from The Dalles Reservoir (96%) were collected when water temperatures ranged between 18°C and 20°C.

Parsley et. al. (1989) first speculated that water velocity, in addition to water temperature, cued White Sturgeon spawning. Discharge, combined with channel morphology and surface gradient, shaped water velocity downstream of the Columbia River dams within the areas studied. Anders and Beckman (1993) identified water velocity in dam tailrace areas to be a spawning cue driven by river discharge. The authors concluded that mean discharge during the 24 hours preceding sampling had significant effects on sturgeon spawning. Spawning occurred when mean discharge exceeded 260 kcfs and apparently did not occur at discharges less than 135 kcfs. Hourly discharge from The Dalles Dam only exceeded 135 kcfs during one 6 hour period in 2015, from 1700 through 2200 on 24 May. The five year investigation from 1987 to 1991 culminated in the establishment of a spawning microhabitat suitability curve for mean column water velocity (Parsley and Beckman 1994).

Water temperature and river flow conditions encountered in 2015 were reminiscent of conditions described in 1987. Based on the water temperature curve documented at The Dalles Dam in 2015, we would have expected spawning to have begun by mid to late May and larvae to be present by late May. The capture of a small number of larvae downstream of The Dalles Dam in late May by staff from the Yakama Nation (YN) confirmed that increasing water temperature did trigger onset of some spawning, but YN catches were minimal and sporadic (Donnella Miller, personal communication). The three instances when we captured White Sturgeon larvae occurred a month and a half past the first of May. What was absent in May and June may have been flows of a large enough magnitude to cue spawning. If a normal amount of spawning were to have occurred during the period sampled, the abnormally low flow may have contributed to larvae settling out before reaching the areas we sampled. The fact that we did captured five larvae from mid to late June is also reminiscent of what happened in 1987, which suggests at least some female sturgeon delay spawning until they encounter both temperature and velocity cues, and if water velocity remains too slow, some individuals eventually spawn while others begin reabsorbing eggs.

Another indication that conditions in 2015 were not conducive to normal sturgeon spawning was the complete lack of any age-0 White Sturgeon encountered during ODFW's and WDFW's October 2015 sampling for age-0 fish in Bonneville, The Dalles, and John Day reservoirs (preliminary results reported by WDFW). This has only occurred once before since sampling of all three reservoirs was initiated in 1997.

Conclusions and Recommendations

Although the efforts expended in this study were exploratory in nature, we were unable to confirm in 2015 that sufficient numbers of White Sturgeon larvae could be captured from Bonneville and The Dalles reservoirs to support a meaningful hatchery supplementation program. However, Parsley and Kofoot (2013) demonstrated that modest numbers of larvae could be caught at the sites in Bonneville Reservoir that we sampled. Where we caught just one sturgeon larvae with 675 hours of effort, they caught 111 larvae with 175 hours of effort. We believe the abnormal in-river conditions present during 2015 were at least partly responsible for the low number of larvae we encountered by causing fish to delaying spawning, either past the expected period dictated by water temperature, or to the point that spawning was abandoned. Because of the unusual nature of the environmental conditions in 2015, an additional year or two of study under normal river conditions is warranted to figure out these two reservoirs potential to contribute to supplementation programs within the basin.

Sampling likely needs to last longer than the four week period tried in 2015 in order to ensure that the full larval drift period is captured. Preparation for sampling should include time to construct a full complement of modular aluminum frames to replace the heavy steel frames that proved very difficult to work with in the rough conditions common to this part of the Columbia River.

We also recommend expanding the area sampled within each reservoir. This portion of the Columbia River was challenging to work with plankton net gear due to the mix of prevailing weather conditions (strong upstream winds and large waves), river traffic, and Tribal fishing sites. Our crew had years of experience deploying setline and gillnet gear in these same waters under similar or even rougher conditions, but since setlines and gillnets are anchored at both ends, they can be deployed and retrieved with the boat heading into the wind which greatly reduces the potential of gear swinging under the boat. During this year's study, we were cautious in selecting areas to sample in order to avoid conflicts with other users and to safely deploy and retrieve nets. Safety concerns also precluded exploring nighttime operations. However, some of these concerns could be alleviated by using a 3-person crew, using only modular aluminum frames, and by lengthening of the vessel's davit arm to lessen the chance of entangling the gear in the propeller. At a minimum, these changes would allow for exploration of additional rough-water sites and maybe allow for some nighttime operations.

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Figure 4. Photograph aboard the WDFW research vessel showing retrieval of a double plankton net frame under typical operating conditions encountered in 2015.

Figure 5. Modular aluminum plankton net frame. The two single frames can be reassembled into a double frame configuration by replacing three of the short horizontal members with the three long tubes.

Figure 6. Close-up showing details of the aluminum plankton net frame assembly.

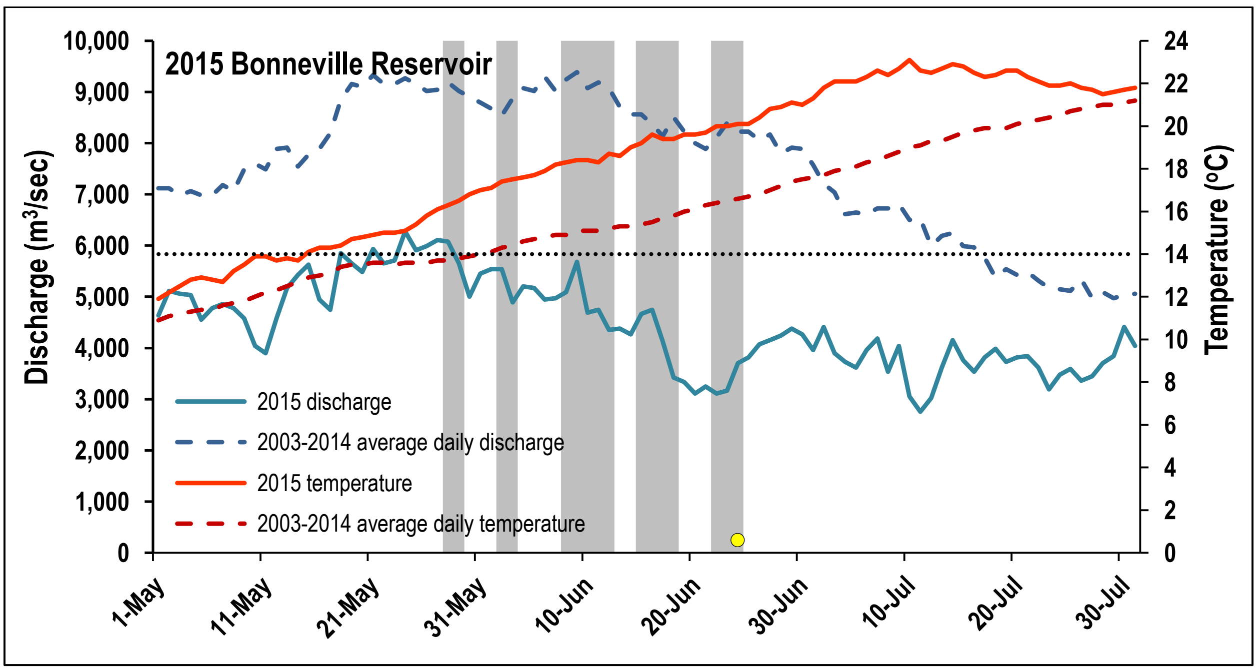

Figure 7. Columbia River discharge and water temperature for May-July 2015 recorded at The Dalles Dam with 10-year averages for comparison. Periods of sampling for White Sturgeon larvae in the upper end of Bonneville Reservoir is denoted by gray shading. Capture of White Sturgeon larvae is denoted by the yellow circle. The dotted line at 14°C delineates the water temperature at which peak spawning generally begins.

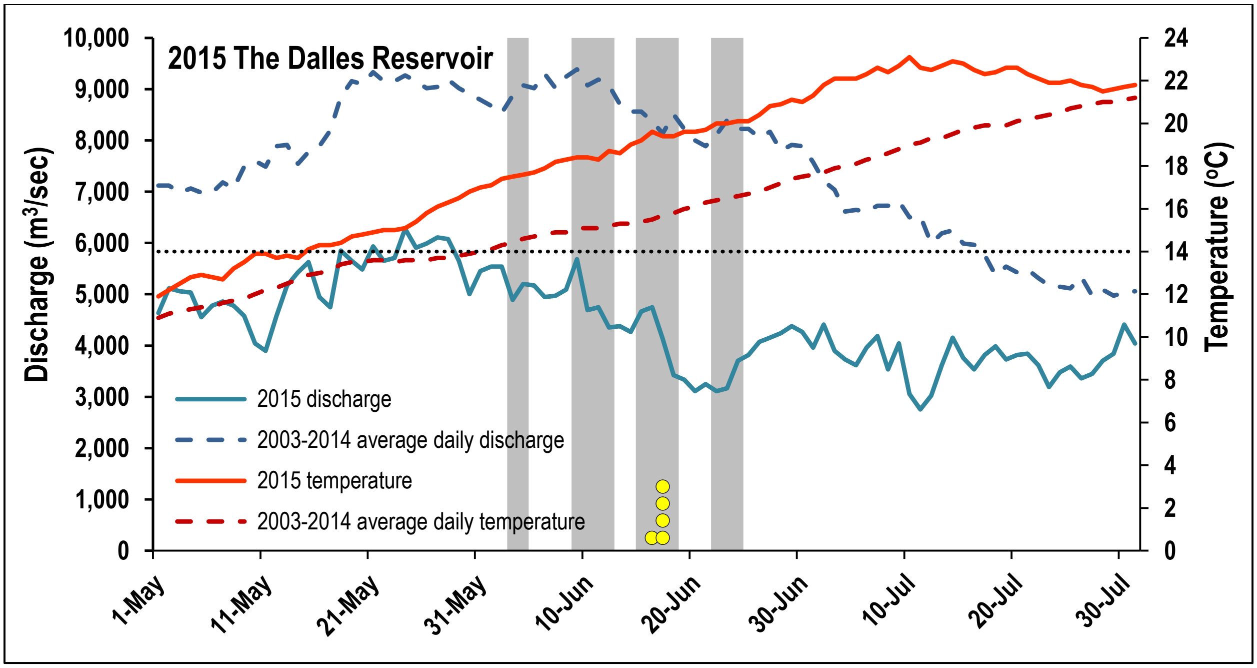

Figure 8. Columbia River discharge and water temperature for May-July 2015 recorded at The Dalles Dam with 10-year averages for comparison. Periods of sampling for White Sturgeon larvae in the upper end of Bonneville Reservoir is denoted by gray shading. Capture of White Sturgeon larvae is denoted by the yellow circles. The dotted line at 14°C delineates the water temperature at which peak spawning generally begins.

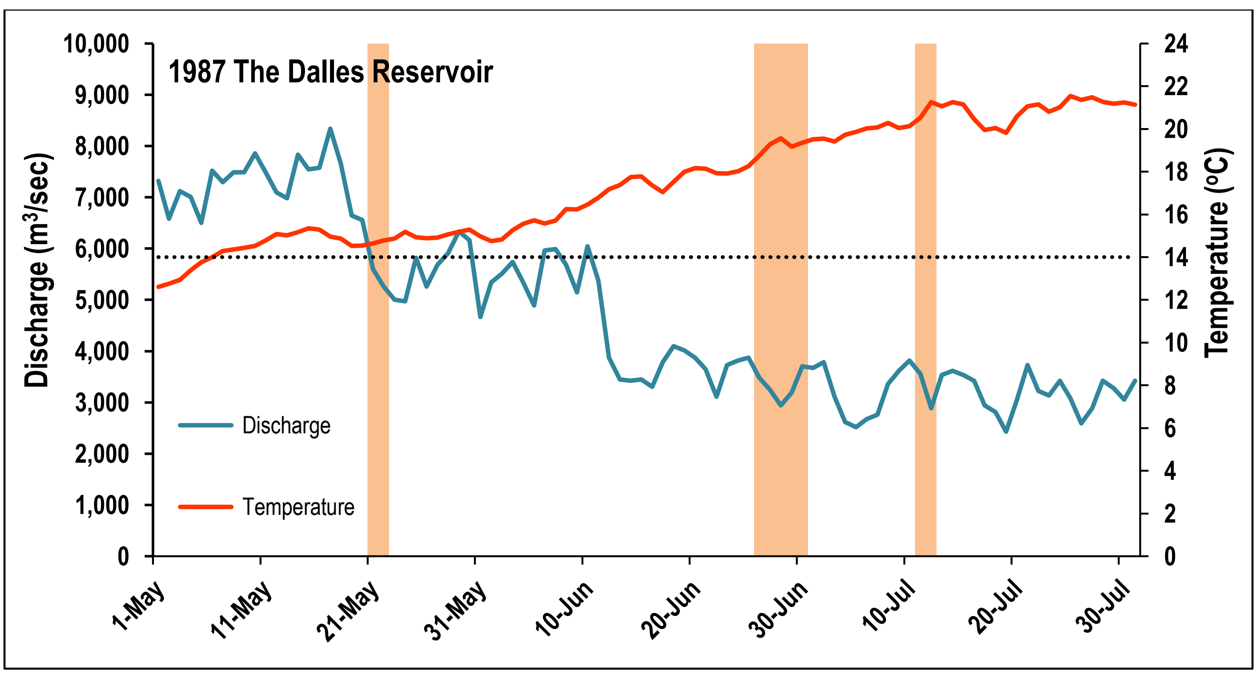

Figure 9. Columbia River discharge and water temperature for May-July 1987 recorded at The Dalles Dam. Periods when White Sturgeon spawning was suspected to have occurred in The Dalles Reservoir (Palmer et. al. 1988) is denoted by tan shading.

Table 1. Description of sampling sites in Bonneville and The Dalles reservoirs used in 2015 to capture White Sturgeon larvae.

Reservoir	Station ID	Station location description		Rkm	Lattitude	Longitude	Depth (m)
Bonneville	B-1	upper Discovery Center	OR shore, shore-side	298.9	45.65424 N	121.20668 W	20.1
Bonneville	B-2	upper Discovery Center	OR shore, channel-side	298.8	45.65498 N	121.20649 W	19.8
Bonneville	B-3	mid Discovery Center	OR shore, midway out	298.6	45.65576 N	121.20766 W	20.1
Bonneville	B-4	mid Discovery Center	OR shore, channel-side	298.6	45.65602 N	121.20843 W	20.1
Bonneville	B-5	mid Discovery Center	OR shore, shore-side	298.6	45.65622 N	121.20712 W	18.3
Bonneville	B-6	lower Discovery Center	OR shore, shore-side	298.3	45.65707 N	121.20956 W	17.7
Bonneville	B-7	lower Discovery Center	OR shore, midway out	298.3	45.65779 N	121.20941 W	19.2
Bonneville	B-8	lower Discovery Center	OR shore, channel-side	298.3	45.65832 N	121.20850 W	15.9
Bonneville	B-9a	upper Squally Point	OR shore, channel-side	297.9	45.65993 N	121.21184 W	19.2
Bonneville	B-9b	upper Squally Point	OR shore, shore-side	297.9	45.65995 N	121.21121 W	18.9
The Dalles	D-1	upper Maryhill	N of channel	339.7	45.68799 N	120.79653 W	8.2
The Dalles	D-2	upper Maryhill	N of channel	339.7	45.68766 N	120.79679 W	9.1
The Dalles	D-3	mid-Maryhill	N of channel	339.0	45.68728 N	120.79721 W	10.7
The Dalles	D-4	mid-Maryhill	N of channel	339.0	45.68584 N	120.80208 W	10.4
The Dalles	D-5	downstream of HWY97 bridge	N of channel	335.5	45.67473 N	120.84755 W	9.5
The Dalles	D-6	downstream of HWY97 bridge	N of channel	334.8	45.67512 N	120.84818 W	9.5

Table 2. Details of sample timing and duration (hh,mm,ss), water temperature (°C), water velocity (m/sec), water volume sampled (m3), and catch for stations sampled with single and double framed plankton nets in Bonneville Reservoir, 28 May to 24 June 2015.

Station ID	Water temp. (°C)	Frame config.	Set: Deployment date and time	Set: Retreival date and time	Set: Duration (hh:mm:ss)	Water velocity (m/sec)	Sample bucket ID	Volume sampled (m^3)	Debris volume (%)	White sturgeon catch: Free embryos Live	Free embryos Dead	Early larvae Live	Early larvae Dead	Catch / hour	juv or adult	Other catch: Lamprey spp.	Cottid spp. Juv-adult	Cottid spp. larvae	Juv. fish spp.
B-2	16.3	double	5/28/15 19:44:58	5/29/15 9:49:45	14:04:47	N/A	B-2-2		10%	0	0	0	0	0.00					
							B-2-1	N/A	25% [1]	0	0	0	0						
B-1	16.3	double	5/28/15 18:30:35	5/29/15 10:12:20	15:41:45	N/A	B-1-5		25% [1]	0	0	0	0	0.00					
							B-1-6	N/A	35% [1]	0	0	0	0						
B-8	16.3	double	5/28/15 18:51:27	5/29/15 8:43:40	13:52:13	N/A	B-8-3		20%	0	0	0	0	0.00					
							B-8-4	N/A	5%	0	0	0	0						
B-7	16.3	single	5/28/15 19:14:40	5/29/15 8:20:0	13:05:20	N/A	B-7-8	N/A	20%	0	0	0	0	0.00					
	16.3	single	5/28/15 19:28:40	5/29/15 8:0:58	12:32:18	N/A	B-7-7	N/A	20%	0	0	0	0	0.00					
B-4	17.4	double	6/2/15 18:59:50	6/3/15 7:56:30	12:56:40	1.14	B-4-9	21,941	20% [1]	0	0	0	0	0.00					
							B-4-10	21,941	20%	0	0	0	0			1			
B-3	17.4	double	6/2/15 19:21:30	6/3/15 8:12:10	12:50:40	1.15	B-3-5	21,884	10%	0	0	0	0	0.00		1			
							B-3-6	21,884	20%	0	0	0	0						
B-5	17.4	double	6/2/15 19:42:5	6/3/15 8:22:0	12:39:55	1.16	B-5-1	21,853	10%	0	0	0	0	0.00		1			
							B-5-2	21,853	5%	0	0	0	0						
B-4	18.3	double	6/8/15 18:19:0	6/9/15 7:40:30	13:21:30	0.87	B-4-9	17,181	40% [1]	0	0	0	0	0.00					
							B-4-10	17,181	40% [1]	0	0	0	0						
B-3	18.3	double	6/8/15 18:37:0	6/9/15 7:55:10	13:18:10	1.11	B-3-5	21,923	5%	0	0	0	0	0.00			1		
							B-3-6	21,923	15%	0	0	0	0			3	1		
B-5	18.3	double	6/8/15 18:55:0	6/9/15 8:9:0	13:14:00	1.11	B-5-1	21,824	10%	0	0	0	0	0.00					
							B-5-2	21,824	5%	0	0	0	0						
B-9a	18.3	double	6/8/15 19:20:0	6/9/15 8:22:0	13:02:00	1.15	B-9a-3	22,165	10%	0	0	0	0	0.00					
							B-9a-4	22,165	15%	0	0	0	0			2			
B-4	18.4	double	6/9/15 7:53:0	6/9/15 18:35:0	10:42:00	1.36	B-4-9	21,660	30%	0	0	0	0	0.00					
							B-4-10	21,660	70% [1]	0	0	0	0						
B-3	18.4	double	6/9/15 8:7:0	6/9/15 18:56:0	10:49:00	1.38	B-3-5	22,133	10%	0	0	0	0	0.00					
							B-3-6	22,133	40% [1]	0	0	0	0						
B-5	18.4	double	6/9/15 8:15:0	6/9/15 19:10:0	10:55:00	1.35	B-5-1	21,826	5%	0	0	0	0	0.00					
							B-5-2	21,826	5%	0	0	0	0						
B-9a	18.4	double	6/9/15 8:29:0	6/9/15 19:25:0	10:56:00	1.37	B-9a-3	22,165	5%	0	0	0	0	0.00					
							B-9a-4	22,165	5%	0	0	0	0						

[1] Net plugged with debris.

Table 2. Continued.

Station ID	Water temp. (°C)	Frame config.	Set: Deployment date and time	Set: Retreival date and time	Set: Duration (hh:mm:ss)	Water velocity (m/sec)	Sample bucket ID	Volume sampled (m^3)	Debris volume (%)	White sturgeon catch: Free embryos Live	Free embryos Dead	Early larvae Live	Early larvae Dead	Catch / hour	juv or adult	Other catch: Lamprey spp.	Cottid spp. Juv-adult	Cottid spp. larvae	Juv. fish spp.
B-4	18.4	double	6/9/15 18:48:0	6/10/15 10:20:0	15:32:00	0.96	B-4-9	22,103	90% [1]	0	0	0	0	0.00		2			
							B-4-10	22,103	70% [1]	0	0	0	0			1			
B-6	18.4	double	6/9/15 19:6:0	6/10/15 10:34:0	15:28:00	0.96	B-6-5	21,953	20%	0	0	0	0	0.00		2			
							B-6-6	21,953	30%	0	0	0	0						
B-5	18.4	double	6/9/15 19:20:0	6/10/15 10:44:0	15:24:00	0.95	B-5-1	21,804	15%	0	0	0	0	0.00					
							B-5-2	21,804	10%	0	0	0	0			1			
B-9a	18.4	double	6/9/15 19:30:0	6/10/15 10:56:0	15:26:00	0.97	B-9a-3	22,165	10%	0	0	0	0	0.00		1			
							B-9a-4	22,165	15%	0	0	0	0						
B-5	18.4	double	6/10/15 10:50:0	6/11/15 7:18:0	20:28:00	1.07	B-5-1	32,455	30%	0	0	0	0	0.00		1			1
							B-5-2	32,455	30%	0	0	0	0			1			
B-9a	18.4	double	6/10/15 11:5:0	6/11/15 7:3:0	19:58:00	1.12	B-9a-3	33,249	25%	0	0	0	0	0.00					
							B-9a-4	33,249	25%	0	0	0	0						
B-8	18.2	double	6/11/15 6:27:0	6/12/15 5:52:0	23:25:00	1.26	B-8-5	43,806	5%	0	0	0	0	0.00					
							B-8-6	43,806	10%	0	0	0	0						1
B-7	18.2	double	6/11/15 7:1:0	6/12/15 5:59:0	22:58:00	1.29	B-7-9	44,104	90% [1]	0	0	0	0	0.00		1			
							B-7-10	44,104	70% [1]	0	0	0	0						
B-9a	18.2	double	6/11/15 7:15:0	6/12/15 5:42:0	22:27:00	1.33	B-9a-3	44,331	30% [1]	0	0	0	0	0.00					
							B-9a-4	44,331	30% [1]	0	0	0	0						
B-5	18.2	double	6/11/15 7:26:0	6/12/15 6:11:0	22:45:00	1.30	B-5-1	43,831	5%	0	0	0	0	0.00		2			
							B-5-2	43,831	20%	0	0	0	0			1			3
B-5	19.5	double	6/15/15 16:48:55	6/16/15 8:12:0	15:23:05	0.96	B-5-1	22,002	40%	0	0	0	0	0.00		1			
							B-5-2	22,002	20% [1]	0	0	0	0						
B-7	19.5	double	6/15/15 17:3:27	6/16/15 7:51:0	14:47:33	1.01	B-7-9	22,099	50% [1]	0	0	0	0	0.00					
							B-7-10	22,099	70% [1]	0	0	0	0						
B-8	19.5	double	6/15/15 17:13:27	6/16/15 8:2:0	14:48:33	0.99	B-8-5	21,876	20%	0	0	0	0	0.00					
							B-8-6	21,876	30%	0	0	0	0			1			
B-9b	19.5	double	6/15/15 17:24:12	6/16/15 7:40:0	14:15:48	1.04	B-9b-3	22,028	50% [1]	0	0	0	0	0.00		1			
							B-9b-4	22,028	70%	0	0	0	0						

[1] Net plugged with debris.

Table 2. Continued.

Station ID	Water temp. (°C)	Frame config.	Set: Deployment date and time	Set: Retreival date and time	Set: Duration (hh:mm:ss)	Water velocity (m/sec)	Sample bucket ID	Volume sampled (m^3)	Debris volume (%)	White sturgeon catch: Free embryos Live	Free embryos Dead	Early larvae Live	Early larvae Dead	Catch / hour	juv or adult	Other catch: Lamprey spp.	Cottid spp. Juv-adult	Cottid spp. larvae	Juv. fish spp.
B-5	19.4	double	6/16/15 8:17:0	6/16/15 18:23:0	10:06:00	0.72	B-5-1	10,814	40%	0	0	0	0	0.00					
							B-5-2	10,814	20%	0	0	0	0						
B-7	19.4	double	6/16/15 8:0:0	6/16/15 18:33:0	10:33:00	0.71	B-7-9	11,073	75% [1]	0	0	0	0	0.00					
							B-7-10	11,073	100% [1]	0	0	0	0						1
B-8	19.4	double	6/16/15 8:10:0	6/16/15 18:10:0	10:00:00	0.73	B-8-5	10,838	20% [2]	0	0	0	0	0.00					
							B-8-6	10,838	10%	0	0	0	0						
B-9b	19.4	double	6/16/15 7:45:0	6/16/15 18:1:0	10:16:00	0.72	B-9b-3	10,994	50%	0	0	0	0	0.00					
							B-9b-4	10,994	20% [1]	0	0	0	0						
B-9b	19.4	double	6/16/15 18:7:0	6/17/15 9:5:0	14:58:00	0.99	B-9b-3	22,029	30%	0	0	0	0	0.00					
							B-9b-4	22,029	30%	0	0	0	0				1		
B-8	19.4	double	6/16/15 18:16:0	6/17/15 8:47:0	14:31:00	1.02	B-8-5	21,929	20%	0	0	0	0	0.00				1	
							B-8-6	21,929	15%	0	0	0	0						
B-5	19.4	double	6/16/15 18:29:0	6/17/15 8:28:0	13:59:00	1.05	B-5-1	21,862	30% [1]	0	0	0	0	0.00					
							B-5-2	21,862	5% [1]	0	0	0	0						
B-8	19.4	double	6/17/15 8:58:0	6/17/15 17:2:0	8:04:00	0.91	B-8-5	10,912	5%	0	0	0	0	0.00					
							B-8-6	10,912	5%	0	0	0	0						
B-5	19.4	double	6/17/15 8:35:0	6/17/15 17:13:0	8:38:00	0.85	B-5-1	10,883	15%	0	0	0	0	0.00		1			
							B-5-2	10,883	10%	0	0	0	0						
B-8	19.4	double	6/17/15 17:10:0	6/18/15 8:20:0	15:10:00	0.97	B-8-5	21,889	10%	0	0	0	0	0.00		1			
							B-8-6	21,889	5%	0	0	0	0				1		
B-5	19.4	double	6/17/15 17:20:0	6/18/15 8:30:0	15:10:00	0.97	B-5-1	21,865	10%	0	0	0	0	0.00				2	
							B-5-2	21,865	10%	0	0	0	0			2			
B-8	19.7	double	6/22/15 16:10:0	6/23/15 8:48:0	16:38:00	0.89	B-8-5	21,903	10%	0	0	0	0	0.00			1		
							B-8-6	21,903	15%	0	0	0	0		1			1	
B-5	19.7	double	6/22/15 16:30:0	6/23/15 9:7:0	16:37:00	0.89	B-5-1	21,923	10%	0	0	0	0	0.00					
							B-5-2	21,923	10%	0	0	0	0						

[1] Net plugged with debris.
[2] Net twisted upon itself.

Table 2. Continued.

Station ID	Water temp. (°C)	Frame config.	Set: Deployment date and time	Set: Retreival date and time	Set: Duration (hh:mm:ss)	Water velocity (m/sec)	Sample bucket ID	Volume sampled (m^3)	Debris volume (%)	White sturgeon catch: Free embryos Live	Free embryos Dead	Early larvae Live	Early larvae Dead	Catch / hour	juv or adult	Other catch: Lamprey spp.	Cottid spp. Juv-adult	Cottid spp. larvae	Juv. fish spp.
B-8	19.7	double	6/23/15 8:59:0	6/23/15 16:42:0	7:43:00	0.96	B-8-5	10,958	5%	0	0	0	0	0.00					
							B-8-6	10,958	5%	0	0	0	0						
B-5	19.7	double	6/23/15 9:12:0	6/23/15 17:2:0	7:50:00	0.94	B-5-1	10,952	5%	0	0	0	0	0.00					
							B-5-2	10,952	5%	0	0	0	0						
B-8	19.8	double	6/23/15 16:52:0	6/24/15 11:53:0	19:01:00	0.77	B-8-5	21,856	10%	0	0	0	0	0.00					
							B-8-6	21,856	10%	0	0	0	0						
B-5	19.8	double	6/23/15 17:12:0	6/24/15 12:14:0	19:02:00	0.77	B-5-1	21,821	10%	0	0	0	0	0.05					
							B-5-2	21,821	15%	0	0	**1**	0						
All	2	single-frame sets		mean	14.4 hrs			22,354 m^3											
	45	double-frame (90 net sets)		range	(7.7-23.4) hrs			(10,814-44,331) m^3											
	92	total net sets		total	675.4 hrs			1,877,730 m^3		0	0	1	0	0.001	1	11	3	4	5

Table 3. Details of sample timing and duration (hh,mm,ss), water temperature (°C), water velocity (m/sec), water volume sampled (m^3), and catch for stations sampled with single and double framed plankton nets in The Dalles Reservoir, 3 June to 24 June 2015.

Station ID	Water temp. (°C)	Frame config.	Set: Deployment date and time	Set: Retreival date and time	Set: Duration (hh:mm:ss)	Water velocity (m/sec)	Sample bucket ID	Volume sampled (m^3)	Debris volume (%)	White sturgeon catch: Free embryos Live	Free embryos Dead	Early larvae Live	Early larvae Dead	Catch / hour	juv or adult	Other catch: Lamprey spp.	Cottid spp. Juv-adult	Cottid spp. larvae	Juv. fish spp.
D-1	17.5	double	6/3/15 13:54:30	6/4/15 8:58:10	19:03:40	1.16	D-1-3	32,921	15%	0	0	0	0	0.00					
							D-1-4	32,921	10%	0	0	0	0						
D-2	17.5	double	6/3/15 14:18:5	6/4/15 8:33:58	18:15:53	1.21	D-2-7	32,786	10%	0	0	0	0	0.00			1		
							D-2-8	32,786	10%	0	0	0	0						
D-3	18.5	single	6/9/15 13:39:0	6/10/15 7:58:0	18:19:00	0.85	D-3-7	26,763	5%	0	0	0	0	0.00	1 adult				
D-6	18.5	single	6/9/15 13:11:0	6/10/15 7:45:0	18:34:00	0.82	D-6-8	26,448	0%	0	0	0	0	0.00					
D-3	18.5	single	6/10/15 8:12:0	6/11/15 9:45:0	25:33:00	1.15	D-3-7	50,880	5%	0	0	0	0	0.00					
D-6	18.5	single	6/10/15 7:49:0	6/11/15 9:26:0	25:37:00	0.89	D-6-8	39,249	5%	0	0	0	0	0.00					1
D-3	18.5	single	6/11/15 9:49:0	6/12/15 9:7:0	23:18:00	1.28	D-3-7	51,335	5%	0	0	0	0	0.00		1			1
D-6	18.5	single	6/11/15 9:36:0	6/12/15 8:50:0	23:14:00	0.98	D-6-8	39,260	5%	0	0	0	0	0.00					
D-3	18.5	single	6/15/15 19:17:0	6/16/15 5:54:0	10:37:00	0.69	D-3-8	12,566	5%	0	0	**1**	0	0.09					
D-6	18.5	single	6/15/15 19:1:0	6/16/15 5:41:0	10:40:00	0.68	D-6-7	12,604	5%	0	0	0	0	0.00		1			
D-3	18.7	single	6/16/15 5:55:0	6/16/15 20:38:0	14:43:00	1.00	D-3-8	25,314	5%	0	0	0	0	0.00					
D-6	18.7	single	6/16/15 5:45:0	6/16/15 20:23:0	14:38:00	1.03	D-6-7	26,049	5%	0	0	0	0	0.00					
D-3	19.0	single	6/16/15 20:42:0	6/17/15 6:12:0	9:30:00	0.77	D-3-8	12,598	0%	0	0	0	**1**	0.11					
D-6	19.0	single	6/16/15 20:26:0	6/17/15 6:1:0	9:35:00	0.73	D-6-7	12,121	0%	0	0	**3**	0	0.31					
D-3	19.6	single	6/17/15 6:16:0	6/17/15 19:50:0	13:34:00	0.59	D-3-8	13,721	5%	0	0	0	0	0.00				2	
D-6	19.6	single	6/17/15 6:5:0	6/17/15 20:12:0	14:07:00	1.04	D-6-7	25,385	5%	0	0	0	0	0.00					
D-5	19.6	double	6/17/15 5:56:0	6/17/15 20:1:0	14:05:00	1.04	D-5-9	21,823	10%	0	0	0	0	0.00					
							D-5-10	21,823	15%	0	0	0	0						
D-3	19.6	single	6/17/15 20:19:0	6/18/15 6:6:0	9:47:00	0.83	D-3-8	13,954	5%	0	0	0	0	0.00				1	
D-6	19.6	single	6/17/15 19:53:0	6/18/15 6:34:0	10:41:00	0.68	D-6-7	12,611	5%	0	0	0	0	0.00		1		5	
D-5	19.6	double	6/17/15 20:8:0	6/18/15 5:57:0	9:49:00	0.75	D-5-9	10,891	5%	0	0	0	0	0.00					
							D-5-10	10,891	5%	0	0	0	0						
D-4	19.6	double	6/17/15 19:46:0	6/18/15 6:26:0	10:40:00	0.76	D-4-3	11,965	5%	0	0	0	0	0.00					
							D-4-4	11,965	5%	0	0	0	0					2	

Table 3. Continued.

Station ID	Water temp. (°C)	Frame config.	Set: Deployment date and time	Set: Retreival date and time	Set: Duration (hh:mm:ss)	Water velocity (m/sec)	Sample bucket ID	Volume sampled (m^3)	Debris volume (%)	White sturgeon catch: Free embryos Live	Free embryos Dead	Early larvae Live	Early larvae Dead	Catch / hour	juv or adult	Other catch: Lamprey spp.	Cottid spp. adult	Cottid spp. larvae	Minnow spp.
D-3	20.2	single	6/22/15 18:47:0	6/23/15 6:34:0	11:47:00	0.62	D-3-8	12,628	5%	0	0	0	0	0.00					
D-6	20.2	single	6/22/15 18:15:0	6/23/15 6:5:0	11:50:00	0.62	D-6-7	12,689	5% [1]	0	0	0	0	0.00				1	
D-5	20.2	double	6/22/15 18:23:0	6/23/15 5:55:0	11:32:00	0.64	D-5-9	10,916	5%	0	0	0	0	0.00					
							D-5-10	10,916	5%	0	0	0	0						
D-4	20.2	double	6/22/15 19:0:0	6/23/15 6:20:0	11:20:00	0.65	D-4-3	10,874	5% [2]	0	0	0	0	0.00					
							D-4-4	10,874	5%	0	0	0	0						
D-3	19.4	single	6/23/15 6:40:0	6/23/15 19:31:0	12:51:00	0.58	D-3-8	12,894	0%	0	0	0	0	0.00					
D-6	19.4	single	6/23/15 6:12:0	6/23/15 19:7:0	12:55:00	0.57	D-6-7	12,638	5%	0	0	0	0	0.00					
D-5	19.4	double	6/23/15 6:0:0	6/23/15 18:57:0	12:57:00	0.56	D-5-9	10,843	0%	0	0	0	0	0.00					
							D-5-10	10,843	0%	0	0	0	0						
D-4	19.4	double	6/23/15 6:29:0	6/23/15 19:20:0	12:51:00	0.58	D-4-3	11,082	0%	0	0	0	0	0.00					
							D-4-4	11,082	0%	0	0	0	0						
D-3	20.0	single	6/23/15 19:37:0	6/24/15 8:49:0	13:12:00	0.57	D-3-8	12,895	0%	0	0	0	0	0.00			2		
D-6	20.0	single	6/23/15 19:12:0	6/24/15 7:30:0	12:18:00	0.60	D-6-7	12,651	10%	0	0	0	0	0.00					
D-5	20.0	double	6/23/15 19:5:0	6/24/15 7:54:0	12:49:00	0.63	D-5-9	11,956	5%	0	0	0	0	0.00			1		
							D-5-10	11,956	5%	0	0	0	0						
D-4	20.0	double	6/23/15 19:26:0	6/24/15 9:9:0	13:43:00	0.53	D-4-3	10,788	5%	0	0	0	0	0.00			4		
							D-4-4	10,788	5%	0	0	0	0						
All	22	single-frame sets		mean	14.4 hrs			18,885 m^3											
	11	double-frame (22 net sets)		range	(9.5-25.6) hrs			(10,788-51,335) m^3											
	44	total net sets		total	474.4 hrs			830,944 m^3		0	0	4	1	0.011	1	3	8	11	2

[1] Net wrapped around haul line.
[2] Net twisted upon itself.

Appendix C
Stakeholder Comments and Grant PUD responses

Submitting Entity	Date Received	Paragraph	Agency Comment	Grant PUD Response
Colville Confederated Tribes	3/1/2016	Page 1 Paragraph 2	This location isn't clear. Was fishing for broodstock conducted in The Dalles Pool or The Dalles Dam tailrace?	Capture efforts were downstream of both dams. Edit accepted.
Colville Confederated Tribes	3/1/2016	Page 2 Paragraph 1	Where is this? Dalles Dam tailrace?	Edit accepted.
Colville Confederated Tribes	3/1/2016	Table 1	Why not use kilometer? Define where the origin is for the RM measurements (i.e., mouth of the Columbia).	River Mile marks for the Project were provided by Grant PUD. River locations in previous studies were reference to the nearest River Mile (typically to the nearest 10th mile). River Mile were used in 2015 to remain consistent with previous work.
Colville Confederated Tribes	3/1/2016	Table 1	Most size at release information is presented in mass. Please provide mean mass (g) at release.	Edit accepted.
Colville Confederated Tribes	3/1/2016	Page 7 Paragraph 1	Anterior of the imaginary vertical line extending through the anterior insertion of the dorsal fin	Edit partially accepted; the schutes that were removed in 2015 were posterior to the dorsal origin, as in the diagram; fins have an origin and an insertion; the anterior insertion is call the origin. We will adjust the 2016 scute marking to your recommendation.
Colville Confederated Tribes	3/1/2016	Figure 2	This isn't the standard scute marking pattern used in the upper Columbia, Wells, and Rocky Reach programs. The scutes marked with the red line in the figure below are the ones that should be removed to remain consistent.	The instructions for scute removal were provided by the FFSBC, as was this figure.
Colville Confederated Tribes	3/1/2016	Page 7 Paragraph2	What were the QA/QC measures taken?	Protocols; not measures
Colville Confederated Tribes	3/1/2016	Page 9 Paragraph 3	Where? The tailrace of the Dalles Dam?	Edit accepted; correction applied.
Colville Confederated Tribes	3/1/2016	Page 9 Paragraph 3	Appears to be a date error	Edit accepted; correction applied.

Submitting Entity	Date Received	Paragraph	Agency Comment	Grant PUD Response
Colville Confederated Tribes	3/1/2016	Page 12 Paragraph 3	Describe how the eggs were transported from the collection site to the incubator.	Edit accepted; text added.
Colville Confederated Tribes	3/1/2016	Page 12 Paragraph 4	More detail on the biospheres is required – size, manufacturer, etc.	Edit accepted; text added.
Colville Confederated Tribes	3/1/2016		What was the catch in this strata in 2012?	Text changed – telemetry data suggest low used, but yes as you point out, this is probably a bias as the primary motivator is that physical condition make sampling in this area difficult
Colville Confederated Tribes	3/1/2016	Page 16 Paragraph 1	How large?	Changed to maturity.
Colville Confederated Tribes	3/1/2016	Page 18 Paragraph 1	Isn't POPAN software program used for generating CIS models?	Apparently it is an add on in Mark
Colville Confederated Tribes	3/1/2016	Page 26 Paragraph 1	Define family? They are essentially individual crosses, not genetic families. There were eight maternal families.	Edit accepted, correction applied
Colville Confederated Tribes	3/1/2016	Page 26 Paragraph 2	How do you know? Couldn't some have swam to a location where they were no longer visible from the release area but remained in shallow water? Consider revising this sentence.	Edit accepted; correction applied.
Colville Confederated Tribes	3/1/2016	Page 37 Paragraph 2	Were healthy eggs added to jars that contained eggs infected with fungus? If so, why?	Text added to clarify. Microscopic images of eggs, taken for the purpose of developmental staging, also indicated that most eggs at capture have some amount of filamentous material that adheres to the egg gel coat. These filaments are generally not visible to the unaided eye. Although not necessarily of fungal origin, the wide prevalence of this filamentous material suggests that low level fungal

Submitting Entity	Date Received	Paragraph	Agency Comment	Grant PUD Response
				infection among spawned eggs maybe the normal condition.
Colville Confederated Tribes	3/1/2016	Page 38 Paragraph 1	Prudent from a safety standpoint, but maybe no from a catch standpoint. Consider revising.	Disagree - fish could not be processed and effectively were lost under these conditions, so catch was affected. Our ability to deploy and retrieve the gear parallel with current was also affected. In high wind situations, the set lines were sometimes deployed in the direction of the prevailing wind instead of the prevailing current, despite effort to correct the deployment orientation with the boat.
Colville Confederated Tribes	3/1/2016	Page 38 Paragraph 2	This is discussion.	More of a description of conditions during sampling, rather than a discussion. Sentence regarding effect on catch removed.
Colville Confederated Tribes	3/1/2016	Page 38 Paragraph 3	This is discussion.	More of a description of conditions during sampling. The implications of high temperature and the effect how processing fish at high water temperature will have on a mark recapture study are not discussed.
Colville Confederated Tribes	3/1/2016	Page 39 Paragraph 1	Calculating CPUE by hook hour is not valid. The experimental unit is the entire line. We don't calculate gill net CPUE by each individual opening in the mesh. How do you account for hooks that get straightened or are retrieved without bait? When was it straightened	A "set line" can have different lengths and different numbers of hooks. Sampling gear (e.g., set lines, gill nets, etc.) is not always

Submitting Entity	Date Received	Paragraph	Agency Comment	Grant PUD Response
			or when was the bait lost? An unbaited hook can't be considered fishing, otherwise we wouldn't use bait. Also, isn't a hook no longer fishing when a fish is on it? CPUE should be calculated as fish/overnight setline set. It can be normalized to a 24 hour set if desired.	deployed overnight. For example, in some studies, gill net deployment are limited to only 2 to 6 hour to reduce risk of fish mortality. Use of hook-hours is valid measure of effort. It captures number of baited hooks we deployed and the duration of deployment. Whether hooks are straightened, bait is lost, or if the hook is fouled relates to gear efficiency. We recorded these data to identify general trends that explain substantial differences in capture efficiency should they occur (e.g., hooks fouled by milfoil, excessive baitless hooks due to poor quality of bait, etc.). The primary benefit of hook-hooks was interyear comparison. If we apply your rationale and change hook-hours, then the same change would have to be applied to the egg collection mat program effort estimate (mat-hours). As both units have been used in previous reports that were accepted, we respectfully decline this edit.
Colville Confederated Tribes	3/1/2016	Table 13	Change to fish/overnight set.	Respectfully decline.
Colville Confederated Tribes	3/1/2016	Table 13	Change to fish/overnight set.	Respectfully decline.

Submitting Entity	Date Received	Paragraph	Agency Comment	Grant PUD Response
Colville Confederated Tribes	3/1/2016	Page 41 Paragraph 1	Reword	Sentence 4 changed regarding GRTS site selection.
Colville Confederated Tribes	3/1/2016	Figure 18	X-axis in all of these plots should be river kilometer. Use metric values for measurement throughout the report.	Respectfully declined.
Colville Confederated Tribes	3/1/2016	Figure 18	Should say “Effort” not “Catch Effort”. Catch implies there is catch in the data presented.	Edit accepted.
Colville Confederated Tribes	3/1/2016	Figure 18	This would be better presented as mean CPUE by river km (mile) on a scatter plot. The CPUE’s from independent lines within a RKM aren’t additive.	These are not summations of CPUE; the effort and catch was binned for each river mile and a CPUE calculated; Respectfully declined.
Colville Confederated Tribes	3/1/2016	Figure 18	Should just say CPUE. The per river mile aspect is apparent in the x-axis title.	A bit redundant, but provides some clarity; respectfully declined.
Colville Confederated Tribes	3/1/2016	Page 48 Paragraph 2	Note, mainly the largest and fastest growing hatchery fish are going to recruit to the large hooks used during this study. Thus, growth estimates from this sampling effort are likely biased high.	Agreed in part; we did catch some small juveniles from the other brood years, even a very small 2014BY that took a size 12 hook.
Colville Confederated Tribes	3/1/2016	Page 53 Paragraph 4	What are the impacts of mining broodstock from the least abundant, productive, and genetically diverse of the lower Columbia River reservoirs? Is there a need to begin evaluating alternate collection sites?	Interesting question but beyond the scope of this data report; the BLE broodstock capture data from the McNary tailrace would provide some insight.
Colville Confederated Tribes	3/1/2016	Page 53 Paragraph 5	They didn’t have issues with gear efficiency. They had issues with deployment. These are separate issues. Revise.	Agreed. “Efficiency” removed.
Colville Confederated Tribes	3/1/2016	Page 53 Paragraph 5	This is a mis-characterization. The high winds and large waves affected gear deployment. It didn’t affect the gear performance. Revise.	Agreed; text changed.
Colville Confederated Tribes	3/1/2016	Page 53 Paragraph 5	Include mention of their late start relative to the likely initiation of spawning based on water temperatures. Also, indicate that production may have been low based on 86-50 sub-yearling indexing results. As written, seems to	Addition of the USGS larval capture summary was a last minute add on to this report requested by Grant; Outside the scope of this

Submitting Entity	Date Received	Paragraph	Agency Comment	Grant PUD Response
			suggest this method isn't valid except in rare cases.	report to accurately summarize the work of others; probably should delete this section if treatment is not adequate. The effect late of start time and 86-50 indexing results on catch would be speculation best left to others.
Colville Confederated Tribes	3/1/2016	Page 53 Paragraph 5	Also note that the USGS conducted a pilot study in 2013 at one of the sites sampled by WDFW and captured more than 100 larvae with less than 1/4 the effort.	This is probably captured by the reference study and the appended report; I will delete the last sentence regarding the size and effort to refine the larval capture location as it is speculative.
Colville Confederated Tribes	3/1/2016	Page 58 Paragraph 3	Why would healthy eggs be added to a jar that is experiencing a fungus problem? There is an obvious reason for the low success - poor movement of eggs in the jars due to system difficulties, subsequent fungal infections, followed by the addition of healthy eggs to the jars experiencing fungal outbreaks.	The words "apparently healthy" should have been used instead; eggs with mycelium and uninfected eggs cannot be easily identified and sorted; suspect a mix of healthy eggs and eggs with low level infection were added with the result all come in contact and become infected. Circulation in MacDonald jar is inconsistent even with adequate flow; needs to be dialed in; text edited.
Colville Confederated Tribes	3/1/2016	Page 58 Paragraph 3	While jars ultimately prove ineffective, this experiment wasn't adequate to derive this conclusion. The experiment needs to be repeated with a system that applies adequate flow to the incubation jars consistently and if a fungal infection is occurring in a jar, newly acquired "healthy" eggs must not be added to it.	Based on the results from the BC Hydro streamside incubator, fungus spread throughout the jar even when adequate flow was provided. Separation and isolation of eggs from each other is

Submitting Entity	Date Received	Paragraph	Agency Comment	Grant PUD Response
				probably the best approach.
Colville Confederated Tribes	3/1/2016	Page 59 Paragraph 4	Underrepresented in what manner - the samples are spatially balanced based on surface area?	Agreed; "underrepresented" was not the correct word; text modified.
Colville Confederated Tribes	3/1/2016	Page 59 Paragraph 4	Are you implying that there are large aggregations in the upper reservoir that are missed by using a GRTS strategy? Why wouldn't this also be true for the remainder of the reservoir as the strategy is an equal, area-based spatially balanced design? There are more sites sampled in the rest of the reservoir, but in proportion to the area. This need more explanation.	Agreed.
Colville Confederated Tribes	3/1/2016	Page 59 Paragraph 5	What do you mean by historical data? All data collected prior to the 2015 survey is technically historical.	Agreed.
Colville Confederated Tribes	3/1/2016	Page 59 Paragraph 6	Based on gonad inspection?	Edit accepted.
Colville Confederated Tribes	3/1/2016	Page 60 Paragraph 1	How so?	Edit accepted; text added.
Colville Confederated Tribes	3/1/2016	Page 60 Paragraph 2	Good relative to what? As previously mentioned, the growth estimates generated from this survey are biased high due to gear selection for the largest, fastest growing hatchery fish.	Edit accepted; they continue to grow. No relative measure required.
Colville Confederated Tribes	3/1/2016	Page 60 Paragraph 4	How so? Are your lines saturated?	Would we ever expect our lines to be fully saturated, which I assume means a fish on every hook. No, but if the hook that caught a CRITFC fish had been available for the other cohort, the catch of these cohorts would have be higher. I am not saying the increase would be one for one, just that we would see some increase above what we caught.
Colville Confederated Tribes	3/1/2016	Page 60 Paragraph 4	Where is the evidence of gear competition? Again, how many lines	See response above.

Submitting Entity	Date Received	Paragraph	Agency Comment	Grant PUD Response
			were saturated (i.e., a fish on every hook)?	
Colville Confederated Tribes	3/1/2016	Page 60 Paragraph 4	If the catch of CRITFC fish were reduced, would there really be a substantial increase in the number of lines fished? If so, how many?	6 to 8 additional lines per day would be my guess.
Washington Department of Ecology	3/10/2016	1	The Department of Ecology (Ecology) has reviewed the 2015 White Sturgeon Plan Annual Report sent via email to Ecology on February 10, 2016.	Comment noted.
Washington Department of Ecology	3/10/2016	2	Ecology has no comments for the 2015 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; 3.) White Sturgeon implementation measure “1) Reporting” requirements in Appendix C “Biological Objectives and Implementation Measures” of the 401 Certification	Comment noted.
Washington Department of Ecology	3/10/2016	3	Please contact me at (509) 329-3567 or pmcg461@ecy.wa.gov if you have questions.	Comment noted.

Appendix D
Washington Department of Ecology Approval of the 2015 WSMP Annual Report

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

March 10, 2016

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

RE: Request for Ecology Review and Comments – *2015 White Sturgeon Management Plan Annual Report.* Priest Rapids Hydroelectric Project No. 2114

Dear Mr. Dresser:

The Department of Ecology (Ecology) has reviewed the *2015 White Sturgeon Management Plan Annual Report* sent via email to Ecology on February 10, 2016.

Ecology has no comments for the *2015 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
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) 329-3567 or pmcg461@ecy.wa.gov if you have any questions.

Sincerely,

Pat McGuire

Patrick McGuire
Eastern Region FERC License Coordinator
Water Quality Program

PDM:jab

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