

# Rocky Reach Fish Forum

Wednesday, 1 November 2017

1:00 – 4:00 p.m.

Chelan PUD Second Floor Conference Room

Wenatchee, WA



CHELAN COUNTY

Meeting called by Steve Hemstrom  
Notes taken by Heidi Kunz

Chairperson, Tracy Hillman

## ***Attending Representatives:***

Hemstrom, Steve	Chelan PUD	(509) 661-4281	steven.hemstrom@chelanpud.org
Rose, Bob*	YN	(509) 865-5121	rosb@yakamafish-nsn.gov
Verhey, Patrick	WDFW	(509) 754-4624	Patrick.verhey@dfw.wa.gov
Zimmerman, Breean*	ECY	(509) 575-2808	breean.zimmerman@ecy.wa.gov

## ***Attending Participants:***

Clement, Marcie*	Chelan PUD	(509) 661-4186	marcie.clement@chelanpud.org
Kunz, Heidi	Chelan PUD	(509) 661-4601	heidi.kunz@chelanpud.org
Goudy, Sean*	YN	(509) 480-5196	gous@yakamafish-nsn.gov
Hillman, Tracy	BioAnalysts	(208) 321-0363	Tracy.hillman@bioanalysts.net
Keller, Lance	Chelan PUD	(509) 661-4299	lance.keller@chelanpud.org
Nelle, RD	USFWS	(509) 548-7573	RD_Nelle@fws.gov
Robichaud, Dave	LGL Limited	(250) 656-0127	drobichaud@lgl.com
Underwood, Alene	Chelan PUD	(509) 661-5192	alene.underwood@chelanpud.org
Wright, Corey	Blue Leaf	(509) 210-7423	cwright@blueleafenviro.com

\* Joined via phone.

# Meeting Minutes

## I. Welcome and Introductions

Tracy Hillman welcomed everyone to the Rocky Reach Fish Forum (RRFF or Forum) meeting. Participants introduced themselves.

## II. Agenda Review

The agenda was reviewed and approved with one addition.

- Tracy Hillman added that Grant PUD needs to know by December 2017 if adult lamprey will need to be collected at Priest Rapids Dam for Rocky Reach fish passage studies in 2018.

## III. Approval of Meeting Minutes

The August RRFF meeting minutes were reviewed and approved with no changes. The October PRFF/RRFF/ASWG Pacific Lamprey Subgroup meeting minutes were reviewed and approved with edits.

## IV. Review Action Items

- Alene Underwood will provide the RRFF with a revised copy of the Tumwater Dam Lamprey Passage Feasibility Study. **Complete**
- Steve Hemstrom will look at lamprey counts at The Dalles Dam and compare those to counts at Rocky Reach Dam. **Ongoing – Data have been compiled; next step will be to graph the data**
- Bob Rose will email Donella Miller asking her for the number of sturgeon eggs per ml in the post-fertilization egg samples. **Complete**
- The RRFF/PRFF will think about plausible hypotheses regarding linkages between operational project effects (avoidable or unavoidable) and adult lamprey fate in reservoirs. **Ongoing**
- Tom Skiles will talk with Brian McIlraith regarding linkages or hypotheses that would explain operational project effects of a reservoir, how the operation could affect a reservoir, and how such a reservoir effect could affect conversion of adult lamprey to Wells Dam. **Complete**
- Breean Zimmerman will contact toxicology about who is responsible for monitoring the effects of herbicide applications. **Complete. Breean reported that the Chelan County Noxious Weed Control Board (Weed Board) applied to be covered under a General Use Permit prepared by Ecology. The General Use Permit covers several active ingredients. The**

Weed Board is mandated to control noxious weeds within their boundaries. There is an overlap of boundaries between the Weed Board and the Rocky Reach project area. This overlap will need to be discussed between the two entities. Breean reported that this is not a toxic cleanup issue, but there may be some overlap. Breean will contact Ecology's Environmental Assessment Program to get more information on the active ingredients used in the herbicide to control Eurasian milfoil. Breean stated that Chelan PUD has additional requirements regulated by FERC. Marcie Clement reported she has had ongoing conversations with the Weed Board over the past several years.

- Marcie Clement will contact Mike Mackey about concerns and additional questions discussed at the August RRFF. The discussion will continue at the September meeting so members absent during the August meeting can provide input. **Complete**
- Lance Keller will contact Donella Miller regarding juvenile sturgeon totals. **Complete**
- Ralph Lampman will email Lance Keller a spreadsheet with PIT-tag codes, release location, and release date for lamprey released by the Yakama Nation in the Wenatchee River. **Complete. Lance will request the full PIT-tag codes in an excel format from Ralph Lampman.**
- Steve Hemstrom will provide the RRFF with a Reservoir Operations Hydraulic Analysis Report. **Complete**
- Tracy Hillman will share the four questions with John Ferguson, Chair of the ASWG. **Complete**
- Steve Lewis will review the comprehensive study at Wells Dam for information that may help answer the four questions. **Status unknown but assumed to be ongoing.**

## V. Aquatic Invasive Species

### Use of Herbicide to Control Eurasian Milfoil in Rocky Reach Reservoir

Tracy Hillman stated that during the August meeting, the RRFF discussed a request from the Weed Board asking Chelan PUD to consider the use of an herbicide to control Eurasian milfoil in Rocky Reach Reservoir. At that time, Chelan PUD asked for recommendations from the RRFF. Marcie Clement clarified that the Weed Board submitted the request as comments on the 2010 Chelan County PUD Aquatic Invasive Species Plan. Because Bob Rose and Patrick Verhey were unable to attend the August meeting, Tracy asked them for their input on the request.

Bob Rose stated that he does not recommend the use of an herbicide in the reservoirs. He would like to see a more detailed proposal including more information on the monitoring strategy, effects on other species, and details of who will pay for it.

Patrick Verhey stated that he supports Ecology as the lead on aquatic weed treatments. However, he is concerned about the effects of the herbicide on Pacific lamprey larvae as well as on their habitat. He suggested a simple laboratory study that would measure the survival of lamprey exposed to different

concentrations of the herbicide, and compare those to a control group. He stated that the density and distribution of milfoil patches within Rocky Reach reservoir have not expanded or contracted significantly other than seasonally. He would like to see the Weed Board's master plan for the treatment of milfoil.

Tracy commented that during the November PRFF meeting, there was a recommendation that Elena Nilsen with USGS speak to the PRFF and RRF about the potential effects of the herbicide on Pacific lamprey. Tracy will contact Elena to see if she can attend a future RRF meeting.

Marcie confirmed that the weed patches do typically contract and expand seasonally. She stated that the patches are not made up entirely of milfoil. The chemical that is being recommended specifically targets milfoil and does not appear to harm native vegetation. The Weed Board treated the milfoil near Entiat. Water quality monitoring did not occur, because it is not a requirement.

Marcie will contact Mike Mackey regarding RRF concerns about possible effects of the herbicide on Pacific lamprey, their master plan for the treatment of milfoil, and to let him know that any further discussions or questions relating to the RRF can be directed to Tracy Hillman.

#### **Action Items:**

- **Breean Zimmerman will contact Ecology's Environmental Assessment Program to get more information on the active ingredients used in the herbicide to control Eurasian milfoil.**
- **Tracy Hillman will contact Elena Nilsen with USGS about speaking to the PRFF/RRF on the effects of the herbicide on Pacific lamprey.**
- **Marcie Clement will contact Mike Mackey about concerns discussed at the November RRF meeting.**

## **VI. White Sturgeon**

### **Juvenile Rearing Update**

Lance Keller reported that there are 6,703 juvenile white sturgeon on station at Chelan Hatchery. These are divided into ten different groups. The largest group is about 70 fish per pound and the smallest is about 174 fish per pound. All sturgeon at the hatchery average about 106.5 fish per pound. Health monitoring found no evidence of white sturgeon iridovirus. They will be evaluated for the virus one last time when they are PIT-tagged. Lance stated that Chelan PUD is a bit concerned about the fish reaching the size target for release, but they are comfortable with the size of the fish at this time.

### **2017 Monitoring Updates**

Lance Keller reported that 2017 monitoring and indexing is now complete. Monitoring occurred over five sessions for a total of 46 days. A total of 1,490 sturgeon were captured in the Rocky Reach reservoir. Of these, 541 had been previously recaptured and 949 had not been captured since release. The 2013

release year continues to dominate the catch with a total of 660 fish, making up 40% of the overall catch. The 2015 release year made up 23% and 2014 made up 17%. About 140 fish were released in 2012 and 8 of those were recaptured (0.5% of the total catch). A total of 47 fish were recaptured from the original release year (2011). Sturgeon released in 2011 may have grown to a size that they no longer recruit to the sampling gear. Lance will look into the possibility of using different gear that may be better suited to capturing the fish from the 2011 release year.

### Presentation on 2016 Monitoring Results

Corey Wright from Blue Leaf Environmental and Dave Robichaud from LGL Limited presented the presentation, *Rocky Reach Reservoir White Sturgeon Monitoring and Evaluation Program 2016* (see Attachment 1).

Corey clarified that movement of white sturgeon is defined as moving upstream or downstream from one detection array to another, a minimum distance of 6 km. He explained that Residence Time is a snapshot of where the total fish are residing. The end of residence within a location occurs when the fish leave that location for more than 20 minutes.

Patrick questioned whether the high density of white sturgeon downstream from Wells Dam could be the reason that adult Pacific lamprey are not entering the fishway there. Dave Robichaud commented that more detailed information on white sturgeon at Wells Dam will be included in the Wells Dam Pacific lamprey Report. Corey reported that the same behavior patterns are occurring with white sturgeon downstream from Rock Island dam.

Corey said the acoustic tags used for the 2012 and 2013 releases have a life of 2 to 3 years and are expiring. Fish from the 2015 release year were tagged with 10-year tags.

Corey clarified that on the Residence Time slide there could be fish that are residing between the receivers that are not represented on the graphic.

Corey stated that no lamprey were found in the stomachs of the white sturgeon they examined. The sturgeon they are monitoring are too small to consume an adult lamprey. The lack of ammocoetes in sturgeon may be a function of the timing of sampling. Corey added that using a rod and reel minimizes the time it takes to catch the fish and therefore minimizes regurgitation. He said it is the most common method of catching white sturgeon for diet sampling. Lance Keller stated that once the sturgeon are in the boat, they have not observed significant regurgitation. He added that gastric lavage is limited because it only samples the upper third of the gut. Sacrificing the fish would give a more complete picture of their diet.

Bob Rose asked if there is anything to be learned from the diet information collected so far. Corey responded that there is nothing novel in the diet sample compared to other white sturgeon populations. The information collected is a preliminary snapshot of what the sturgeon are eating. In the future, the monitoring could look at different areas in the reservoir that might have different prey bases and how

that relates to growth and survival levels. Diet will be an important factor in studying the effects of stocking sturgeon in the reservoir and estimating carrying capacity.

Bob stated that the frequency of insects in the diet seemed high and the frequency of crayfish seemed lower than expected. Corey responded that crayfish were a significant weight contribution, although it appeared small compared to fish. He stated that all but two of the diet samples were from the upper third of the river, with the majority collected in the Wells Tailrace. He would like to sample fish from a larger part of the reservoir in the future. Lance would also like to look at how diets may change with sturgeon age.

Dave explained how they calculated long-term survival. Each year a subset of the population is caught, and the detection probability is calculated by looking at how many fish are recaptured from each release year. Survival rates can be calculated using the detection probability and the total number of fish caught from each release year. Survival rates can be calculated for each time step, including short, intermediate, and long-term. The long-term survival rates are a percentage of how many fish survive per year. The survival rates are subject to change as more data are added each year. Modeled survivals reflect "apparent survival," because they don't account for other reasons the fish may not be detected such as tag loss or emigration. Telemetry was used to estimate the emigration rate at about 8%. Emigration would affect the survival rates in a minor way and would also apply across the board for all release years.

Bob Rose asked if Dave is reasonably confident in the information contained in slide 39, "Abundance Estimates." Dave responded that the information on the newer release cohorts will likely move around, but the patterns observed in previous years have held steady each year. Specific survival rates will change from year to year depending on the addition of new data.

Bob Rose asked if they assume no mortality from hooking and handling. Dave responded that the survival rate does not account for the agent of mortality. Survival is estimated from one survey to the next, regardless of why or how the fish died. Instantaneous mortality ranges from 0-4 fish per year and the majority of these losses are from set lines that were fished for 48 hours instead of 24 hours. Long-term mortality from capture is unknown. In general, the fish look healthy when they come off the set lines.

Tracy Hillman asked if there is any evidence the model is over parameterized. Dave responded that there are a lot of data and the confidence bounds seem to be believable.

Steve Hemstrom asked how many years of data it will take to determine that the capture probabilities are robust. Dave responded that there are only two years of data using the current methods. As data continue to be added each year, eventually the capture probabilities will stabilize. If different methods or gear types need to be used in the future, two separate models may be required. Corey stated that the first six years of survival estimates will have the greatest effect on adjustments to stocking.

Alene asked if any conclusions can be drawn from the apparent downturn in survival rates for each release year. Dave responded that his first conclusion would be the presence of density dependence. Corey stated that there are some other signs of density dependence, such as higher growth rates in the lower reservoir where sturgeon densities are lowest. This will be discussed in the 2017 draft report, which should be available in January 2018.

Steve Hemstrom asked if length/weight relationships will give the best indication of growth rates to estimate carrying capacity. Dave said growth over time is also an important consideration. Tracy stated that growth, movement, and survival are good indicators of density dependence. Dave commented that they have been comparing the fish against standard lengths and weights, and that this metric can also be used as an indicator. Alene said she is interested in observing changes over time with each individual group.

## VII. Pacific Lamprey

### Lamprey Passage Feasibility Study at Tumwater

Alene Underwood reviewed the Tumwater Dam Lamprey Passage Feasibility Study. Alene commented that with the additional number of arrays at Tumwater this year, more information is available about what is going on at the facility. Steve Hemstrom said that Ralph Lampman has already provided comments on the report.

#### Action Item:

- **Provide comments on the Tumwater Dam Lamprey Passage Feasibility Study to Alene Underwood by 30 November 2017.**

### Comments on 2016 Final Passage and Escapement Report

Tracy Hillman reported that comments on the *2016 Draft Passage and Escapement Report* were due in February 2017. After the final report was submitted to the RRF, some members identified additional comments. Tracy said it is unlikely we can address these comments in the 2016 report; however, they can be addressed in the 2017 report. Steve Hemstrom added that he will incorporate those comments into the 2017 report as best possible. He requested that future comments or responses be put directly into draft reports during the document review period.

Steve Hemstrom gave a brief update on the final 2016 report. In 2016, Chelan PUD released 211 PIT-tagged adult Pacific lamprey at Kirby-Billingsley Hydro Park. The main objective of the study was to measure passage rates through the fishway at Rocky Reach Dam and to determine if improvements made to the fishway in 2011 improved passage rates. Of the tagged fish released, 164 were detected in the fishway at Rocky Reach. Of those, 162 were detected at the exit antenna and were not detected again downstream in the same year. In June and July 2017, five of those fish were detected in the

juvenile fish bypass system at Rocky Reach. The fish resided upstream for nearly a year and were most likely post-spawn lamprey. None of these five fish were detected previously in the Entiat River.

Another objective of the study was to estimate escapement rates into the Entiat, Wenatchee, and Methow rivers. Based on detection through September 2017, 11 of the 2016 PIT-tagged fish were detected in the Wenatchee River and 13 in the Entiat River. Detection probabilities within the tributaries is unknown and depends on when the fish enter the tributary and the flows that are occurring at that time.

**Action Item:**

- **Steve Hemstrom will talk to Ralph Lampman about his comments on the *2016 Final Passage and Escapement Report*.**

### **Update on 2017 Passage and Escapement Study**

Steve Hemstrom reported that Chelan PUD conducted another passage study in 2017 with methods identical to those in 2016. A total of 300 fish were captured and tagged at Priest Rapids and released at Kirby-Billingsley Hydro Park. Of those, 274 have been detected somewhere. A total of 257 have been detected in the fishway at Rocky Reach Dam and 249 of those were last detected at the exit antenna at the top of the fishway. Steve noted that for the fish released in 2016, no additional tagged lampreys were detected in the Rocky Reach fishway past September of that year. Chelan PUD will continue to monitor the adult lamprey released in 2017.

### **Summary of 2017 Half-Duplex PIT-Tag Detections at Rocky Reach**

Steve Hemstrom reported that Grant PUD released 100 Half-Duplex PIT-tagged fish as part of a pilot test of entrance efficiencies at Wanapum and Priest Rapids dams. Of those released, 60 were detected at the exit antenna at Rocky Reach. Steve will provide a more detailed report on their detections within the fishway and also share the information with Grant PUD.

Bob Rose commented that over 500 Pacific lamprey entered the Yakima River this year, which is a significant increase from past years. None of the fish were from the 2017 release year.

Steve Hemstrom stated that it is unknown at this time if Chelan PUD will conduct another lamprey study in 2018. With two years in a row of passage rates above 90%, another study may not be necessary. Steve will have internal discussions to determine if Chelan PUD is interested in doing another study and then contact RRFF for their input by email.

**Action Item:**

- **Steve Hemstrom will have internal discussions at Chelan PUD about conducting a 2018 Adult Lamprey Passage and Escapement Study. He will contact Grant PUD about a fish source if needed.**



## Results from the October Subgroup Meeting

Tracy Hillman sent the four questions from the PRFF/RRFF Pacific Lamprey Subgroups to John Ferguson (Chair of the ASWG) and Andrew Gingerich (Douglas PUD). The questions were:

1. Is there any evidence that adult sturgeon are in the fishways and tailrace of Wells Dam during the time adult lamprey are migrating through the project area?
2. Is there a summary of results of tailrace and fishway passage efficiencies and entrance efficiencies for adult lamprey at Wells Dam? If so, would the ASWG please share those with the Subgroups?
3. Are there velocity profiles for various flow conditions at the entrances of the fishways at Wells Dam? If so, would the ASWG share those with the Subgroups?
4. Why is the ASWG not comfortable using adult lamprey trapped downstream (e.g., at Priest Rapids Dam or other downstream locations) for conducting passage efficiency studies?

The ASWG will discuss the questions at their next meeting and Tracy expects to receive feedback from them after that.

## Pacific Lamprey Summit

Tracy commented that there will be a Pacific Lamprey Summit at the Convention Center in Portland, OR during the first week in December. Bob Rose is a co-chair for the event. There will be a policy meeting on 5 December and technical discussions on 6 and 7 December. Bob Rose asked policy members to RSVP for the summit.

## VIII. Bull Trout

### 2018 Rocky Reach Bull Trout 10-Year Check-In Study

Steve Hemstrom reported that a 10-year check-in study is required for Bull Trout. The study will be conducted in 2018. This will include trapping adult fish at Rocky Reach and tagging them. He will update the RRFF as more details on the study are known.

Steve commented that Chelan PUD would prefer not to do a bull trout trapping study and a Pacific lamprey passage study in the same year. If both studies are done, the timing would need to be discussed.

## IX. Public Comment

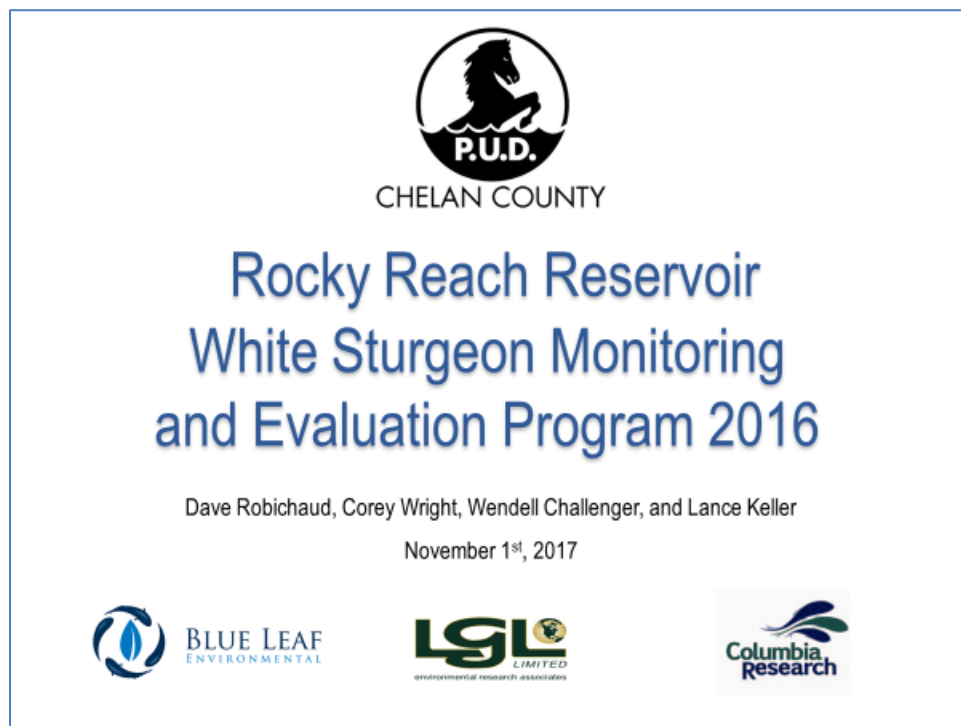
None.

## X. Next Meeting

The next meeting of the RRF is scheduled for Wednesday, 3 January 2018 from 1:00 to 4:00 p.m. at the Chelan PUD office in Wenatchee at 327 N. Wenatchee Avenue (2<sup>nd</sup> Floor Conference Room). There will not be a RRF meeting in December because of the Pacific Lamprey Summit in Portland. Please contact Tracy with any issues that may need to be discussed before the next scheduled meeting in January.

# Attachment 1

## Rocky Reach Reservoir White Sturgeon Monitoring and Evaluation Program, 2016

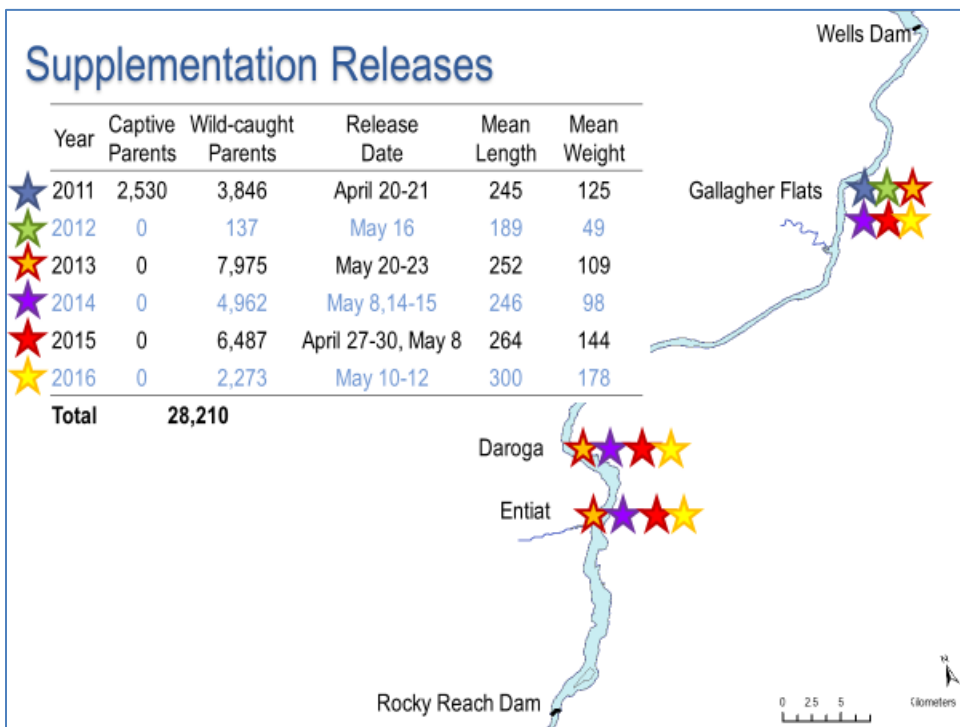
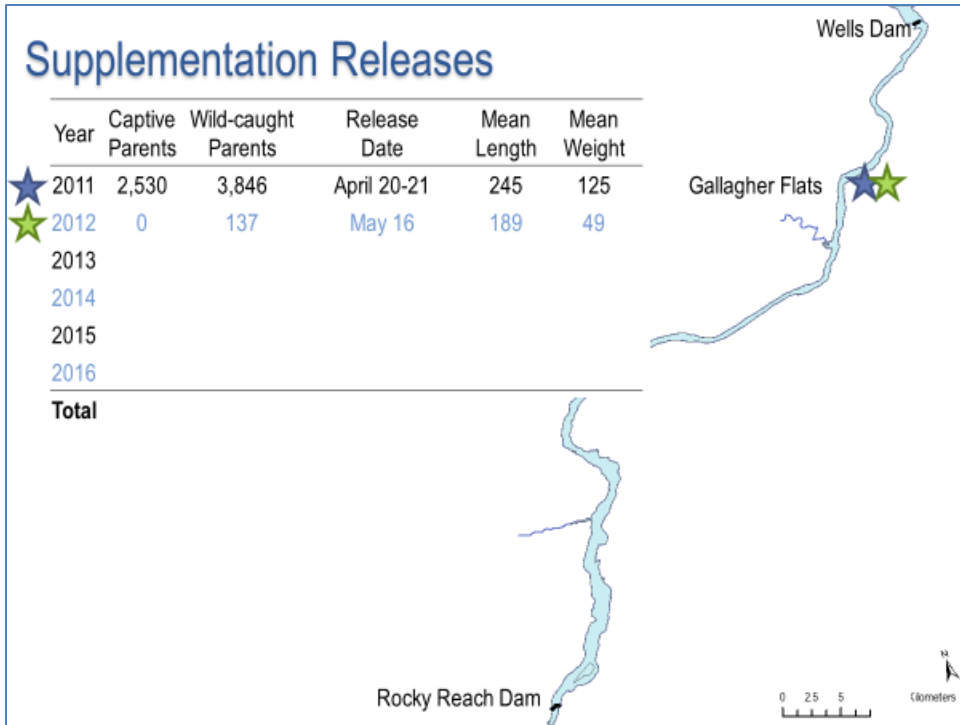


# White Sturgeon Management Plan

- Need for supplementation identified and management plan adopted with overall goal of  
*“promoting white sturgeon population growth in the Rocky Reach Reservoir to a level that is commensurate with available habitat”*
- **Supplementation Program** began in 2010 with first broodstock collection (first released in 2011)
- **Monitoring and Evaluation Program** began in 2012

## Supplementation Program



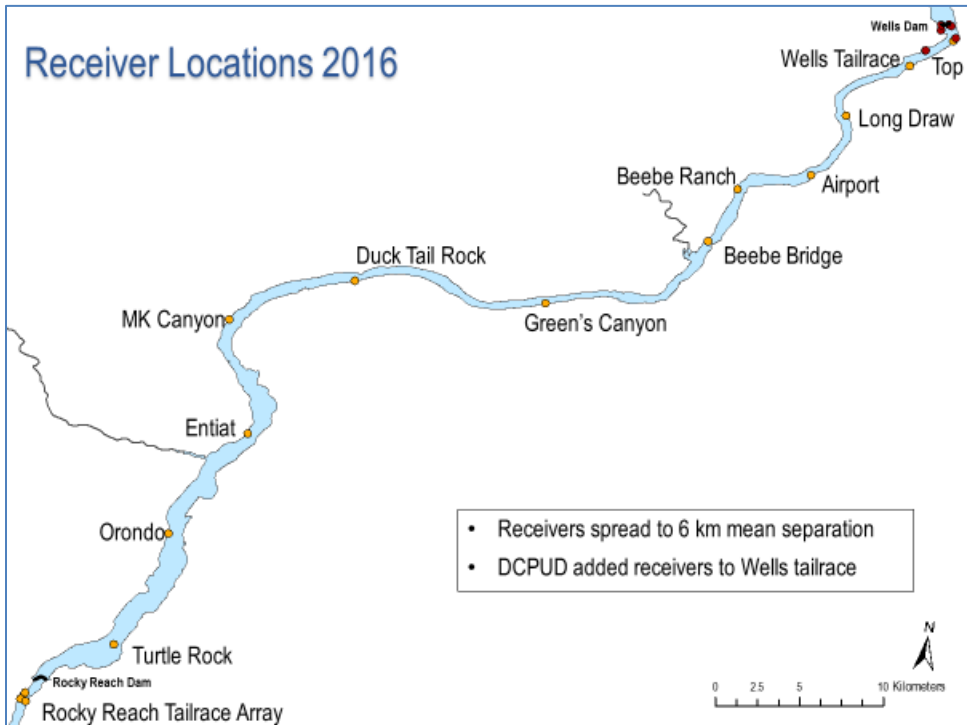
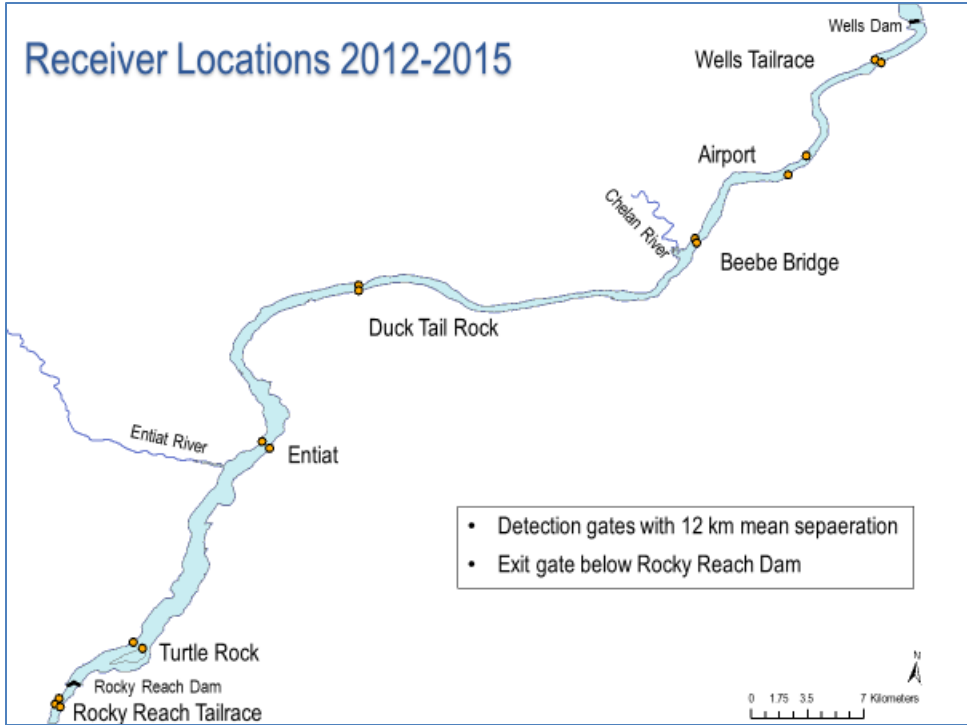


# Monitoring and Evaluation Program

- **Acoustic Telemetry Study:** tracking tagged fish to determine emigration rates (part of survival analysis), investigate behavior & look at habitat use (2012 – 2016)
- **Indexing Study:** random sampling & mark-recapture study to look at survival, growth, and distribution (2013 - 2016)
- **Diet Study:** rod and reel angling with gastric lavage to determine diet of supplementation sturgeon (2016)

## Acoustic Telemetry Study





## Vemco Acoustic Tags



- Tag 1% of each years release 2012-2014
- 2015 50 larger older recaptured sturgeon tagged to estimate emigration over time

Year	Acoustic Tags Released
2012	35
2013	69
2014	65
2015	50
<b>Total</b>	<b>216</b>

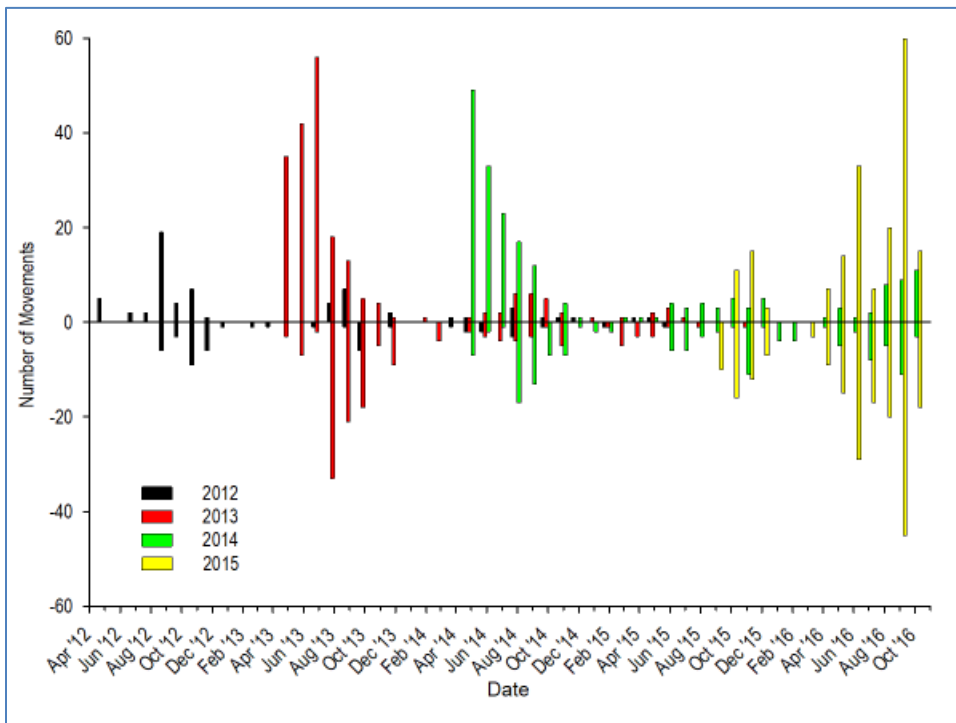
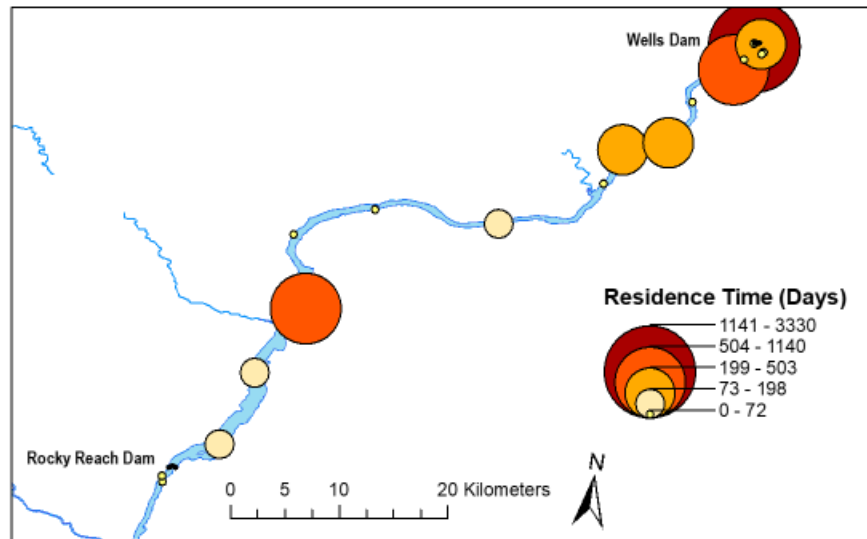
Vemco Tag Model	Qty	Est. Expiration Dates/Years
V9P-2L	5	1 Jun 2016
V13P-1L	1	26 Dec 2016
V9-2L	50	2017
V13-1L	3	2017
V13-1L	50	2020
<b>Total</b>	<b>109</b>	

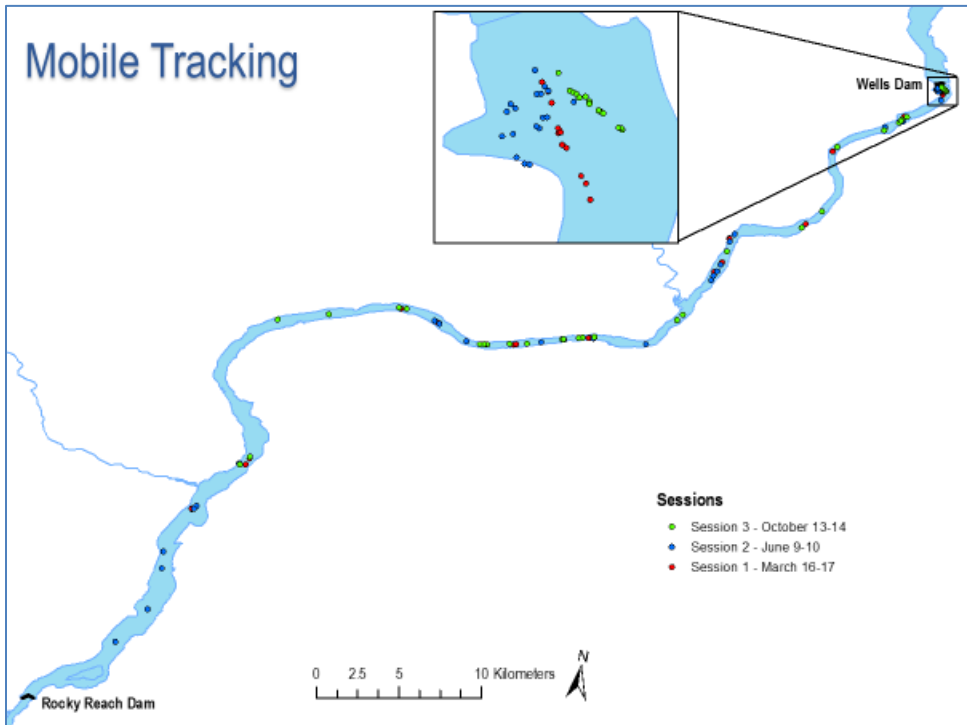
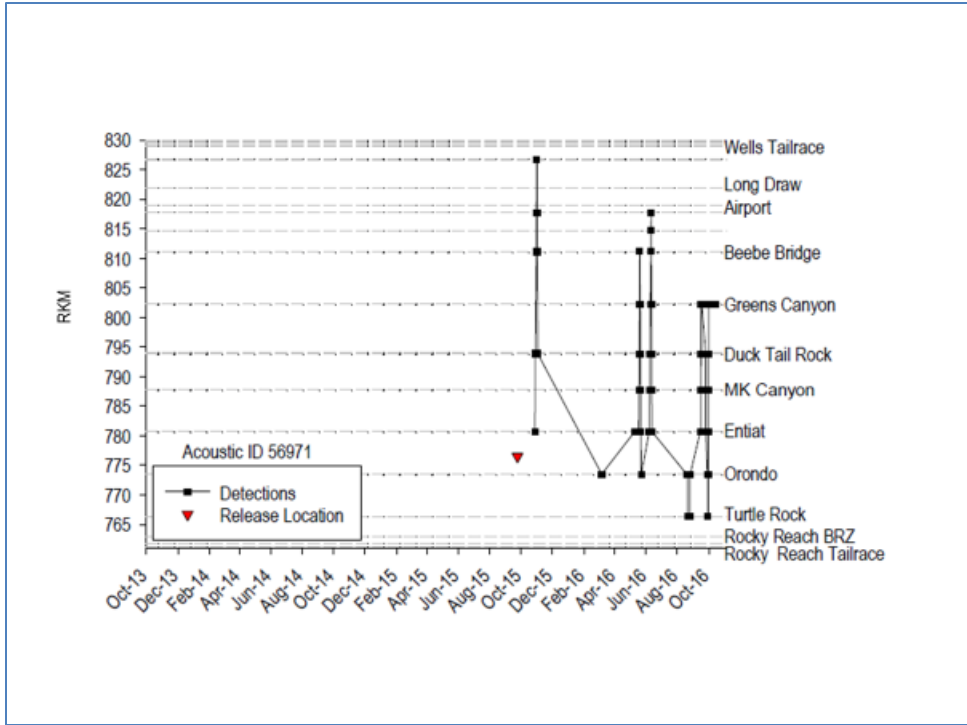
## Acoustic Detections

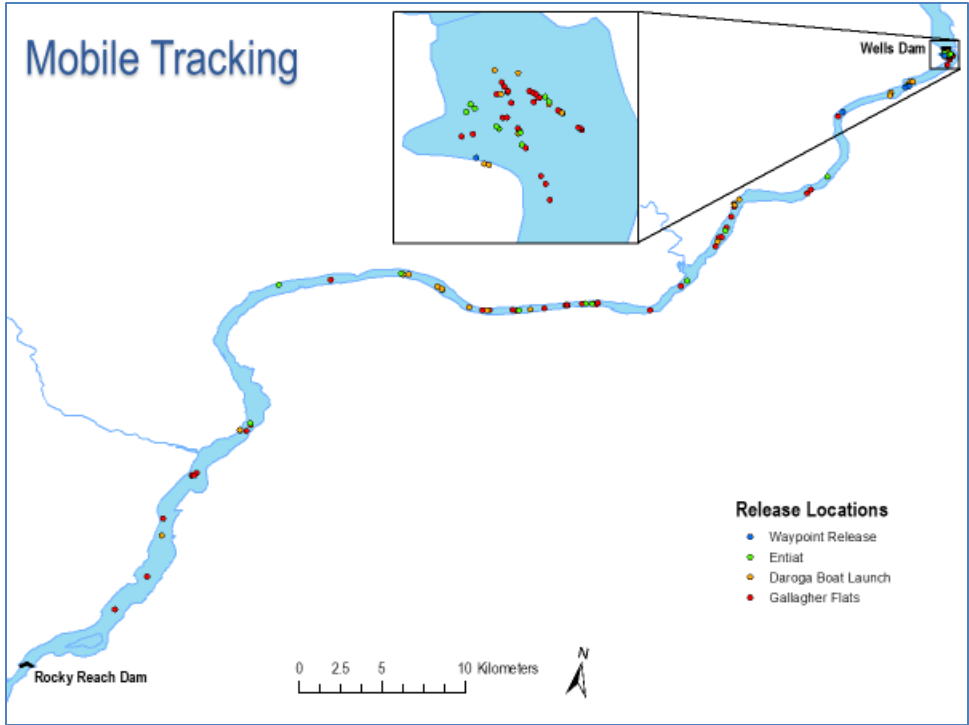
- Similar to past years, high use of upper reservoir persists with the most individuals and longest residence times in the top third of the reservoir.
- The 50 older (age-4 and age-6) sturgeon tagged in 2015 comprised 78% of movements in 2016.
- A subset of the older tagged sturgeon traveled farther than younger fish and some even made multiple reservoir transects more similar to behavior seen in adults.



## Residence Time







## Emigration

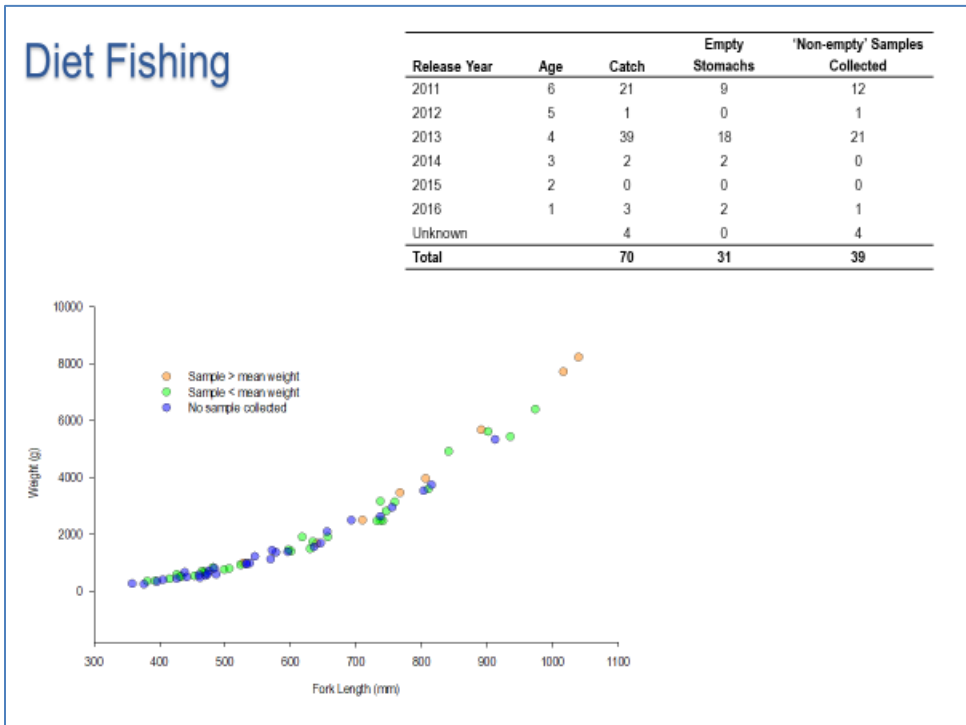
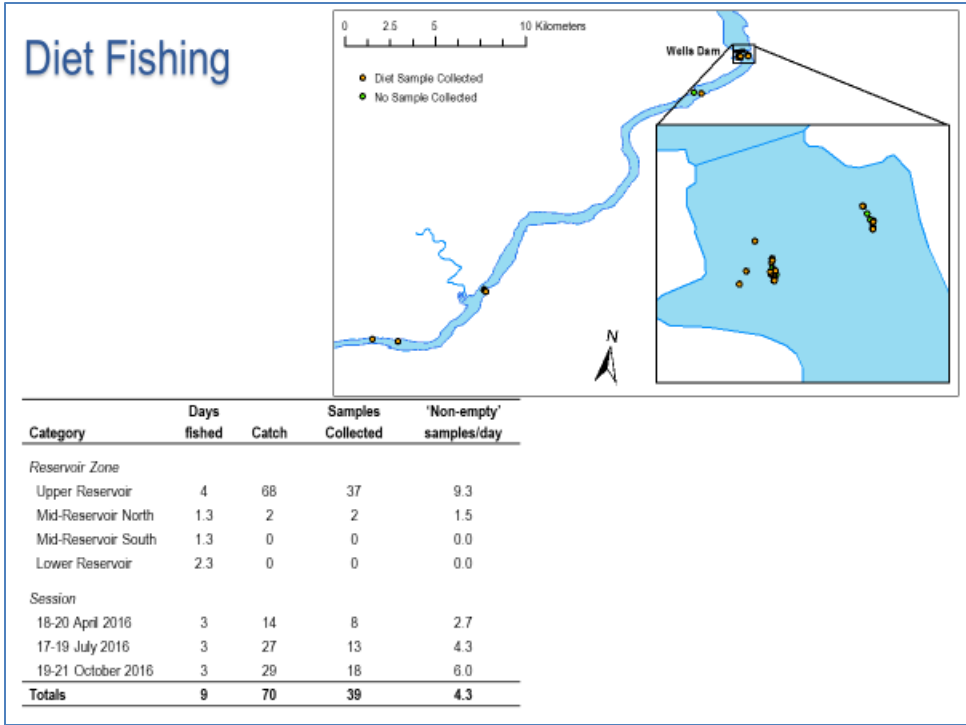
Time Interval	Months After Release from Hatchery	Average Number of Active Tags	Total # of Emigration Events	Emigration Proportion	Equivalent Emigration Rate (% per year)	Hypothetical: 10,000 Fish Released	
						Emigrated	Remained
Before 1 <sup>st</sup> index	1-3	137.5	2	1.45%	5.82%	145	9,855
1 <sup>st</sup> - 2 <sup>nd</sup> index	5-15	118.0	3	2.54%	2.54%	250	9,605
2 <sup>nd</sup> - 3 <sup>rd</sup> index	16-27	127.8	3	2.35%	2.35%	226	9,379
After 3 <sup>rd</sup> index	28+	95.1	2	2.10%	2.10%	197	9,182
<b>TOTAL</b>			<b>10</b>			<b>818 of 10,000 (8.2%)</b>	

## Diet Study

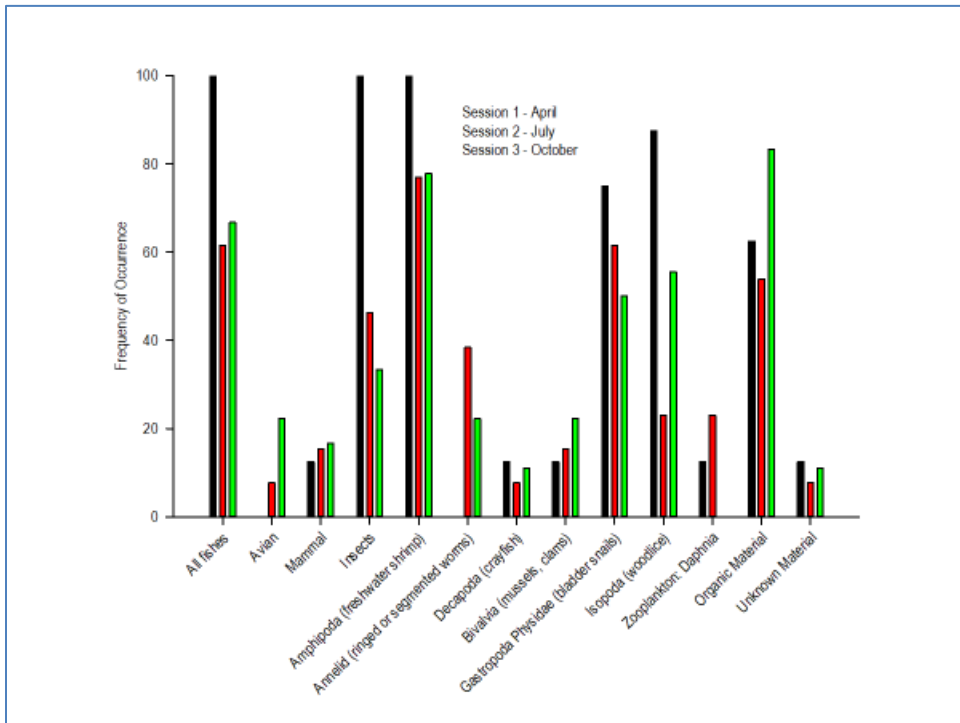


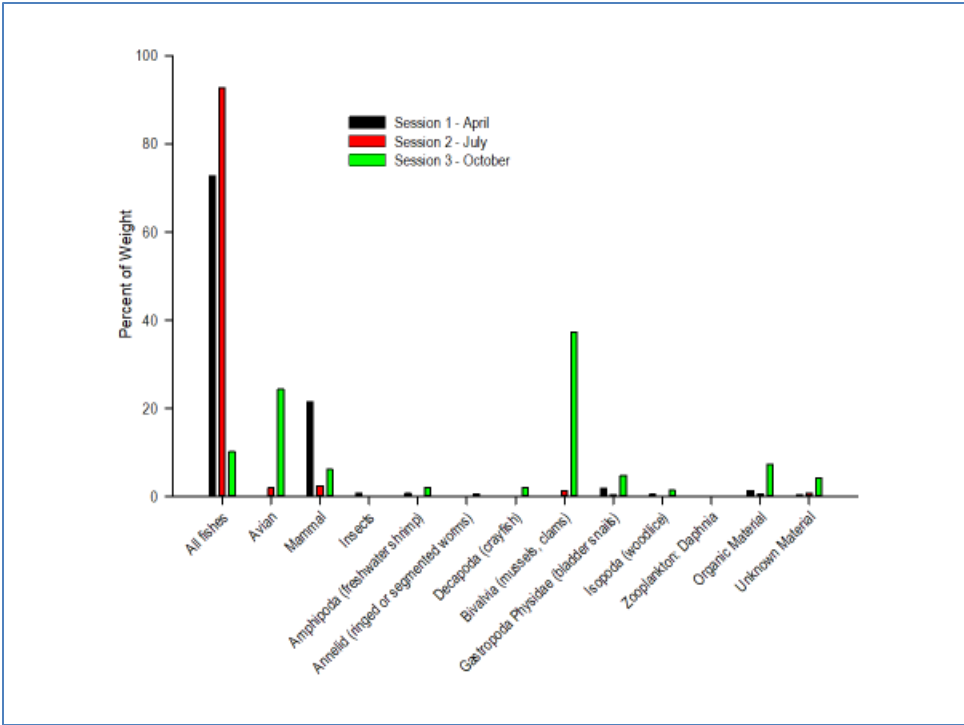
## Diet Study





Prey Taxa	Number of samples (N= 39)	Frequency of occurrence (% out of 39 samples)	Weight (g) all samples	Proportion of total weight	Mean proportion of individual's sample weight
<b>Fish</b>					
Unknown Fish	18	46.2%	53.17	45.2%	22.6%
Unknown Salmonid	1	2.6%	0.52	0.4%	0.4%
Unknown Non-salmonid	3	7.7%	0.28	0.2%	3.7%
Chiselmouth ( <i>Acrocheilus alufaceus</i> )	1	2.6%	28.02	23.8%	1.5%
Sculpin (Cottidae)	1	2.6%	0.61	0.5%	0.5%
Three-spined Stickleback ( <i>Gasterosteus aculeatus</i> )	9	23.1%	1.49	1.3%	10.0%
Northern Pike/minnow	2	5.1%	5.15	4.4%	2.2%
<b>All Fish</b>	<b>28</b>	<b>71.8%</b>	<b>89.24</b>	<b>75.8%</b>	<b>40.9%</b>
<b>Other</b>					
Unknown Mammals	6	15.4%	8.39	7.1%	6.3%
Birds	5	12.8%	5.28	4.5%	4.4%
Rodents	1	2.6%	1.24	1.1%	0.1%
Coleoptera (Beetles)	1	2.6%	0.09	0.1%	0.1%
Diptera (Flies)	14	35.9%	0.11	0.1%	0.5%
Ephemeroptera (Mayflies)	3	7.7%	0.05	< 0.1%	< 0.1%
Hemiptera (True bugs)	1	2.6%	< 0.01	< 0.1%	< 0.1%
Plecoptera (Stoneflies)	1	2.6%	0.01	< 0.1%	< 0.1%
Tricoptera (Caddisflies)	9	23.1%	0.05	< 0.1%	0.6%
Unknown Insect Parts	5	12.8%	0.01	< 0.1%	< 0.1%
Amphipoda (freshwater shrimp)	32	82.1%	0.65	0.6%	8.6%
Annelid (ringed or segmented worms)	9	23.1%	0.14	0.1%	3.3%
Bivalvia (mussels, clams)	4	10.3%	0.36	0.3%	0.3%
Decapoda (crayfish)	7	17.9%	6.93	5.9%	7.8%
Gastropoda: Physidae (bladder snails)	23	59.0%	1.61	1.4%	10.4%
Isopoda (woodlice)	20	51.3%	0.38	0.3%	2.7%
Zooplankton: Daphnia	4	10.3%	< 0.01	< 0.1%	0.0%
Organic Material	27	69.2%	1.96	1.7%	11.5%





# Questions

## Acoustic Telemetry and Diet Analysis

# Indexing Study



## Setline Fishing

### 2011-2012: White sturgeon caught incidentally in Pikeminnow gear

12-14 setlines per day. Effort unknown.  
Lines 76 m, 100 treble hooks (size 2-6), baited with crickets or worms.

### 2013: Indexing Program – Phase I start

8-10 setlines per day. 50 days over five sessions.  
Stratified random site selection. Supplemented with targeted sets.  
Lines 76 m, 80 treble hooks (size 2-6), baited with crickets or worms.  
At end of year, experimented with circle hooks & squid bait.

### 2014-15: Indexing Program – Phase I continued

8-10 setlines per day. 45 days over five sessions.  
Stratified random site selection. Supplemented with targeted sets.  
Lines 76 m, 80 hooks (some with treble hooks with crickets or worms; others circle hooks with squid)

### 2016: Indexing Program – Phase II start

8-10 setlines per day. 45 days over five sessions.  
Method standardized with other mid-Columbia River PUDs.  
Random location selection. No more targeted sets.  
Lines 122 m, 40 circle hooks (2.0 and 4.0 gauge), baited with squid.





## Mark Recapture Model

Cormack Jolly Seber (CJS) Model estimates both:

- capture probability ( $p$ ) during each sampling event
- survival rate ( $\Phi$ ) between each sampling event

**The better you can resolve  $p$ , the greater your confidence in  $\Phi$ .**



Survival Man &  
Capture Probability Kid

## Indexing Design

- Don't be surprised if modifications are required
- Changes are more likely over sturgeon time-frames

**If you are going to make changes to the indexing methods, you need detection and survival models that can account for them**



## Detection Modelling

Capture Probability ( $p$ ) Model Terms:

- $M_t$  Sampling method (incidental, random, targeted)
- $H_t$  Gear (treble-cricket vs. circle-squid)
- $E_t$  Effort (number of setlines deployed)
- $A_{i,t}$  Sturgeon age (cohort effects)
- $year_t$  Annual differences



## Detection Modelling

Detection Model: $\text{logit}(p_{i,t}) =$	npar	$\Delta\text{AICc}$
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + \text{year}_t; M_t; H_t; \log(A_{i,t})$	35	0.00
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + M_t; H_t; \log(A_{i,t}) + M_t; H_t; \log(E_t): \log(A_{i,t})$	33	15.01
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + M_t; H_t; \log(A_{i,t})$	27	18.29
$M_t + H_t + M_t; H_t; \log(E_t) + M_t; H_t; \log(A_{i,t})$	19	109.55
$M_t + H_t + M_t; H_t; \log(E_t) + H_t; \log(A_{i,t})$	16	114.82
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + M_t; H_t; \log(E_t): \log(A_{i,t})$	27	248.32
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + H_t; A_{i,t}$	24	308.84
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + M_t; H_t; A_{i,t}$	27	310.10
$M_t + H_t + M_t; H_t; \log(E_t) + M_t; H_t; \log(A_{i,t}): \log(E_t)$	19	354.22
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + \log(A_{i,t})$	22	356.43
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + A_{i,t}$	22	451.01
$M_t + H_t + M_t; H_t; \log(E_t) + \log(A_{i,t})$	14	487.27
$M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t)$	21	503.95
$M_t + H_t + \text{year}_t + M_t; H_t; \log(E_t)$	18	619.25
$M_t + H_t + M_t; H_t; \log(E_t)$	13	626.67
$M_t + H_t + M_t; H_t; E_t$	13	723.64
$M_t + H_t + M_t; H_t$	10	1906.77
$M_t; \text{year}_t$	12	2633.27
$M_t$	5	4501.37
$\beta_0$	3	4540.64

COMPLEXITY



## Detection Modelling

Capture Probability ( $p$ ) Model Terms:

- $M_t$  Sampling method (incidental, random, targeted)
- $H_t$  Gear (treble-cricket vs. circle-squid)
- $E_t$  Effort (number of setlines deployed)
- $A_{i,t}$  Sturgeon age (cohort effects)
- $\text{year}_t$  Annual differences

Final Detection Model (33 parameters):

$$\text{logit}(p_{i,t}) = M_t + H_t + \text{year}_t; M_t; H_t; \log(E_t) + M_t; H_t; \log(A_{i,t}) + M_t; H_t; \log(E_t): \log(A_{i,t})$$

Method Gear Effort Effects Age Effects



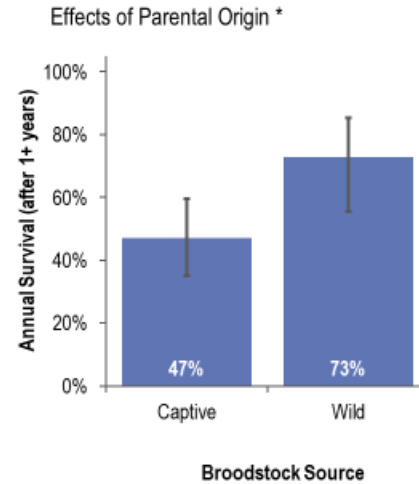
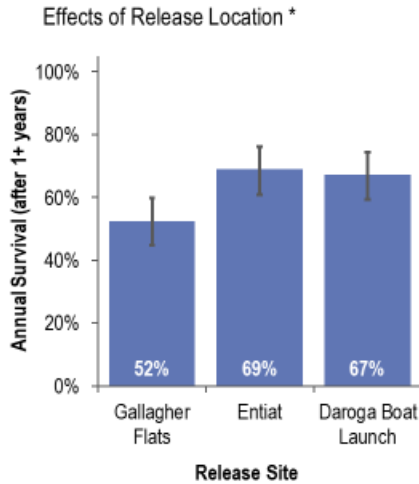
## Survival Modelling

Survival ( $\Phi$ ) Model Terms:

- $\beta$  Base survival rate (intercept)
- $R_{i,t}$  'Short-term survival' (first few months) -- distinguishes short- vs. long-term survival
- $Y'_{i,t}$  'Medium-term survival' (rest of first year)
  
- $G_j$  Release group (cohort effects)
- $L_j$  Sturgeon length
- $H_j$  Hatchery effects
- $O_j$  Parental origin (progeny of wild vs. captive parents)
- $RL_j$  Release location (3 locations to compare)

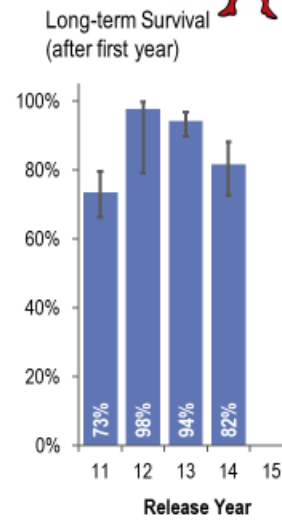
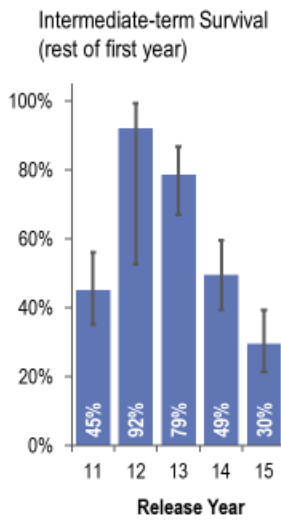
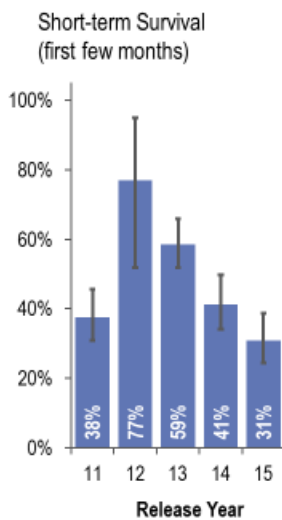


## Survival Modelling Hypothesis Tests



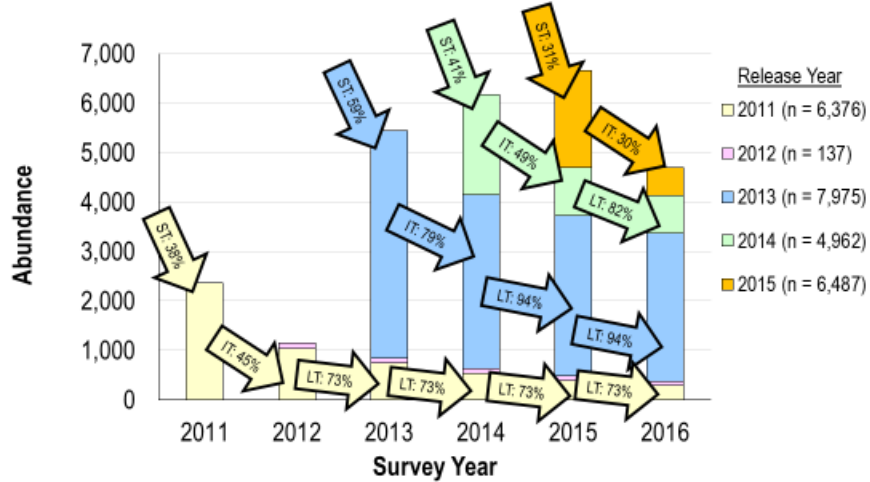
\* 2015 results

## Survival Modelling Cohort Differences



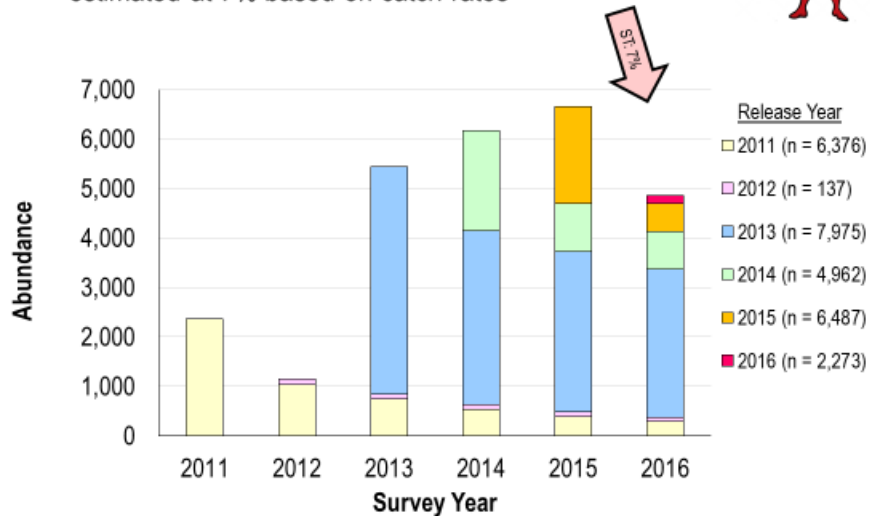
## Abundance Estimates

Next step: survival rates are used to estimate age-structured abundance in reservoir



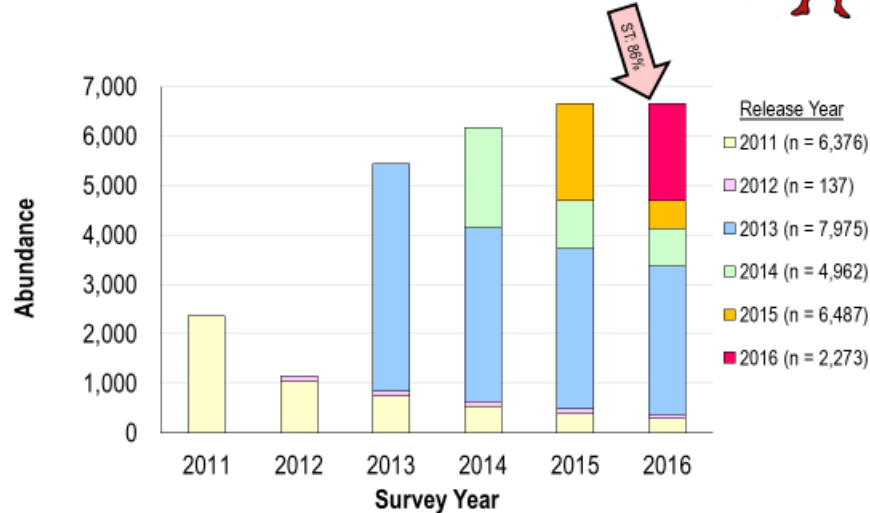
## Abundance Estimates

Survival of 2016 remains unknown; estimated at 7% based on catch rates



## Abundance Estimates

Survival of 2016 remains unknown;  
would have to be 86% for stable Reservoir abundance



## Conclusions

- High use of upper reservoir with relatively low emigration from reservoir of acoustically tagged individuals to date
- Diets consistent with other studies with the exception of birds and mammals
- Complex detection model allowed survival differences between parental origin and among release locations to be detected
- Survival rates low initially, improve over time
- Cohort-specific survival rates have been declining since 2012
- Abundance in Reservoir declining, despite addition of thousands of new fish



