Grant County
PUBLIC UTILITY DISTRICT
*Excellence in Service and Leadership*

# Priest Rapids Fish Forum
# Meeting

**Wednesday, 1 October 2014**
**9:00 a.m. – 12:00 p.m.**
**Grant PUD, 11 Spokane St., Suite 205B, Wenatchee, WA**
**Call-In Number: 1-800-977-8002, Bridge: 7422882**

## AGENDA

I. Welcome and Introductions (9:00 to 9:10)

II. Agenda Review (9:10 to 9:15)
   - A. Additional agenda items (All)
   - B. Approve September Meeting Notes (All)
   - C. Review Action Items from September meeting (All)

III. Update on Wanapum Dam and fish passage (9:15-10:00)

IV. Update on PLMP (10:00-11:00)
   - A. NNI update (Rose and Clement)
   - B. Lamprey passage and trap-n-haul (Clement)
   - C. Lamprey Regional Implementation Planning Process (Nelle)
   - D. Summary of OLAFT tour (All)
   - E. Other lamprey items (All)

V. Update on WSMP (11:00-12:00)
   - A. Update on 2014 stocking (Clement)
   - B. Stocking decision for 2015 (All)
   - C. Update on rearing (Rose and Miller)
   - D. Monitoring updates (Clement)
   - E. Protocol for dealing with dead broodstock (All)
   - F. Other white sturgeon items (All)

VI. Next Meeting: 5 November 2014 – Grant PUD Natural Resources Wenatchee Office

# Priest Rapids Fish Forum

Wednesday, 1 October 2014
Grant PUD Wenatchee Office

## PRFF Members

Stephen Lewis, USFWS
Bob Rose, YN
Carl Merkle, Umatilla Tribe
Tom Dresser, GCPUD
Aaron Jackson, CTUIR
Patrick Verhey, WDFW
Keith Hatch, BIA
Pat McGuire, WDOE
Mike Clement, GCPUD
Jason McLellan, CCT

## Attendees:

Pat McGuire, WDOE
RD Nelle, USFWS
Doris Squeochs, Wanapum
Jason McClellan, CCT (Via phone)
Mike Clement, GCPUD
Donella Miller, YN
Tracy Hillman, Facilitator
Patrick Verhey, WDFW
Tom Skiles, CRITFC (Via phone)
Chad Jackson, WDFW (Via phone)
Steve Lewis, USFWS (Via phone)
Debbie Williams, GCPUD
Brian McIlraith, CRITFC (Via phone)

## Distributed Items:

1. None

## Action Items:

1. PRFF members will review the Pacific Lamprey Management Plan.
2. Mike Clement will send lamprey PIT-tag data to Tom Skiles pending 2014 results.
3. Tracy Hillman will append Bob Rose's email comments on the sturgeon stocking decision 2015 to these minutes.
4. Jason McClellan will send the sturgeon indexing data table to Debbie Williams for incorporation into the meeting minutes.

# Final Meeting Minutes

I. Welcome and Introductions

II. Agenda Review

A. Additional agenda items – No additions were made to the agenda.

B. Meeting Minute approval – 03 September 2014 – Approved.

C. Action Items from last meeting

1. Patrick Verhey will ask Ben Truscott if he can give a guided tour on 15 September. Tracy Hillman will send a reminder to PRFF members to send their information to Mike Clement. Complete

2. Debbie Williams will post the lamprey trapping video to the PRFF box.net site and send the link to members. Complete

3. On 17 September, Tracy Hillman will request a vote on the revised number of juvenile white sturgeon to be released into the Priest Rapids Project in 2015. Complete and unanimously approved.

III. Update on Wanapum Dam and Fish Passage – Mike Clement provided an update on issues at Wanapum Dam. The update described the successful passage of fish, ongoing cleaning of aquatic vegetation from the pump screens, evaluation of adult Pacific lamprey passage including adult lamprey trap and haul, and the status of installation of tendons in the monolith piers. Grant PUD has proposed an interim pool elevation of 558 to 562 feet for later this year. The proposal has to be approved by the Board of Consultants and FERC.

Fish counts will continue through 15 November 2014. To provide passage for bull trout, one ladder will remain in criteria at all times. Normal winter maintenance will occur to both ladders. Divers will continue to clean pumps throughout the winter.

IV. Update on PLMP

A. NNI Update – Mike Clement reported that the PRFF Pacific Lamprey Subcommittee met on Wednesday, 17 September to discuss possible actions to implement over the next few years to address NNI. Grant PUD is entertaining the continuation of adult lamprey trapping for translocation and research if it contributes to their NNI obligations. Grant PUD will meet with the Yakama Nation in two or three weeks to further discuss NNI actions. Tracy Hillman suggested all PRFF members review the Pacific Lamprey Management Plan (PLMP). Changes to the PLMP would have to be agreed on by WDOE and FERC, via license amendment.

B. Lamprey Passage and Trap-n-Transport – Mike Clement noted that trap and haul activities at Priest Rapids and Wanapum dams ended on 30 September. About 2,463 adult lamprey were trapped and transported upstream from Rock Island Dam. Most adult lamprey were captured in mechanized traps. Tube traps were more effective in areas of low flow.

Mike reported that a total of 133 unique PIT-tagged adult lamprey have been detected at Priest Rapids Dam (PRD). These fish were tagged downstream in the Columbia River. Two of those overwintered below PRD. About 92.4% (123 fish) of the tagged fish passed PRD. Of the 121 lamprey that exited PRD, 116 were detected at Wanapum Dam (WD) and of these 67 have exited. Passage at WD is about 60%. The remaining 49 fish are still in the Wanapum adult ladders (most in the left-bank ladder).

Mike said that of the 28 lamprey released into the spiral chute at PRD, 18 have been detected at Rock Island Dam and 15 have exited Rocky Reach Dam (RRD). Last week, 44 lamprey were PIT-tagged by Chelan PUD. A total of 237 unique tag codes have exited RRD.

C. Lamprey Regional Implementation Planning Process – RD Nelle indicated that local experts will continue to meet to fill out templates for the Pacific Lamprey Regional

Implementation Planning process. Templates for all Upper Columbia areas except the Methow and Okanogan have been completed.

D. Summary of Off Ladder Adult Fish Trap (OLAFT) Tour – Tracy Hillman stated that five PRFF members toured the OLAFT in an attempt to determine if OLAFT operations have an adverse effect on lamprey using the PRD Left Bank Fish Ladder. After observing the trap in operation, PRFF members in attendance agreed that they observed no significant issues with the trap and its operations. Patrick Verhey suggested that when the trap is dewatered, the turning pool before the denil should be checked to make sure that the pickets do not go all the way down, impeding lamprey passage. Tom Skiles noted that the length of Left Bank Ladder is 1/3rd longer than the other three ladders in the Project, and asked Clement to provide lamprey data as it's not reported in PTAGIS.

E. Other Lamprey Items – None

V. Update on WSMP

A. Update on Dispute Resolution and Stocking Decision for 2014 – Mike Clement reported that during the week of 15 September, the remaining 2,168 juvenile sturgeon at Marion Drain from the 2013 brood year were scute marked and PIT tagged (1% of the fish received acoustic tags) and then released into the Priest Rapids Project Area. Thus, a total of 6,500 juvenile sturgeon were released into the Project Area in 2014. Mike said that the fish looked considerably smaller and there was a high level of fin deformity.

B. Stocking Decision for 2015 – Tracy Hillman stated that last month, WDFW provided the PRFF with a revised proposal on the number of juvenile white sturgeon to release into the Project Area in 2015. The PRFF approved the proposal unanimously. Although the Yakama Nation supported the proposal, they reiterated their concerns with basing releases on numbers of half-sibling families. Bob Rose, who was unable to attend the meeting, asked Tracy to read his email to the PRFF and append it to these notes. Tracy Hillman will append Bob Rose's email to these minutes (see Attachment 1).

C. Rearing Update – Donella Miller and Chad Jackson reported that juvenile sturgeon rearing at Marion Drain and at WDFW facilities from the 2014 brood year are doing well. The first culling and health sampling was completed at the WDFW facilities.

D. Monitoring Updates – The Colville Tribes have been conducting sturgeon index surveys in the Priest Rapids Project Area. Jason McLellan indicated that they completed surveys in the Priest Rapids and Wanapum reservoirs. In total, they captured 364 sturgeon. Brood year 2010 sturgeon released from the Chelan PUD hatchery program were captured in Wanapum Pool (n = 17 sturgeon) and in Priest Rapids Pool (n = 2 sturgeon). No entrained fish from the releases of 2012 or 2013 brood years were collected in the Project Area. Jason McClellan will send the sturgeon indexing data table to Debbie Williams for incorporation into the meeting minutes (see Attachment 2).

E. Protocol for Dealing with Dead Broodstock – Tracy Hillman distributed the necropsy protocols to the PRFF in Microsoft Word. No members provided comments or edits to the document.

VI. New Zealand Mudsnails

Patrick Verhey was uncertain if any monitoring for New Zealand Mudsnails is occurring in the Hanford Reach. Mike Clement said that Grant PUD will provide the PRFF with a draft report later this year on

their assessment of benthic organisms stranded in Wanapum Reservoir due to water level reductions. Aquatic Invasive Species annual reports will be out for review mid-February.

VII. Next Meeting – 5 November 2014 at Grant PUD's Hatchery/Habitat Wenatchee office.

# Attachment 1

## E-mail from the Yakama Nation on the 2015 Juvenile Sturgeon Release Number Proposal

**From:** Bob Rose [mailto:rosb@yakamafish-nsn.gov]
**Sent:** Friday, September 19, 2014 3:40 PM
**To:** Tracy Hillman; Tom Skiles; Jackson, Chad S (DFW); Patrick McGuire
**Cc:** Donella Miller; Steve Parker; Jeff Korth; John Monahan; Mike Clement
**Subject:** Re: FW: PRFF: 2015 Juvenile Sturgeon Release Number

Hi Tracy - and all,

The Yakama Nation will vote YES on this matter but we are not at all comfortable with this vote. We recognize that there is an overwhelming likelihood that we will have sufficient families to provide the total 6,500 juvenile release. To move forward and try to keep peace within the family, this is the only reason for a YES vote.

We would like to remind the PRFF that if, for some reason, we had only 15 half-sibling families (for example) and are then compelled to release a smaller number of fish, this would be, in fact, completely contrary to Ecologies recent Dispute Resolution ruling. We would be in exactly the same place for the same reason as we were last year. The "experts" were clear - it didn't matter. Ecology ruled that there isn't sufficient information to indicate it does matter.

In addition, I also wish to remind the PRFF that Grant PUD has been a champion of this genetic diversity conversation. However we have consistently fallen below the 6X6 cross (goal) within the Management Plan. As we move forward, it is now incumbent upon Grant PUD to meet or exceed this goal. Imposing budgetary constraints is no longer consistent with the WSMP.

Tracy - I'd like to have these comments entered into the Meeting Minutes at the next PRFF meeting.

Thanks.

# Attachment 2

# Juvenile Sturgeon Setline Summary from the Colville Tribes

**2014 GPUD Juvenile Sturgeon Setline Survey Summary (Preliminary Results)**

**Project Code 103-93003-02**

**September 14, 2014**

**Study Period:**

- Priest: 12-14 Aug & 18-22 Aug
- Wanapum: 25-29 Aug & 2-6 Sept

**Gear:**

- Groundline: 600ft long; ¼" twisted three-strand marked at 15ft intervals for placement of 40 gangions
- Hooks: Gamakatsu Octopus Circle; 10 each of 2/0, 4/0, 6/0, 8/0 per line. On occasion, Mustad 12/0 substituted for 8/0 (similar size hook) due to higher than expected hook loss to large fish.
- Bait: Pickled squid (Gilmore Fish Smokehouse)
- Boats: 28'x 10' Almar; 30' x 10' Munson; 26'x 8'-6" Almar

**Effort:**

- Priest: 80 overnight GRTS sets; 16 overnight supplemental sets
- Wanapum: 150 overnight GRTS sets; 4 overnight supplemental sets
- No angling was conducted due to limited time

**Catch (see tables below):**

- 364 White Sturgeon
- 379 Northern Pikeminnow
- 7 Largescale Sucker
- 1 Carp

**Entrainment observations:**

- Chelan PUD hatchery sturgeon (all BY2010; n=19) were captured in both Wanapum Pool (n=17 or 22.1% of all BY2010 captured in Wanapum; Table 2) and Priest Pool (n=2 or 3.5% of all BY2010 captured in Priest; Table 2).
- Seven Wanapum Pool releases (all 2010 BY; Table 2) were captured in Priest Pool (12.3% of all 2010BY fish captured in Priest)
- Lack of evidence for entrainment in brood years 2012 and 2013 suggests that high spring/summer flows in 2012 may have been responsible for the observed distribution of 2010 BY.

Table 1. Sturgeon catch summary and catch rate (Ep; proportion of overnight setline sets where catch >0) during GRTS and supplemental (SUPP.) setline sampling in Priest and Wanapum Reservoirs, 12 Aug – 6 September, 2014.

| SPECIES | WANAPUM | | | | | | PRIEST | | | | | | ALL | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GRTS (n=150) | | SUPP. (n=4) | | ALL (n=154) | | GRTS (n=80) | | SUPP. (n=16) | | ALL (n=96) | | GRTS (n=230) | | SUPP. (n=20) | | ALL (n=250) | |
| ORIGIN | N | Ep | N | Ep | n | Ep | n | Ep | n | Ep | n | Ep | n | Ep | n | Ep | n | Ep |
| STURGEON | | | | | | | | | | | | | | | | | | |
| 123LAD (BY2010) | 73 | 0.31 | 4 | 0.50 | 77 | 0.31 | 45 | 0.30 | 12 | 0.56 | 57 | 0.34 | 118 | 0.30 | 16 | 0.55 | 134 | 0.34 |
| 123LAD (BY2012) | 48 | 0.21 | - | - | 48 | 0.20 | 17 | 0.14 | 7 | 0.31 | 24 | 0.17 | 65 | 0.18 | 7 | 0.25 | 72 | 0.20 |
| 123LAD (BY2013) | 22 | 0.12 | - | - | 22 | 0.12 | - | - | 1 | 0.06 | 1 | 0.01 | 22 | 0.08 | 1 | 0.05 | 23 | 0.08 |
| 123LAD (UNKNOWN)[1] | 7 | 0.05 | - | - | 7 | - | 3 | 0.04 | - | - | 3 | 0.03 | 10 | 0.04 | - | - | 10 | - |
| **123LAD (ALL)** | **150** | **0.49** | **4** | **0.50** | **154** | **0.49** | **65** | **0.35** | **20** | **0.69** | **85** | **0.41** | **215** | **0.44** | **24** | **0.65** | **239** | **0.48** |
| CRITFC | 76 | 0.32 | 10 | 0.50 | 86 | 0.32 | 24 | 0.20 | 9 | 0.31 | 33 | 0.22 | 100 | 0.28 | 19 | 0.35 | 119 | 0.30 |
| WILD | 5 | 0.03 | 1 | 0.25 | 6 | 0.04 | - | | - | - | - | - | 5 | 0.02 | 1 | 0.05 | 6 | 0.03 |
| **ALL STURGEON** | **231** | **0.61** | **15** | **0.50** | **246** | **0.60** | **89** | **0.44** | **29** | **0.75** | **118** | **0.49** | **320** | **0.55** | **44** | **0.70** | **364** | **0.58** |
| NORTHERN PIKEMINNOW | 278 | 0.85 | 3 | 0.50 | 281 | 0.84 | 80 | 0.61 | 18 | 0.69 | 98 | 0.63 | 358 | 0.77 | 21 | 0.65 | 379 | 0.79 |
| LARGESCALE SUCKER | - | - | - | - | - | - | 7 | 0.08 | - | 0.56 | - | 0.06 | 7 | 0.03 | - | - | 7 | 0.03 |
| CARP | 1 | <0.01 | - | - | - | - | - | - | - | - | - | - | 1 | <0.01 | - | - | 1 | <0.01 |
| **ALL SPECIES** | **510** | **0.95** | **18** | **0.75** | **528** | **0.95** | **176** | **0.81** | **47** | **0.94** | **223** | **0.83** | **686** | **0.90** | **65** | **0.90** | **751** | **0.94** |

1/ PIT tag not present/inoperable (n=8) or PIT number not in GPUD database or PITAGIS (n=2).

Table 2. Release histories for all 123LAD marked sturgeon captured during GRTS and supplemental setline sampling in Priest and Wanapum Reservoirs, 12 Aug – 6 September, 2014.

| CAPTURE RESERVOIR / BROOD YEAR | RELEASE RESERVOIR: PRIEST | WANAPUM | ROCKY REACH | UNKNOWN[1] | TOTAL |
|---|---|---|---|---|---|
| PRIEST | | | | | |
| BY 2010 | 48 | 7 | 2 | - | 57 |
| BY 2012 | 24 | - | - | - | 24 |
| BY 2013 | 1 | - | - | - | 1 |
| UNKNOWN[1] | - | - | - | 3 | 3 |
| **ALL** | **73** | **7** | **2** | **3** | **85** |
| WANAPUM | | | | | |
| BY 2010 | - | 60 | 17 | - | 77 |
| BY 2012 | - | 48 | - | - | 48 |
| BY 2013 | - | 22 | - | - | 22 |
| UNKNOWN[1] | - | - | - | 7 | 7 |
| **ALL** | **-** | **130** | **17** | **7** | **154** |
| **ALL** | **73** | **144** | **19** | **10** | **239** |

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Table 3. Fork length (cm) summary for all sturgeon captured during both GRTS and supplemental setline sampling in Priest and Wanapum Reservoirs, 12 Aug – 6 September, 2014.

| ORIGIN | WANAPUM | | | PRIEST | | | ALL | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | mean | range | n | mean | range | n | mean | range |
| 123LAD | | | | | | | | | |
| BY2010 | 77 | 60.3 | 41.8-86.3 | 57 | 65.6 | 43.2-89.7 | 134 | 62.5 | 41.8-89.7 |
| BY2012 | 48 | 42.3 | 34.3-52.0 | 24 | 42.6 | 35.5-48.3 | 72 | 42.4 | 34.3-52.0 |
| BY2013 | 22 | 36.6 | 24.7-42.4 | 1 | 39.0 | - | 23 | 36.7 | 24.7-42.4 |
| UNKNOWN[1] | 7 | 56.0 | 38.5-87.9 | 3 | 44.8 | 40.5-50.9 | 10 | 52.6 | 38.5-87.9 |
| ALL | 154 | 51.1 | 24.7-87.9 | 85 | 58.1 | 35.5-89.7 | 239 | 53.5 | 24.7-89.7 |
| CRITFC | 86 | 102.6 | 58.3-145.8 | 33 | 97.8 | 64.7-133.6 | 119 | 101.3 | 58.3-145.8 |
| WILD | 5 | 57.0 | 46.9-72.6 | - | - | - | 5 | 57.0 | 46.9-72.6 |
| **ALL** | **245** | **69.3** | **24.7-145.8** | **118** | **69.1** | **35.5-133.6** | **363** | **69.3** | **24.7-145.8** |

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Table 4. Growth in FL (cm) since release of 123LAD marked sturgeon captured during both GRTS and supplemental setline sampling in Priest and Wanapum Reservoirs, 12 Aug – 6 September, 2014.

| | WANAPUM | | | PRIEST | | | ALL | | |
|---|---|---|---|---|---|---|---|---|---|
| BROOD YEAR | n | mean | range | n | mean | range | n | mean | range |
| 2010 | 77 | 30.2 | 9.7-61.1 | 57 | 37.3 | 12.6-62.1 | 134 | 33.3 | 9.7-62.1 |
| 2012 | 48 | 12.2 | 2.5-21.7 | 24 | 13.5 | 3.2-21.4 | 72 | 12.6 | 2.5-21.7 |
| 2013 | 22 | 6.6 | 0.9-10.1 | 1 | 5.7 | - | 23 | 6.6 | 0.9-10.1 |

Table 5. Number and size (FL; cm) of all sturgeon captured during GRTS and supplemental setline sampling according to hook size. Note: hook sizes were not recorded for nine sturgeon captured during the survey.

| Hook size | n | mean | range |
|---|---|---|---|
| 2/0 | 92 | 55.6 | 33.7-104.0 |
| 4/0 | 97 | 63.7 | 24.7-135.6 |
| 6/0 | 89 | 79.2 | 35.5-199.8 |
| 8/0 (Gamakatsu) & 12/0 (Mustad) | 77 | 81.9 | 36.8-144.5 |
| **ALL** | **355** | **69.4** | **24.7-199.8** |

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| ORIGIN | N | Ep | N | Ep | n | Ep | n | Ep | n | Ep | n | Ep | n | Ep | n | Ep | n | Ep |
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| 123LAD (UNKNOWN)[1] | 7 | 0.05 | - | - | 7 | - | 3 | 0.04 | - | - | 3 | 0.03 | 10 | 0.04 | - | - | 10 | - |
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| LARGESCALE SUCKER | - | - | - | - | - | - | 7 | 0.08 | - | 0.56 | - | 0.06 | 7 | 0.03 | - | - | 7 | 0.03 |
| CARP | 1 | <0.01 | - | - | - | - | - | - | - | - | - | - | 1 | <0.01 | - | - | 1 | <0.01 |
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1/ PIT tag not present/inoperable (n=8) or PIT number not in GPUD database or PITAGIS (n=2).

Table 2. Release histories for all 123LAD marked sturgeon captured during GRTS and supplemental setline sampling in Priest and Wanapum Reservoirs, 12 Aug – 6 September, 2014.

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|---|---|---|---|---|---|
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| PRIEST | | | | | |
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| BY 2012 | 24 | - | - | - | 24 |
| BY 2013 | 1 | - | - | - | 1 |
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| ORIGIN | WANAPUM | | | PRIEST | | | ALL | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | mean | range | n | mean | range | n | mean | range |
| 123LAD | | | | | | | | | |
| BY2010 | 77 | 60.3 | 41.8-86.3 | 57 | 65.6 | 43.2-89.7 | 134 | 62.5 | 41.8-89.7 |
| BY2012 | 48 | 42.3 | 34.3-52.0 | 24 | 42.6 | 35.5-48.3 | 72 | 42.4 | 34.3-52.0 |
| BY2013 | 22 | 36.6 | 24.7-42.4 | 1 | 39.0 | - | 23 | 36.7 | 24.7-42.4 |
| UNKNOWN[1] | 7 | 56.0 | 38.5-87.9 | 3 | 44.8 | 40.5-50.9 | 10 | 52.6 | 38.5-87.9 |
| ALL | 154 | 51.1 | 24.7-87.9 | 85 | 58.1 | 35.5-89.7 | 239 | 53.5 | 24.7-89.7 |
| CRITFC | 86 | 102.6 | 58.3-145.8 | 33 | 97.8 | 64.7-133.6 | 119 | 101.3 | 58.3-145.8 |
| WILD | 5 | 57.0 | 46.9-72.6 | - | - | - | 5 | 57.0 | 46.9-72.6 |
| **ALL** | **245** | **69.3** | **24.7-145.8** | **118** | **69.1** | **35.5-133.6** | **363** | **69.3** | **24.7-145.8** |

1/ PIT tag not present/inoperable (n=8) or PIT number not in GPUD database or PITAGIS (n=2).

Table 4. Growth in FL (cm) since release of 123LAD marked sturgeon captured during both GRTS and supplemental setline sampling in Priest and Wanapum Reservoirs, 12 Aug – 6 September, 2014.

| | WANAPUM | | | PRIEST | | | ALL | | |
|---|---|---|---|---|---|---|---|---|---|
| BROOD YEAR | n | mean | range | n | mean | range | n | mean | range |
| 2010 | 77 | 30.2 | 9.7-61.1 | 57 | 37.3 | 12.6-62.1 | 134 | 33.3 | 9.7-62.1 |
| 2012 | 48 | 12.2 | 2.5-21.7 | 24 | 13.5 | 3.2-21.4 | 72 | 12.6 | 2.5-21.7 |
| 2013 | 22 | 6.6 | 0.9-10.1 | 1 | 5.7 | - | 23 | 6.6 | 0.9-10.1 |

Table 5. Number and size (FL; cm) of all sturgeon captured during GRTS and supplemental setline sampling according to hook size. Note: hook sizes were not recorded for nine sturgeon captured during the survey.

| Hook size | n | mean | range |
|---|---|---|---|
| 2/0 | 92 | 55.6 | 33.7-104.0 |
| 4/0 | 97 | 63.7 | 24.7-135.6 |
| 6/0 | 89 | 79.2 | 35.5-199.8 |
| 8/0 (Gamakatsu) & 12/0 (Mustad) | 77 | 81.9 | 36.8-144.5 |
| **ALL** | **355** | **69.4** | **24.7-199.8** |

**FEDERAL ENERGY REGULATORY COMMISSION**
**Washington, DC 20426**

**OFFICE OF ENERGY PROJECTS**

Project No. 2114-116 -- Washington
Priest Rapids Project
Grant County PUD

**September 12, 2014**

Jim Boyd
Chairman, Colville Business Council
The Confederated Tribes of the Colville Reservation
PO Box 150
Nespelem, WA 99155

Subject: 2014 juvenile white sturgeon stocking levels

Dear Mr. Boyd:

This regards your letter dated August 26, 2014, and filed with the Federal Energy Regulatory Commission (Commission) on September 2, 2014, related to the recent decision by the Priest Rapids Fish Forum (PRFF)[1] on the number of juvenile white sturgeon to be released in 2014 under Grant County PUD's (licensee) White Sturgeon Management Plan (WSMP) for the Priest Rapids Project (FERC No. 2114). On October 22, 2009, the Commission issued the Order Modifying and Approving White Sturgeon Management Plan under license Article 401(a)(11).[2]

You state that based on white sturgeon broodstock collection targets not being met in 2013, a pro-rated release of 4,332 juveniles was recommended to address genetic concerns of some members of the PRFF. Accordingly, a release of 4,332 juveniles has already occurred in 2014; however, you state that the

[1] The PRFF is comprised of representatives from the U.S. Fish and Wildlife Service, Washington Department of Ecology, Washington Department of Fish and Wildlife, Bureau of Indian Affairs, and the licensee.

[2] *See* 129 FERC ¶ 62,057.

release of 2,168[3] additional juveniles has the potential to cause irreversible consequences to sturgeon populations. Consequently, you request that the Commission advise the Tribe on the Commission's role in ensuring compliance with the project's Section 401 Water Quality Certification (WQC), clarification of the process for resolving PRFF disputes, and the Commission's position on the appropriate release number for 2014.

By letter dated and filed with the Commission on September 5, 2014, the licensee provided information related to your August 27, 2014 letter. Its filing included: (a) the March 24, 2014 letter from the PRFF Technical Committee Chair to the Washington Department of Ecology (WDOE) requesting initiation of the formal Dispute Resolution Process; (b) PRFF meeting protocols, including the Dispute Resolution Process; (c) meeting minutes from the June 26, 2014 PRFF-Policy Committee meeting; (d) the July 15, 2014 letter from the licensee to WDOE requesting expedited review and decision regarding the number of juveniles to be released in 2014; (e) the July 21, 2014 letter from WDOE to the licensee stating that a release of 6,500 juveniles in 2014 is appropriate; (f) your August 5, 2014 letter to WDOE requesting a formal government to government meeting; and (g) the September 3, 2014 letter from WDOE to the licensee directing the release of the additional 2,168 juveniles (for a total release of 6,500) by September 18, 2014.

Based on the licensee's September 5 filing, and as indicated in your August 27 letter, the formal Dispute Resolution Process was unsuccessful in resolving the dispute over the number of juvenile white sturgeon to be released in 2014 under the licensee's WSMP. According to your letter, the [Colville] Tribe, U.S. Fish and Wildlife Service, Wanapum Tribe, and the licensee supported a release of 4,332, whereas the Yakama Nation, Umatilla Tribe, and Washington Department of Fish and Wildlife supported a release of 6,500 juveniles. Although you state that the release of 4,332 juveniles is based on guidance provided in the WSMP as it relates to the maternal family matrix, the licensee's WSMP, approved by the WDOE as stipulated in the project license, proposed the release of up to 5,000 juveniles into Wanapum Reservoir and 1,500 into Priest Rapids Reservoir (less than the 10,000 stipulated in the WQC) annually in years 3 through 7 of the program, with

[3] The Section 401 Water Quality Certification, Appendix A of the April 17, 2008 Order Issuing New License, requires the licensee to stock a total of 10,000 juveniles annually in the Wanapum and Priest Rapids Reservoirs (6,500 and 3,500, respectively) in years 3, 4 and 5 to increase the reservoirs' white sturgeon populations; and from year 6 through the end of the license term or as adjusted by Grant PUD, in consultation with the PRFF, through the adaptive management process consistent with monitoring and evaluation results.

subsequent annual release levels to be determined by the PRFF, based on monitoring results.

While we understand there is disagreement regarding the program's current year of implementation (i.e., year 3 or year 6), the WSMP proposed the release of *up to* 6,500 juveniles in years 3 through 7 of the program. Furthermore, as you assert, the WSMP provides guidance on the number of juveniles to be released as it relates to the maternal family matrix. Although using this guidance provides for a release of 4,332 juveniles in 2014, we will defer to the mandatory conditioning agency, in this case, the WDOE and their September 3, 2014 letter. Accordingly, we will expect the licensee to release the additional juveniles, for a total of 6,500 in 2014, as directed by the WDOE in their September 3 letter, by September 18, 2014.

We appreciate your concerns regarding this matter. If you have any questions, please contact Mr. Erich Gaedeke at (503) 552-2716.

Sincerely,

Andrea Claros

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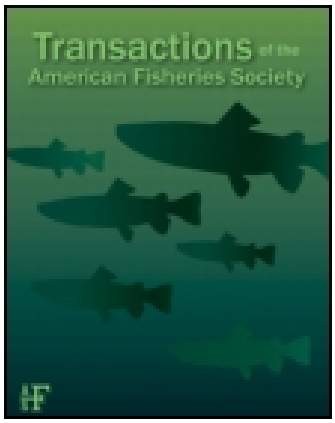


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# Estimates of Effective Number of Breeding Adults and Reproductive Success for White Sturgeon

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ARTICLE

# Estimates of Effective Number of Breeding Adults and Reproductive Success for White Sturgeon

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***Abstract***

**Accurate estimates of the number of adults contributing to offspring ($N_s$), effective breeding number ($N_b$), and individual adult contributions to recruitment are required for recovery planning for endangered White Sturgeon *Acipenser transmontanus* populations, many of which are suffering from prolonged periods of recruitment failure. We show that genetic techniques can be used to characterize important features of White Sturgeon reproductive ecology in large rivers where census data are extremely difficult to obtain. We used 12 microsatellite loci and likelihood-based pedigree analysis to estimate $N_s$, $N_b$, number of kin groups ($N_k$), and individual reproductive success of White Sturgeon contributing to viable eggs and larvae collected in the upper Columbia River in each of 2 years. Estimated mean ±SD annual $N_s$ was 121.5 ± 34.7, $N_b$ was 86.5 ± 10.6, and $N_k$ was 73.5 ± 17.3. Large variations in estimates of $N_s$, $N_b$, and $N_k$ were observed between three spawning areas, in which one spawning site representing 61% of total adult spawning population. Variation in adult reproductive success was observed within and among sites. Estimated mean ±SD individual spawning duration was 1.9 ± 1.1 d, and number of mates per adult was 2.9 ± 2.5, which also varied spatially and temporally. Based on age of collected eggs and larvae, number of spawning days ranged from 5 to 19 d between years and among sites. Genetically derived estimates of $N_s$ were lower but generally concordant with empirical estimates of available spawners ($N_c$), based on sex ratios and maturation staging of adults captured independently ($N_s/N_c$ ratio = 0.683). Results increase our understanding of White Sturgeon reproductive ecology and recruitment and allow projections of cohort levels of genetic diversity. Similar data can be applied to recovery planning and aquaculture programs for this and other species of conservation concern.**

Large interannual variability in levels of recruitment and number of adults contributing offspring can have considerable effects on genetic diversity and population abundance. Reliable data on the actual number of adults contributing to annual recruitment ($N_s$) in large river systems is important for population management but can be labor-intensive and difficult to obtain. Indices of relative abundance (e.g., CPUE) or estimates of spawning population that are census-size-derived using traditional means (e.g., capture-mark–recapture; Pledger et al. 2013) are probably made with high or unknown levels of uncertainty. That, in part, is because of ineffectiveness of sampling gear and considerable uncertainty over timing and

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duration of occupancy of spawning sites relative to when surveys are conducted. Therefore, to more effectively address conservation and restoration needs, genetic data have become a standard component of many recovery programs (Pemberton 2008; Anders et al. 2011).

Genetic techniques allow biologists to examine aspects of recruitment immediately after spawning (Wirgin et al. 1997; Duong et al. 2011), facilitating estimates of spawner–recruitment relationships to be made during early life history stages when data can be interpreted based on environmental conditions. Using a combination of statistical and genetic techniques, it is increasingly easy to use genetically based parentage or pedigree methods (Blouin 2003; Wang 2004; Jones et al. 2010) to estimate, using genetic markers of disomic inheritance, the number of parents that produced those offspring (Duong et al. 2011). However, most population genetic analyses developed for diploid species are inapplicable to species like sturgeon that are polyploid. Rodzen et al. (2004) proposed a simple and general solution to convert the microsatellite genotypes of polyploids to diploid dominant genotypes. Wang and Scribner (2014) have shown, using simulated and empirical data, that this method can be used to reconstruct pedigree and parentage relationships with a modest number of polymorphic nondisomic loci.

Genetic diversity is important for long-term population viability by providing greater potential for adaptation to environmental change (Reed and Frankham 2003). Effective population size ($N_e$) is defined as the number of individuals in an ideal population having the same magnitude of random genetic drift, inbreeding, or loss of heterozygosity as the actual population (Wright 1931). Factors contributing to the reduction in $N_e$ include variations in lifetime reproductive success, skewed sex ratios, and fluctuations in population size over time (Frankham 1995; Charlesworth 2009; Waples 2010). Additionally, fragmentation and isolation of habitat and species' ecological characteristics (e.g., attributes of the mating system, generation length, and inbreeding interval) influence $N_e$ (Waples 1990). Accordingly, $N_e$ reflects the effects of evolutionary processes on population levels of genetic diversity. Therefore estimates of $N_e$ and annual recruitment are important variables to understand for endangered species (Charlesworth 2009; Waples 2010) because small populations are at risk of extinction through demographic stochasicity, genetic drift, and environmental variation (Braude and Low 2010).

The effective breeding number ($N_b$) represents a measure of effective size for a single reproductive season. This metric is important for understanding the ecological dynamics within a spawning season and is similarly influenced by factors affecting general estimates of $N_e$ (Waples 2002). Thus, $N_b$ can vary among years, especially when interannual fluctuations in environmental conditions affect recruitment (Myers 1998). For example, if few adults produce a large proportion of annual progeny, the ratio between $N_b$ and actual number of adults contributing to recruitment ($N_s$) can be low. For semelparous species, the relationship between $N_b$ and $N_e$ is well established (Nunney 2002; Waples 2002). However, for long-lived, iteroparous species, such as sturgeon, $N_e$ is difficult to estimate because $N_e$ depends on variance in lifetime reproductive success among adults in the population (Hill 1972). Accordingly, there has been considerable interest in estimating $N_b$. (e.g., Duong et al. 2013).

White Sturgeon *Acipenser transmontanus* is a native species of western North America that has undergone significant reductions in population abundance and distribution due to overexploitation, environmental degradation, and loss of habitat connectivity (Billard and Leconintre 2001). Despite documentation of annual spawning activity over the past 20 years, the upper Columbia River (UCR) population is listed as endangered and has been experiencing recruitment failure over the past several decades (Hildebrand and Parsley 2013). To date, estimating the fertilization date of collected eggs has provided the sole measure of spawning activity and is currently the best available metric of spawning duration within the upper Columbia River. However, despite annual spawning activity (e.g., based on egg and larval captures) being detected for this population, little information is available regarding the number of annual breeders, including estimates of individual reproductive success, at known or suspected spawning sites within the upper Columbia River. This information is critical in the development of recovery strategies (Fisheries and Oceans Canada 2014) and when measuring progress towards recovery.

The main objective of this study was to estimate the annual UCR White Sturgeon $N_b$ and $N_s$. Given the large size of the upper Columbia River, the highly dispersed nature of known or suspected spawning areas, and low population abundance, we hypothesized that the number of adults spawning at each spawning site would be a small proportion to the entire spawning population. An additional objective was to characterize aspects of the species' reproductive ecology, including individual adult reproductive success, spawning duration, mate number, and spawning group composition. We also examined the efficacy of using empirical data regarding the sexual maturity stage of adult White Sturgeon to predict the number of contributing adults to an annual spawning season. We hypothesized that independent estimates of spawning population size derived with the use of both genetic ($N_s$) and empirical ($N_c$) data would be concordant and therefore would highlight the importance of employing multiple methods to determine annual spawning population size when possible. Additionally, results could determine if one technique may be substituted for estimating spawning population size if the other is not available to researchers.

## METHODS

*Study area.*—We monitored spawning of White Sturgeon during two consecutive years (2011–2012) within a 57-km

reach of the most downstream main-stem impoundment of the Canadian section of the upper Columbia River between Hugh L. Keenleyside Dam (HLK) at river kilometer (rkm) 0.0 to the USA–Canada border (rkm 57) within Washington and British Columbia (Figure 1). The population of White Sturgeon in this section of the river is estimated at 1,157 (95% CI: 414–1,900; Irvine et al. 2007) with an additional 2,003 sturgeon estimated (95% CI: 1,093–3,223) for the river south of the border (Howell and McLellan 2007). Within the upper Columbia River, fidelity to specific locations is high (>65%; BC Hydro 2013) though demographic patterns (McAdam 2012) and movement data (Howell and McLellan 2007) suggest movement between habitats in the Canadian and USA areas occurs. This section of the upper Columbia River is highly regulated by hydroelectric generation and storage dams controlling flows from three major rivers including the Columbia River, the Kootenay River, and the Pend D'Orielle River. This altered hydrograph is one of several potential reasons for recruitment failure (Gregory and Long 2008).

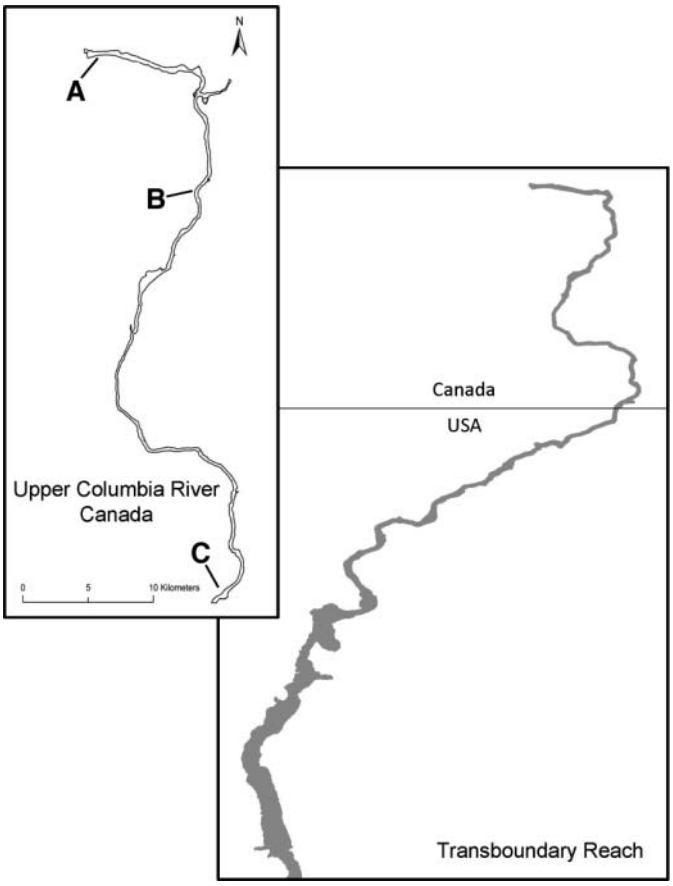


FIGURE 1. Transboundary reach of the upper Columbia River between Hugh L. Keenleyside Dam (HLK), British Columbia, Canada, and Gifford, Washington, USA, where egg mats and drift nets were deployed to sample White Sturgeon eggs and larvae in 2011 and 2012 within in the Canadian portion of the upper Columbia River. Sampling sites: A = Arrow Lakes Generating Station (ALH) at river kilometer (rkm) 0.1, including HLK; B = rkm 18.2; and C = Waneta at rkm 56.0.

Within the Canadian portion of the Columbia River, White Sturgeon reproduction occurs from mid-June through August at two known spawning sites: downstream of Arrow Lakes Generating Station (ALH at rkm 0.1) and Waneta Dam (Waneta at rkm 56.0; Figure 1). The ALH is located beside HLK and regulates flow from the Arrow Lakes Reservoir to meet requirements of the Columbia River Treaty. Waneta regulates flow of the Pend d'Orielle River into the upper Columbia River. At ALH, sampling was conducted downstream of both the ALH tailraces and immediately downstream of the HLK spillways. Sampling at Waneta was conducted downstream of the tailrace. The known geographical boundaries of the ALH and Waneta spawning areas, based on egg and larval captures, are small, covering approximately 0.1 and 0.16 $km^2$, respectively. Further details regarding the spawning areas and their geographical boundaries are available in Terraquatic Resource Management (2011) for ALH and in Golder Associates (2009) for Waneta. An additional site located at rkm 18.2 was also sampled (Figure 1) based on (1) suitable spawning habitat (substrate and water velocities), (2) egg and larval collection at this site in previous years, and (3) identified movements of mature adult White Sturgeon to this area during the spawning period (BC Hydro 2013). The exact geographical boundaries of sturgeon spawning near site rkm 18.2 are unknown, but the sampling location represents the downstream extent of where spawning may occur. White Sturgeon from the upper Columbia River are also known to spawn annually at two U.S. locations (Howell and McLellan 2007), though these locations were not monitored in this study. Though interannual exchange between different spawning areas is unknown, adults making spawning-related movements within the Canadian section of the upper Columbia River tend to remain within the specific river section they occupy (adults residing within 10 rkm of 18.2 tend to spawn in this area), and this has been repeatable across multiple years (Hildebrand and Parsley 2013). Though some work has suggested that White Sturgeon in the Canadian portion of the Columbia River may have historically had population substructuring (Nelson and McAdam 2012), other work looking at current levels of genetic diversity, found that White Sturgeon in the transboundary reach were not genetically different from downstream populations (Drauch Schreier et al. 2013) and additional investigations of historical genetic population structure are ongoing.

Spawning in this population typically occurs when water temperatures exceed 14°C and upper Columbia River flows are on a descending pattern (Hildebrand et al. 1999; BC Hydro 2013). Further, UCR adults cannot be observed congregating to spawn due to the water depth (mean = 6.0 m, SD = 3.0) and relatively high flow volume (daily average = 510.0–1754.4 $m^3/s$ during the spawning season). Therefore spawning was documented through the collection of progeny.

*Egg and larval collection*.—White Sturgeon are broadcast spawners exhibiting a promiscuous and aggregate mating

system, where gametes from multiple females, fertilized by multiple males, are dispersed over large sections of rivers (Billard and Leconintre 2001). Therefore, passive techniques including egg mats and drift nets have been successfully used in the past to collect the demersal eggs and drifting yolk sac larvae (McCabe and Beckman 1990; Parsley et al. 1993). Egg mats consisted of a steel frame (0.76 × 0.91 m) enclosing latex-coated animal hair filter material. Drift nets consisted of a 1.3-m-diameter stainless steel frame ("D"-shaped) with a 0.6 × 0.8-m opening and 4-m tapered plankton net (0.16 cm delta mesh size) and a removable collection cup attached to the frame. Sampling gear was deployed on top of substrate (cobble to boulders, all sites) on the river bottom using a fixed anchor system that remained constant throughout the sampling period. Egg mats were placed at the site of spawning activity (five at ALH in 2011, 7 at Waneta in 2011, and 12 at Waneta in 2012), and drift nets were set immediately downstream from the spawning site (8 at ALH in 2011, 4 at rkm 18.2 in 2011, 1 at Waneta in 2011, 8 at ALH in 2012, 2 at rkm 18.2 in 2012, and 2 at Waneta in 2012).

Sampling was conducted from mid-June to mid-August. Due to river hydrology, sampling gear and effort varied among monitoring sites. Egg mats were deployed (24-h sets) only at the known spawning sites of Waneta and ALH. Drift nets were deployed at all sites for 24 h excluding Waneta, where nets were set for only 3 h due to time constraints and river hydrology. Sampling location within a site remained consistent across years (Figure 1). The period of sampling coincided with typical thermal regimes (12–18°C) documented during White Sturgeon spawning activity (Parsley and Beckman 1994; Hildebrand et al. 1999; Paragamian et al. 2001; Perrin et al. 2003). Due to warmer temperature influences of the Pend D'Oreille River, sampling at Waneta was initiated on June 13 in 2011 and June 11 in 2012. Sampling at ALH and rkm 18.2 commenced July 11 in 2011 and was delayed to July 26 in 2012 due to high water flows that prevented gear deployment. Sampling was terminated at all sites on August 17 in 2011 and August 16 in 2012.

Live eggs collected from the river were placed in incubation trays until hatch to obtain a sufficient genetic tissue sample. Incubation trays were suspended in the upper Columbia River 3 m below the water surface in a stacked configuration on a 30-kg anchor system downstream from each spawning site in areas of low flow (<1 m/s). Incubation trays consisted of a middle plate of plexiglass (180 × 200 × 6 mm) with 100 perforations (6 mm in diameter) distributed in a rectangular grid (10 × 10). Two similarly perforated plexiglass plates (180 × 180 × 3 mm), with 1-mm plastic screen secured to one side, were placed on either side of the middle plate to enclose the eggs within the incubator. Incubation trays remained in the river, in situ, until all yolk sac larvae successfully hatched within a tray.

Upon hatch, yolk sac larvae were euthanized with an overdose of tricaine methanesulfonate (MS-222) and preserved in 95% ethanol. Captured drifting larvae were also euthanized and preserved in 95% ethanol. Due to the large number of eggs and larvae collected at Waneta, a random subsample of eggs (about 20%) was preserved in Prefer (solution of glyoxcal, buffer, and alcohol) for assignment of developmental stage (see below), a random subsample of eggs (about 20%) was incubated to obtain genetic tissue, and a random subsample of captured drifting larvae (about 20%) was euthanized and preserved in 95% ethanol.

Water temperatures were recorded hourly throughout the period of sampling using VEMCO Minilog-II-T data loggers placed at all sampling sites. Data loggers were also paired with each incubation station.

*Developmental staging and fertilization date*.—To assign developmental stage, preserved eggs and larvae were randomly examined with respect to date, stage, and site (to reduce observer bias) using a digital compound microscope (Nikon SMZ-745t Stereo Microscope with 10× eyepiece). Enumeration of stages corresponded to the classification by Dettlaff et al. (1993), including embryonic stages (1 through 35; fertilization to prehatch) and yolk sac larval stages (36 through 45; hatch to exogenous feeding). Each developmental stage was associated with the appearance of at least one new feature, so stages were not determined strictly by quantitative changes. No preserved samples had developed beyond stage 45.

Fertilization date for collected eggs and larvae was estimated by back-calculation from the recorded date and time of preservation based on developmental stage (eggs, M. Parsley, U.S. Geological Survey, unpublished; K. Jay unpublished), and mean incubation water temperature. The estimated age (hours) was subtracted from the preservation date and time to determine the estimated date and time of fertilization (i.e., spawning date). Calculated fertilization dates provided an estimation of spawning duration for each spawning site. The poor condition of collected samples at rkm 18.2 prohibited the estimation of fertilization date; therefore estimated spawning duration was only calculated for ALH and Waneta sampling sites.

*Genetic analysis*.—The total number of larvae collected in 2011 was subsampled for genotyping due to disparity in total sample sizes between spawning sites. In order of capture date, every other Waneta larval sample (about 50%) and every fourth ALH larvae (about 25%) were genotyped. Due to very low numbers ($n = 33$), all larvae collected at rkm 18.2 were selected for genotyping. All larvae collected in 2012 were genotyped. We extracted DNA from larval tissue samples using QIAGEN DNeasy kits (QIAGEN Inc.) according to manufacturers' protocols, and quantified DNA using a Nanodrop spectrophotometer. All samples were diluted to a constant concentration (20 ng/μL) for use in polymerase chain reactions (PCR). Individuals were genotyped using 12 microsatellite loci: *AciG-35, AciG-2, AciG-53, AciG-140* (Bork et al. 2008), *Atr-105* (Drauch and May 2007), *Atr-107, Atr-109, Atr-117, Atr-1101, Atr-1173, Atr-100*, and *Atr-113* (Rodzen and May

2002; Drauch and May 2007). We conducted PCR reactions to amplify 100 ng DNA in 25 μL reaction mixtures containing 2.5 μL of 10× PCR Buffer (0.1 M tris-HCl, 15 mM $MgCl_2$, 0.5 M KCl, 0.1% gelatin, 0.1% NP-40, 0.1% Triton-X); additions of 1 μL $MgCl_2$ (25 mM; 0.5 μL $MgCl_2$ for *Atr-109*; 1.5 μL $MgCl_2$ for *Atr-107*; 2 μL $MgCl_2$ for *Atr-1101*) for all reactions, excluding *Atr-105* and *Atr-117*; 2.5 μL deoxynucleotide triphosphates (dNTPs; 0.8 mmol/L); 1 μL of fluorescently labeled forward and unlabeled reverse primers (10 pmol/μL), and 1 unit of Taq DNA polymerase (5U/μL).

All PCR reactions were conducted using a Robocycler 96 thermal cycler (Stratogene). The PCR conditions were 94°C for 2 min, followed by 35 cycles (33 cycles for *Atr-109*; 37 cycles for *Atr-107* and *AciG-2*) of 1 min at 94°C, 1 min for primer-specific annealing temperatures (55°C for *AciG-35,* and *AciG-53*; 56°C for *Atr-100*, *Atr-105, Atr-107, Atr-109, Atr-113, Atr-117, Atr-1101,* and *Atr-1173*; 57°C for *AciG-2*; and 58°C for *AciG-140*), 72°C for 2 min, and a final extension for 5 min at 72°C (excluding *Atr-105, Atr-107, Atr-109, Atr-117, Atr-1173,* and *AciG-35*). The PCR products were run on 6% denaturing polyacrylamide gels and genotypes were visualized using a Hitachi FMBIO II scanner. Allele sizes were determined using commercially available size standards (MapMarkerTM, BioVentures Inc.) and based on several standard samples of known genotype. To minimize error, all genotypes were independently scored by two experienced laboratory personnel and verified again after data were entered into electronic databases. Errors in genotyping were empirically checked by blindly re-genotyping a random 10% of all samples within a year. Reported genotyping error was the ratio between observed number of allelic errors and the total number of alleles compared (Bonin et al. 2004).

*Data conversion*.—Due to the polyploid nature of the White Sturgeon genome (Blacklidge and Bidwell 1993), microsatellite alleles were treated as dominant data. Following Rodzen et al. (2004), each individual phenotype was converted into a $1 \times n$ vector, where $n$ is the number of bands at the locus. Each band at a given microsatellite locus was indexed as 1 if the band was present (dominant) or indexed as 0 if the band was absent (recessive) within an individual's phenotype. Therefore, an individual phenotype showing bands 1, 3, and 7 at an 8-band microsatellite locus was converted to a $1 \times n$ vector of [1, 0, 1, 0, 0, 0, 1, 0], yielding eight dominant markers. This process was repeated for each microsatellite locus, and data were combined to produce a $1 \times n_T$ vector, where $n_T$ is the total number of bands across all microsatellite loci for each individual.

*Pedigree analysis*.—Pedigree analyses were conducted using COLONY version 2.0.4.0 (Jones and Wang 2010). This software uses a maximum likelihood method to estimate pedigree relationships among offspring belonging to a single cohort of the population by identifying networks of full-sibling and half-sibling families using their multi-locus genotypes inferred from dominate data while incorporating genotyping errors. Offspring may be inferred as full siblings who share two parents, half siblings who share a single parent, or nonsiblings who share no parents. Analyses were conducted separately for each sampling site and year to estimate the number of kin groups ($N_k$; groupings of inferred offspring sharing at least one common parent), $N_s$ (the actual number of adults that contributed at least one offspring based pedigree reconstruction), and $N_b$ (the effective number of breeding adults within a single reproductive season, estimated based on relative frequencies of full-sibling and half-sibling dyads within a random sample of individuals with respect to kin; see Wang 2009), which is inversely related to the probability that two individuals drawn at random are siblings sharing one or two parents. Reproductive skew (e.g., unequal sex ratios, variance in reproductive success) increases the probability that two randomly selected individuals are full or half siblings, thereby decreasing $N_b$ regardless of the estimated number of adults contributing offspring ($N_s$).

For each analysis, male and female polygamy was assumed. The full-likelihood method was used with most of the default parameter settings (e.g., dioecious, diploid, no inbreeding, a single run of medium length, medium likelihood precision, no sibship prior, and no update of allele frequencies). The full-likelidhood method assigns all sampled individuals to various inferred relationships (full-siblings, half-siblings, unrelated) jointly and is the most accurate COLONY method, as verified by simulated and empirical data analyses (Wang 2004; Wang and Santure 2009). Due to sampling methods (collection of offspring of unknown parentage) COLONY parameters of sibship size, number of parent candidates, paternal sibships, maternal sibships, and population allele frequency were unknown or zero. Additionally, the sex of the inferred adults was unknown.

The value for allelic dropout rate was set at 0 for all loci across both years. The values for rate of other kinds of genotyping errors (including mistyping and mutations) were empirically estimated to be 0.008 for the 2011 data and 0.003 for the 2012 data. Error rates were determined through the reanalysis of a random subset (about 10%) of individuals per year. The transformation of polyploidy codominant phenotypes to diploid dominant phenotpyes could cause an apparent distortion of Mendelian segregation and thus may lead to the split of large full sib families in the likelihood reconstruction (Wang and Scribner 2014). However, when genotyping error rates are permitted at each locus, rare phenotypes will be considered to be due to genotyping errors, and the large sibship will not be incorrectly split during pedigree reconstruction (Wang and Scribner 2014). To test whether higher genotyping error rates, relative to empirically calculated values, resulted in differences in sibship reconstruction, additional genotyping error rates (0.02 and 0.04; as suggested by Wang and Scribner 2014) were used for the 2011 ALH data. To test whether subsampling biased results by underestimating $N_s$, $N_b$, and $N_k$, additional analyses were

conducted for the 2011 ALH and Waneta data. Of the total samples collected, a subsample of the Waneta (25% and 12%) and ALH (12% and 6%) samples were systematically selected (i.e., every fourth sample collected in order of capture date to represent 25% of total capture) and analyzed in COLONY.

For each analysis, a replicate run was conducted using the same data and parameter values but different random number seeds allowing for the comparison of maximum likelihood estimates and best pedigree configurations, as well as to evaluate program convergence for each data set. An analysis of variance was used to test for differences in the number of kin groups ($N_k$) between sites and years.

With the combination of the estimated fertilization dates and genetic analyses data, the proportion of full-sibling individuals estimated to be fertilized within 24 and 48 h of each other was calculated. Additionally, the duration of spawning per inferred adult, the mean ± SD of number of contributing adults per estimated spawning date, number of spawning partners per inferred adult, and number of estimated spawning days an inferred adult contributed progeny to were calculated.

*Genetic and empirical estimates of mature adult population*.—Estimates of spawning population size derived with the use of genetic and empirical data were compared. Spawning population size based on genetic data was estimated as described above ($N_s$). Empirical estimates of the Canadian UCR population in spawning condition each year was calculated based on visual determination of maturation stages of adults captured during the prespawning season (early to mid-June) and corresponding sex ratios.

In 2009 through 2012, adult White Sturgeon were captured within the Canadian portion of the upper Columbia River using baited (frozen kokanee *Oncorhynchus nerka*) setlines in a medium line configuration (ten 20/0 circle hooks; for capture and processing see BC Hydro 2013). Setline sampling sites were spatially balanced and randomly selected throughout the entire spatial extent of the upper Columbia River from rkm 0.0 to 56.0 (Figure 1). Each adult (>150 cm) was surgically examined to determine sex and maturity stage. Sexually mature males were indicated with having large, cream to whitish testes that were deeply lobed and filling most of the abdominal cavity (UCWSRI 2006). Sexually mature females were identified with having large dark ovaries filling much of the abdominal cavity. Black eggs contained tight in the ovary exhibited a distinct bulls-eye and a diameter greater than 3 mm (UCWSRI 2006). The number of available annual spawners ($N_c$) and proportion of the total Canadian UCR population (1,157 [95% CI: 414–1,889]; 1:1 sex ratio; Irvine et al. 2007) in spawning condition were estimated based on the proportion of total sexually mature adults captured. This method of estimation was then compared with inferred $N_s$, as determined by pedigree analysis of the 2011 genetic data. Comparisons were conducted only using the 2011 genetic data because not all sampling sites were represented by the 2012 genetic data.

## RESULTS

### Egg and Larval Collection and Estimated Fertilization Date

Egg and larval collection in 2011 extended from July 4 to August 6 at Waneta ($n = 466$ collected), August 2 to August 12 at ALH ($n = 417$), and July 26 to August 9 at rkm 18.2 ($n = 33$). Water temperatures increased throughout the sampling period ranging from 10.8°C to 19.8°C. Based on back-calculating fertilization dates from developmental stages of collected eggs and larvae, spawning at Waneta was estimated to have occurred from June 30 through August 3, which covered 19 spawning days at water temperatures ranging from 11.8°C to 18.1°C (Figure 2*a*). Spawning was estimated to have occurred at ALH over a duration of 5 d from August 1 to August 5 when water temperatures were 14.8°C to 16.1°C (Figure 2*a*). Spawning activity was multimodal at Waneta with three distinct peaks while one estimated spawning peak was found at ALH.

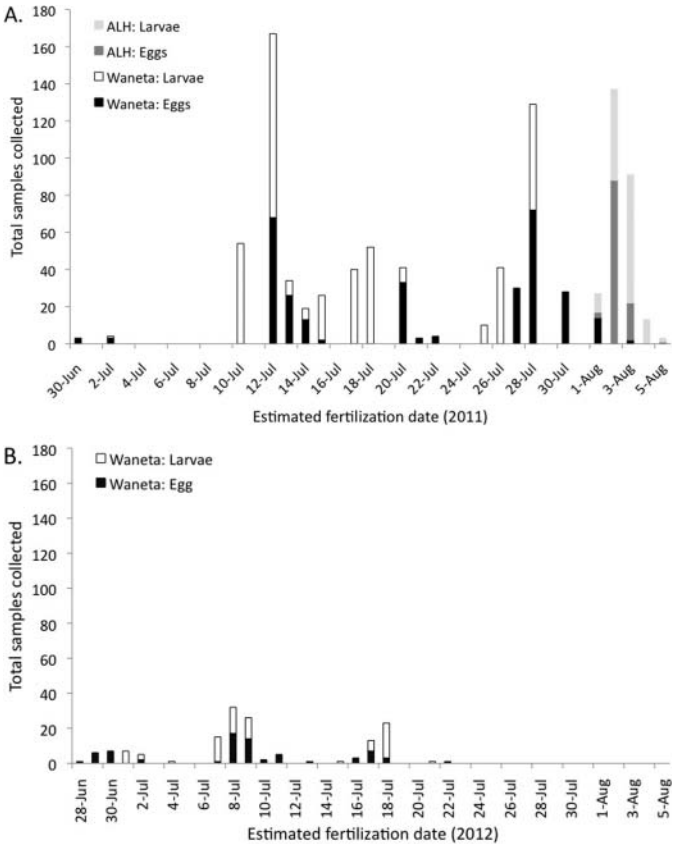


FIGURE 2. Estimated spawning activity (dates of spawining) duration and sample size of White Sturgeon eggs and larvae at the spawn monitoring sites of Arrow Lakes Generating Station (ALH) and Waneta for the **(A)** 2011 and **(B)** 2012 spawning seasons. Estimated fertilization date was back-calculated for wild eggs and larvae as a function of developmental stage (Dettlaff et al. 1993) and temperature (Parsley, unpublished; Jay unpublished).

Egg and larval collection in 2012 occurred between July 4 and July 27 at Waneta ($n = 112$ collected), and no eggs or larvae were collected at ALH and rkm 18.2. Water temperatures increased from 11.0°C to 19.5°C through the sampling period. Based on back calculation of fertilization dates of collected eggs and larvae, spawning was estimated to have occurred at Waneta between the dates of June 28 and July 22, covering 18 spawning days (Figure 2b). Spawning was estimated to have occurred at water temperatures ranging from 13.0°C to 16.0°C. Consistent with 2011, spawning was estimated to have occurred in three distinct peaks at Waneta.

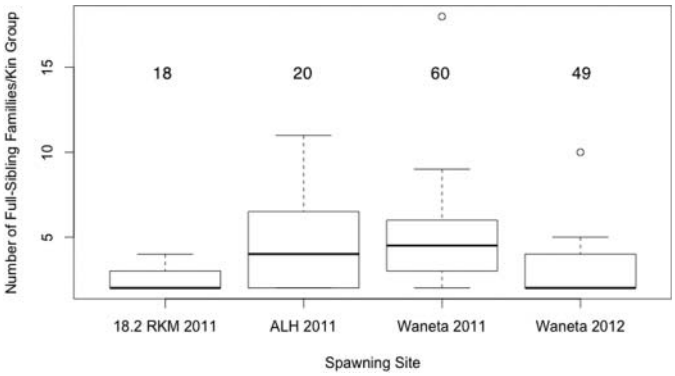


FIGURE 3. Whisker plots of the number of inferred full-sibling White Sturgeon families per kin group for each year at the spawning sites of Arrow Lakes Generating Station (ALH), rkm 18.2, and Waneta. Numbers above box plots represent the number of kin groups inferred at each site.

## Pedigree Analysis

Across the 12 microsatellite loci, the number of alleles per locus varied from means of 5 to 21 (SD, 6.4). The total number of alleles observed was similar in 2011 (143 total alleles) and 2012 (139 total alleles).

The number of kin groups ($N_k$) varied among sites and between years (Table 1; Figure 3 and 4). The number of full-sibling families nested within each kin group was significantly different between sites and years (Figure 3; $F = 10.181$, $P < 0.001$). In 2011, the Waneta site was estimated to have had the greatest number of kin groups ($N_k = 60$) with a mean of 4.75 (SD, 2.61) full-sibling families nested within a kin group. Twenty kin groups were identified at the ALH site in 2011. However, the mean number of full-sibling families nested within a kin group, at 4.75 (SD, 2.79), was similar to Waneta (2011). Additionally, inferred kin groups at ALH exhibited greater variability in numbers of full-sibling families per group than the other sites. Comparatively, fewer full-sibling families per kin group were estimated to have occurred at Waneta in 2012 ($2.94 \pm 1.49$; $N_k = 49$) and rkm 18.2 in 2011 ($2.44 \pm 0.62$; $N_k = 18$), indicating spawning individuals at these sites had a lower number of reproductive partners relative to ALH and Waneta in 2011. In 2011, the proportion of full-sibling individuals estimated to be fertilized within 24 and 48 h of each other was 0.792 and 0.917 at ALH and 0.711 and 0.844 at Waneta, respectively. In 2012, 0.286 and 1.000 of full-sibling individuals were estimated to be fertilized within 24 and 48 h at Waneta, respectively.

In 2011, the estimated effective breeding number ($N_b$) for the Waneta site was 46 (95% CI: 31–70), representing 48.9% of the total UCR population estimated $N_b$, while ALH and rkm 18.2 had an estimated $N_b$ of 16 (95% CI: 9–34) and 32 (95% CI: 19–58), contributing 17.0% and 34.0% of the total estimated $N_b$, respectively (Table 1). Over the sections of upper Columbia River surveyed, the Waneta site was the major contributor to the estimated number of adults contributing offspring ($N_s$) with 89 inferred spawning adults representing 61.0% of the total estimated $N_s$, while ALH and rkm 18.2 were estimated to have 29 and 28 spawning adults contributing to progeny sampled, respectively; both representing 19% of

TABLE 1. Estimates of White Sturgeon effective breeding number ($N_b$), number of adults contributing to offspring ($N_s$), and number of kin groups ($N_k$) based on pedigree analyses of wild larvae of unknown parentage collected by means of egg mats and drift nets in the upper Columbia River (see Figure 1 for sites) in summer 2011 and 2012.

| Year and site | Number genotyped | $N_b$ | 95% CI of $N_b$ | $N_s$ | $N_k$ |
|---|---|---|---|---|---|
| 2011 | | | | | |
| rkm 18.2 | 33 | 32 | 19–58 | 28 | 18 |
| ALH | 104 | 16 | 9–34 | 29 | 20 |
| Waneta | 232 | 46 | 31–70 | 89 | 60 |
| 2012 | | | | | |
| Waneta | 112 | 79 | 56–110 | 97 | 49 |

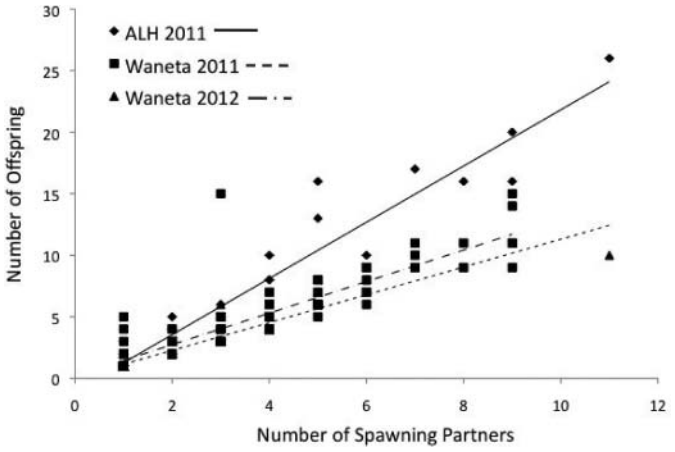


FIGURE 4. Relationship between number of spawning partners and number of offspring produced (as a measure of reproductive success) for inferred adult White Sturgeon at sites of Arrow Lakes Generating Station (ALH) and Waneta in 2011 and 2012. Lines are of best fit.

the total $N_s$. Both $N_s$ and $N_b$ remained relatively constant when the number of samples used within an analysis was reduced for ALH and Waneta, while $N_k$ decreased (Table 4). Subsampling 50%, 25%, and 12% of the Waneta larvae resulted in estimated $N_s$ of 89, 87, and 48 and estimated $N_b$ of 46, 52, and 43, respectively. The $N_k$ reduced from 61 with a subsample of 50% of the total larvae to 46 at 25% subsampling and to 28 at 12% subsampling. Subsampling 25%, 12% and 6% of the total ALH larvae collected resulted in estimated $N_s$ of 29, 24, and 21 and estimated $N_b$ of 16, 17, and 24, respectively. A reduction in $N_k$ was also observed within the ALH data when a subsample of larvae was analyzed: 20 at 25%, 15 at 12%, and 13 at 6%. In 2012, $N_b$ was estimated to be of 79 (95% CI: 56, 110) and $N_s$ was 97. However, results only represent adults spawning at the Waneta site because no samples were collected at the ALH or rkm 18.2 sites (Table 1).

Estimated fertilization dates of progeny assigned to adults were used to infer variation in individual adult reproductive success within spawning sites and between spawning sites and years (Table 2; Figure 4). At the ALH site in 2011, the number of inferred adults that contributed to an estimated spawning day was 10.4 (SD, 7.7) , the number of spawning partners per adult was 3.6 (SD, 2.9), and the number of estimated spawning days an inferred adult contributed to was 2.1 (SD, 1.1). In 2011, the number of inferred adults per estimated spawning day at Waneta was 17.9 (SD, 12.9), the number of spawning partners was 3.6 (SD, 2.8), and number of estimated spawning days an inferred adult contributed to was 2.4 (SD, 1.2). During the 2012 spawning season, the number of inferred spawning adults within a given estimated spawning day was 12.4 (SD, 11.9), inferred adults had 2.0 (SD, 1.5) spawning partners, and the number of estimated spawning days an inferred adult contributed to was 1.4 (SD, 0.6). COLONY is unable to determine sex of inferred adults through pedigree analysis. However, based on the pedigree data, both sexes were estimated to have spawned over multiple days with multiple partners and multiple individuals of each sex contributed to spawn within an estimated spawning day.

### Comparison of Empirical and Genetic Data

Based on empirical data collected between 2009 and 2012, the mean annual number of captured and sexed individuals was 221.12 (SD, 25.61; data provided by BC Hydro; Table 3). The annual number of males in spawning condition was 137.80 (SD, 15.33) and females was 83.32 (SD, 21.25); those males represented 0.24 (SD, 0.03) of the total population, and the females represented 0.14 (SD, 0.04). In 2011, a total of 213 individuals were empirically estimated to be in spawning condition. The number of males was empirically estimated to be 141 (0.24 of the total population) and females 72 (0.13; Table 3). Based on genetic data collected in 2011, the number of spawning adults was 146 representing a proportion of 0.13 of the total population. The ratio of $N_c$ : $N_s$ (number of available spawners empirically estimated to inferred number of adults contributing offspring through pedigree analysis) was 0.683.

## DISCUSSION

We used pedigree analyses to quantify the effective number of breeding adults, number of adults contributing progeny, and individual reproductive success of UCR White Sturgeon. Developmentally staging collected eggs and larvae allowed for estimation of spawning period, and thereby spawning group composition and duration of spawning by an individual adult. Reductions in $N_b$ relative to $N_s$ were observed and varied among sites and between years, suggesting variation in number of adults contributing offspring ($N_s$), sex ratios, and reproductive success. Estimation of fertilization date of collected eggs and larvae provided a measure of spawning activity. However, the observed variation in number of mates, number of adults contributing offspring within a single spawning day, and spawning duration of individual adults implies that the estimated number of spawning days was a poor indication of number of adults contributing to larval production. This study did not incorporate downstream spawning areas south of the Canada–U.S. border where adults from the upper Columbia

TABLE 2. Variation in inferred upper Columbia River adult White Sturgeon (Table 1) reproductive success between sampling years (summer 2011 and 2012) and among sites (ALH and Waneta; see Table 1 and Figure 1) including number of contributing inferred adults per estimated spawning day (ESD), number of breeding partners per inferred adult, and number of ESD per inferred adult.

| | Estimate or mean (± SD where provided) | | |
|---|---|---|---|
| Variable | ALH 2011 | Waneta 2011 | Waneta 2012 |
| ESD | 5 | 19 | 18 |
| $N_s$ | 29 | 89 | 97 |
| $N_b$ | 16 | 46 | 79 |
| Number of contributing adults/ESD | 10.4 ± 7.7 | 17.9 ± 12.9 | 12.4 ± 11.9 |
| Number of breeding partners/adult | 3.6 ± 2.9 | 3.6 ± 2.8 | 2.0 ± 1.5 |
| ESD/adult | 2.1 ± 1.1 | 2.4 ± 1.2 | 1.4 ± 0.6 |
| Number of offspring/adult | 7.2 ± 6.9 | 5.1 ± 5.6 | 2.2 ± 1.8 |

TABLE 3. Empirical ($N_c$) and genetic ($N_s$; see Table 1) estimates of the proportion of the total White Sturgeon population in the Canadian portion of the upper Columbia River (1,157 [95% CI: 414–1,889]; Irvine et al. 2007) in spawning condition. Empirical estimates of number of individuals in spawning condition were calculated based on sex ratios (1:1) and maturation stages of adults captured via set line during the 2009–2012 broodstock programs (June).

| Sex | Year | Number sexed | Mature individuals | Proportion in spawning condition[a] | Individuals in spawning condition[a] |
|---|---|---|---|---|---|
| | | | **Estimates of available spawners ($N_c$)** | | |
| Female | 2009 | 51 | 10 | 0.20 | 113.33 |
| | 2010 | 63 | 9 | 0.14 | 82.57 |
| | 2011 | 64 | 8 | 0.13 | 72.25 |
| | 2012 | 71 | 8 | 0.11 | 65.13 |
| | Mean | 62 | 8 | 0.14 | 83.32 |
| Male | 2009 | 38 | 9 | 0.24 | 136.89 |
| | 2010 | 41 | 11 | 0.27 | 155.07 |
| | 2011 | 45 | 11 | 0.24 | 141.29 |
| | 2012 | 49 | 10 | 0.20 | 117.96 |
| | Mean | 43 | 10 | 0.24 | 137.80 |
| | | | **Adults contributing to offspring ($N_s$)** | | |
| Both sexes | | | | 0.13 | 146 |

[a]Proportion of Canadian population (1,157).

River are known to migrate to spawn. Future studies incorporating samples from other accessible spawning grounds would improve estimates of the total spawning population of this transboundary population and would further increase knowledge of reproductive ecology.

Results of these pedigree analyses revealed that Waneta is the main spawning site within the upper Columbia River, representing 61% of the total UCR spawning population during the 2 years of study. A smaller group of adults was estimated to have spawned over a shorter period at the ALH site; a site that has only been identified in recent years and probably represents an important contributing spawning site. Despite the few samples collected at rkm 18.2, the number of inferred adults contributing to the collected offspring represented 19% of the total spawning population. Importantly, the exact geographical extent of this spawning area is still being described, and sampling proximity to the egg depositional area is unknown. Samples collected at all sites were developed only to the yolk sac stage, indicating their origination from our sampling sites rather than farther upstream. In the wild, hatched yolk sac larvae burrow into the substrate where they remain until yolk sac reserves are depleted (McAdam 2011). Yolk-sac larvae captured here were estimated to be 0–3 d post-hatch, suggesting either larvae were hatching immediately upstream from the sampling equipment or larval rearing habitat at spawning sites is poor and results in nonvolitional dispersal prior to the larvae utilizing endogenous yolk sac reserves.

Variance in reproductive success, based on number of offspring produced by individual adults, was inferred within spawning sites, among spawning sites and between years. Reconstructed pedigrees revealed differences in (1) the duration of spawning among individual fish, (2) the number of days over which spawning occurred among individual fish, and (3) the number of spawning partners, all of which were unknown for White Sturgeon populations prior to this study.

TABLE 4. Comparison of pedigree analyses using reduced number of White Sturgeon tissue samples to determine the effects of subsampling on pedigree reconstruction. Estimates include $N_b$, $N_s$ and $N_k$ (see Table 1) of collected progeny from the upper Columbia River in summer 2011 at the sites of Waneta and ALH (see Figure 1).

| Total samples collected | Total samples analyzed | Proportion of total collection | $N_b$ | 95% CI of $N_b$ | $N_s$ | $N_k$ |
|---|---|---|---|---|---|---|
| 466 | 232 | 0.50 | 46 | 31–70 | 89 | 61 |
| 466 | 116 | 0.25 | 52 | 37–77 | 87 | 46 |
| 466 | 58 | 0.12 | 43 | 29–70 | 48 | 28 |
| 417 | 104 | 0.25 | 16 | 9–34 | 29 | 20 |
| 417 | 52 | 0.12 | 17 | 10–34 | 24 | 15 |
| 417 | 26 | 0.06 | 24 | 14–44 | 21 | 13 |

Spawning was estimated to have occurred over shorter periods at the ALH site in 2011 than at the Waneta site during 2011 and 2012. However, inferred adults spawning at ALH were estimated to have a similar mean number of spawning partners and contributed to a similar mean number of estimated spawning days. The number of contributing adults per estimated spawning day was greater at the Waneta site in 2011 than at ALH in 2011 and Waneta in 2012. Within all sites, variation in number of spawning days and duration of spawning between inferred individual adults was observed. Although sex was unknown, both sexes were estimated to have spawned during multiple days. Analyses of genetic data also determined variation in number of spawning partners within and between sexes. This observed variation in number of adults spawning on a given day and number of days a single inferred adult spawned implied that the number of estimated spawning days is not a reliable estimate of annual spawner abundance. Estimating White Sturgeon spawning period within the upper Columbia River using staged eggs has been used as the primary measure of spawning activity for many years and has been the best available metric describing start and end dates of spawning activity. We included staged larvae in the spawning duration estimate to provide a better representation of all spawning days. Based on these results, managers would be advised to estimate the number of spawning days using both staged eggs and larvae as a management tool to determine duration of spawning but not to infer the number of spawning adults.

The ratio of $N_s$ (genetically estimated) to $N_c$ (number of available spawners based on stage of maturation) was 0.683. Although $N_s$ was lower, an underestimation is expected due to restrictions in sampling methods and genotyping a subsample of the total capture. However, when pedigree analyses were conducted using reduced data sets from Waneta and ALH 2011 samples, estimates of $N_s$ were similar (Table 4). Estimates of $N_b$ were also similar, while $N_k$ decreased when pedigrees were reconstructed with reduced number of samples. These results show that sample sizes of larvae used were representative of the population present. Not all family crosses were observed with reduced sample size and (or) collection duration, suggesting sample size may affect estimates of individual reproductive success. An overestimation of $N_c$ within the Canadian portion of the upper Columbia River is expected because all sexually mature adults may not successfully reproduce or mature adults may spawn in areas south of the border. This data highlights the importance of using multiple methods to describe adult demographics for under-studied species. Future studies that investigate spawning periodicity for adult males and females would add further information regarding the number of adults available to spawn in any given year. Finally, additional years of empirical and genetic data collection would be beneficial to further compare estimates made using both methods.

Estimates of $N_b$ were found to be less than $N_s$ at the ALH and Waneta sites, implying there is between-individual variation in reproductive success. Variation could be due to unequal sex ratios (Moyer et al. 2012), variance in reproductive success (Duong et al. 2013), and variation in the number of spawning individuals over time, which was seen in our results of individual reproductive success. Despite a stable $N_s$ across years, Duong et al. (2013) found the polygamous mating system of Lake Sturgeon *Acipenser fulvescens* resulted in low standardized variance in reproductive success causing interannual variation in $N_b/N_s$ ratios. We also observed relatively constant estimates of $N_s$ at Waneta across both years, despite the eightfold difference in number of offspring collected. Results presented here, and by past studies (Moyer et al. 2012; Duong et al. 2013), indicate that environmental conditions and the nature of sturgeon reproductive ecology interact to affect demographic parameters, $N_b/N_s$ estimates, and offspring survival.

The pedigree methods employed in this study are useful for populations where access to spawning adults is not possible, making more traditional parentage analysis difficult. Further, the White Sturgeon genome has complicated genetic analyses to date due to issues with polyploidy. A recent study by Wang and Scribner (2014) examined the effects of polyploidy levels, actual pedigree structures, and marker number and polymorphism on the accuracy of sibship assignments derived using simulated and empirical data of polyploid species based on full likelihood and pairwise likelihood methods. Their results showed that sibship could be accurately recovered for polyploid species based on a typical set of microsatellites (e.g., 10 markers each with 10 alleles) and by using the full likelihood methods developed for diploid species (Wang 2004; Wang and Santure 2009) and applying the marker data transformation described by Rodzen et al. (2004). Wang and Scribner (2014) also showed that including more marker information and allowing for a small mistyping error rate ($e = 0.04$) treats the low proportions of the probability of recessive phenotypes as a mistyping error within the analysis, thereby reducing sibship grouping split during reconstruction. Additionally, they found that 80 transformed loci were sufficient to achieve almost perfect sibship of uniformly large full-sib families, while 125 transformed loci were able to correctly reconstruct sibships containing unrelated individuals (singletons) at a rate of 99%. The inference accuracy for all types of relationships increased rapidly with an increased number of alleles per untransformed locus. The findings of Wang and Scribner (2014) validated our methods of inferring sibship from 12 microsatellite loci (a total of 143 transformed loci; Rodzen et al. 2004) using the full likelihood method. The empirical estimates of mistyping error rate we used in analyses were low (0.008 for 2011 and 0.003 for 2012 data). However, pedigree reconstruction and estimates of $N_b$ and $N_s$ were similar when the ALH 2011 data were analyzed using error rates of 0.02 and 0.04 (data not shown). Additionally, we observed a high

degree of consistency in pedigree assignment and estimated $N_b$ and $N_s$ across replicate runs within a site further confirming the reliability of the results.

The UCR White Sturgeon population has been experiencing recruitment failure over the past several decades, and hatchery supplementation has been the primary means of mitigation while research into recruitment failure is ongoing (Hildebrand and Parsley 2013). For hatchery programs focused on species that do not use captive broodstock, factors such as number of spawning adults, limited access to spawning adults, and life history characteristics (i.e., intermittent spawning, delayed maturity, skewed sex ratios) can lead to management practices that reduce offspring levels of genetic diversity relative to levels represented in the natural spawning population (Allendorf and Phelps 1980; Ryman 1991; Crossman et al. 2011). Crossman et al. (2011) found that Lake Sturgeon offspring of naturally produced eggs and larvae collected in drift nets and raised in a hatchery were less related (lower coancestry) and were produced by greater effective breeding numbers than offspring produced from direct gamete collections from adults. Current UCR White Sturgeon recovery measures include a hatchery supplemental program capturing broodstock of up to 20 adults (10 females and 10 males) annually for the production of offspring. Results from this study and Crossman et al. (2011) suggest that representation of additional spawning adults could be achieved by collecting and incorporating naturally produced eggs and larvae into the culture program. This has been recommended for other sturgeon species (e.g., Lake Sturgeon; Crossman et al. 2011).

Using genetic data, we estimated the effective breeding number for polyploid species inhabiting large river systems where direct observation of mating is impossible or misleading and spawning population census data are difficult to obtain. If genetic techniques are not available or affordable, concordance between empirical estimates of spawning census size and genetic estimates of number of adults contributing offspring supports the use of alternative means of estimating the number of adults that may be spawning in any given year. Conversely, census data support genetic findings, and thus, in situations where adult sampling is not feasible but eggs and larvae are sampled, genetic data can provide viable means of inferring the number of spawning adults, at least to the larval stage. These methods of determining spawning population size and effective population size are fundamental to our understanding of life history strategies and can be applied to recovery planning and aquaculture programs for species of conservational concern.

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# PRCC-HCP Briefing

**September 22, 2014**

Grant County
PUBLIC UTILITY DISTRICT
*Excellence in Service and Leadership*

# Wanapum Fishway Exit Passage System Debris/Aquatic Vegetation

**Grant PUD is currently implementing maintenance dives on left and right bank fish ladder exit pump screens. Maintenance dives on LB are every other day**

# Wanapum Fishway Exit Passage System Left Bank Issues

- September 18, 2014 (am): 4 pumps cleaned of 3-5” of material/debris;
- September 18, 2014 (afternoon): 4 pumps cleaned of material/debris;
- September 18, 2014 (pm): Ladder flows began dropping off;
- September 19, 2014 (am): Ladder lost nearly all flows;
- September 19, 2014 (pm): Ladder flows restored;

**During time of no flow, an estimated 30-40 adult fish were stranded in a low water situation**

**It was estimated that 9-12 fish were mortalities.**

**Not all stranded fish were able observed, those observed were fall Chinook**

**No lamprey were observed**

# Adult Pacific Lamprey - Passage

- A total of 6,739 adult lamprey have been documented via the video count system passing through Priest Rapids Dam (9/19/14);
- 2,267 adult lamprey have been transported upstream and released above Rock Island Dam (9/9/14);
- At this time ~35% of the adult lamprey migration has been trap-n-transported upstream of Rock Island dam.
- To date a total of 4,601 adult lamprey have either volitionally passed through the PR Project (n=2,334) have been trapped and transported upstream of Rock Island (n=2,267).
- At this time ~68.3% of the adult lamprey migration has either volitionally migrated or has been trap-n-transported upstream of Rock Island dam

# Construction status

- Approximately 350 drilled holes in the Wanapum spillway to complete the project
  - 37 pier tendons
  - Remaining holes:
    - Post tensioned anchor bars
    - Lift joint drains
    - Lift joint drain efficiency holes
    - Grout holes
    - Piezometers
    - Crack exploratory holes
    - Geotechnical exploratory holes
    - Temporary post tensioned anchor bars

# Construction status

- First tendon installed in Monolith 7 (9/3);
- Second tendon installed in Monolith 4 (9/11);
- General tendon installation process
  - DRILLING: Drill pilot hole, drill 10” hole, drill 16” hole to full depth; test for water tightness; grout and re-drill as needed throughout drilling
  - SHEATH: Place sheath in 16” hole; grout into place
  - TENDON: Place tendon into the sheath; bond zone grouting; tension; final grouting
  - Multiple holes in various steps of the process
- Continuing surveillance and monitoring


NICHOLSON


Link-Belt


7


NICHOLSON
NICHOLSON

# Intermediate Pool Raise

- Still expected in Q4 2014
- After more construction, refine timeline

# Refill Plan

- Operating band 558’–562’
- Total refill ~17’ at maximum of 3’/day
- 3 refill hold points along the way
- Data collection and analysis at each hold point
- Data collection will determine next step
- Pending start date, 2 to 3 weeks to reach 561.5’
- 6 refill scenario’s (Oct, Nov and Dec)

All subject to BOC and FERC review and approval

# Next major process milestones

- Board of Consultant meeting
  - September 25 & 26
- Approval on Monolith 4 design package
  - Need approval for and on lesser seismic event
- Approval on Monoliths 3, 5 – 12 design package
- Approval on Monolith 2 at 562’
- Approval on Monoliths 1 & 13
  - ½ monoliths on each side of the spillway
- Approval for the intermediate pool raise
  - Surveillance and Monitoring Plans
  - Refill Plan

# Revised Proposal from WDFW on the Number of Juvenile White Sturgeon to Release in 2015

**2015 White Sturgeon Stocking Agreement (Priest Rapids Project Area):**

I. **Grant PUD currently has 40 half-sibling families available for stocking.**
II. **Based off available half-sibling families in the hatchery, the PRFF agrees (through unanimous vote) to stock 6,500 age-1 juvenile white sturgeon into the Priest Rapids Project Area in 2015 provided:**
    i. **≥18 half-sibling families are available at the time of release.**
    ii. **Half-sibling equalization is reflected in the release to the greatest extent possible.**
III. **If <18 half-sibling families are available at the time of release, a reduced and pro-rated release strategy will be employed.**
    i. **For example: If 10 half-sibling families are available then the 2015 release would be 3,610 age-1 juvenile white sturgeon (6,500/18 half-sibling families = 361 fish/half-sibling family; 361 fish/half-sibling family X 10 half-sibling families = 3,610 stocking rate)**
IV. **This white sturgeon stocking agreement only affects release year 2015 and does not have any bearing on future releases.**

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
*PO Box 47600 • Olympia, WA 98504-7600 • 360-407-6000*
*711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341*

September 3, 2014

Mr. Jeff Grizzel
Natural Resources Director
Grant County PUD
PO Box 878
Ephrata, WA 98823

RE: Ecology review and record on the 2014 White Sturgeon Supplementation Plan.
Priest Rapids Hydroelectric Project No. 2114

Dear Mr. Grizzel: Jeff

I would like to follow up with you from our August 25, 2014 conference call and subsequent e-mail communications to reiterate the direction provided by the Washington State Department of Ecology (Ecology) with regard to the white sturgeon supplementation issue brought to our attention in March 2014. The discussions and dialogue have been helpful and I appreciate our continued work on implementing the White Sturgeon Management Plan (WSMP) for the Priest Rapids Hydroelectric Project.

As you are aware, after many months of review and deliberation, the Priest Rapids Fish Forum (PRFF) was unable to reach agreement on the number of juvenile white sturgeon to be released into the Priest Rapids project area in 2014. The impasse occurred despite thoughtful and thorough discussions amongst the voting members of the PRFF about the scientific merits of the options under consideration. The lack of agreement prompted the PRFF to initiate a dispute resolution process which ultimately led to an Ecology decision to stock 6,500 juvenile white sturgeon in 2014. Following the decision by Ecology, the Confederated Tribes of the Colville Reservation (CTCR) contacted Ecology seeking government to government discussions beyond the formal steps identified in the PRFF dispute resolution protocol. Ecology also understands that the Federal Energy Regulatory Commission (FERC) has been contacted and subsequent discussions may be underway between some parties of the PRFF, though also outside the scope of the PRFF dispute resolution protocol.

Our interest with this letter is to clarify our decision should there have been any ambiguity. In addition, we want to provide a record of the issue and decision for the signators to use as appropriate for continued work and collaboration on implementing the WSMP.

A review of the history and record for this dispute indicates that the Order and the 401 Water Quality Certification (401 Certification) was issued to Grant PUD on April 3, 2007, for the Priest Rapids Hydroelectric Project and was developed to provide beneficial uses for a variety of fish species, including white sturgeon. In the 401 Certification, Appendix C defines the biological objectives and implementation measures for developing fish management plans. In April 2009, the PRFF developed a WSMP with specific outcome-based performance actions and measures.

The WSMP includes a specific biological objective to sustain a population at a level commensurate with the available habitat through the supplementation program. The supplementation program is to provide an initial foundation for the monitoring and evaluation (M&E) program. In turn, the M&E program is the basis for adaptive management. In section 3.1, *Objective 1: Increase the Spawning and Rearing of White sturgeon in the Priest Rapids Project*, states that the initial population "targets are intended to be maintained for the present as a mechanism to rapidly rebuild the population." These targets can be adjusted at any point in the future as M&E verifies that these abundance levels will exceed carrying capacity.

As I referenced earlier, the PRFF was not able to reach consensus on the number of juvenile white sturgeon to be stocked in the Priest Rapids project area. On March 24, 2014, the voting members of the PRFF sent a letter to Ecology stating they were exercising their right to use the dispute resolution process found in Article VI of the Final PRFF Protocols. The PRFF members followed each step of the resolution process but remained unable to reach consensus. Because of this impasse, Grant County PUD, as is their right within the dispute resolution protocol process, sent a letter to Ecology on July 15, 2014, requesting Ecology resolve the dispute.

Ecology engaged, with guidance and technical support from the Washington Department of Fish and Wildlife (WDFW). Ecology's expertise and regulatory oversight in the 401 certification process is primarily directed at water quality issues. However, the 401 certification includes an "Aquatic Life Uses" section so Ecology and WDFW developed a formal inter-agency agreement (Agreement) to make use of the WDFW fisheries experience and expertise. The Agreement is in the 401 Certification, Appendix A. The Agreement codifies the relationship of the two state agencies in the process and "recognizes that WDFW has certain expertise that Ecology does not currently possess."

As stated in our decision letter dated July 21, 2014, WDFW and Ecology believe releasing 6,500 juvenile fish is appropriate for 2014. The basis for the decision is as follows:

- The 2014 white sturgeon supplementation effort is near the end of the "front-loaded" phase of the white sturgeon supplementation. The WSMP and the 401 certification call for M&E to inform and allow for adaptive management during subsequent years.
- There is no new science to definitively point to a release number that deviates from what was originally incorporated into the 401 certification. Ecology deferred to Washington Department of Fish and Wildlife as our fisheries experts.
- Ecology foresees the opportunity for parties to further collaborate next year to reach a consensus decision on the supplementation number based on a shift from the survival

number ("…a mechanism to rapidly rebuild the population") to greater emphasis on habitat carrying capacity and genetic diversity.

Ecology's decision acknowledges the concerns of Grant County PUD and the CTCR. However, Ecology believes that we should honor the dispute resolution process as defined in the formal protocols and the decisions made as part of the process. This decision is for just one year of five in the up-front supplementation. The WSMP also calls for the PRFF to use M&E and adaptive management to determine the remaining years of white sturgeon supplementation. There are many years of work and opportunity ahead for all of us.

As you stated on the conference call and in your follow-up August 26, 2014 e-mail, Grant County PUD intends to implement Ecology's order by marking and releasing the remaining fish. I am encouraged by this commitment and request that you release the remaining 2,168 juvenile white sturgeon by September 18, 2014. This timeline is based on the two week estimate provided in your e-mail.

Again, I appreciate the open communication with Grant County PUD and look forward to continued progress with implementing the WSMP for the Priest Rapids Hydroelectric Project.

Please contact me at (360) 407-6405 or heba461@ecy.wa.gov if you have any questions.

Sincerely,

Heather R. Bartlett
Water Quality Program Manager

cc: Tom Dresser, Grant County PUD
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Mike Clement, Grant County PUD
Jim Brown, WDFW
Jeff Korth, WDFW
Chad Jackson, WDFW
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