Priest Rapids Coordinating Committee
Meeting Agenda (amended 23Feb15)

Wednesday, February 25, 2015
9:00 am – 2:00 pm
Radisson Hotel, Alaska Conference Room
SeaTac, WA

Audio: 1-800-977-8002 Bridge: 45582544

Go to https://grantpud.webex.com/grantpud/j.php?MTID=mbeae78c6ebae1b294db7934688c72d32
If requested, enter your name and email address.
If a password is required, enter the meeting password: go; Next Click "Join".

PRCC Representatives

Scott Carlon/Justin Yeager (Alt), NMFS
Bob Rose, YN
Jeff Korth, C. Andonaegui (Alt), P. Verhey (Alt) WDFW
Curt Dotson, Tom Dresser (Alt), GCPUD
Jim Craig, USFWS
Kirk Truscott, CCT
Tom Skiles, CTUIR

PRCC Administration

Denny Rohr, Rohr & Associates, Facilitator
Debbie Williams, GCPUD, Administrative Assistant

I. Welcome and Introductions

II. Meeting Minutes Approval – January 28, 2015 (D. Rohr)

III. Agenda Review (D. Rohr)

IV. Action Items Review – from January 28, 2015 (D. Rohr)

V. Update of Wanapum Dam Activities (T. Dresser)

VI. ACTION ITEM: NNI Funding – "Barkley Irrigation Company Permanent Point of Diversion Change and Pressurization- CONSTRUCTION" (D. Rohr)

VII. 2014 / 2015 PNI Report (C. Dotson)

VIII. Discussion of Joint Meeting with Habitat SC (D. Rohr)

IX. Agenda Addition: Re-evaluation of Out-migration Turbine Operations (C. Dotson)

X. Agenda Addition: Wanapum Fish Bypass Flow Requirements (C. Dotson)

XI. Potpourri (D. Rohr)

XII. Updates

A. Inland Avian Predation Activities (C. Dotson)

B. Hatchery Activities (T. Dresser)

1. Carlton Acclimation Facility
2. Nason Creek Acclimation Facility
3. Priest Rapids Hatchery Modifications
4. Penticton Hatchery

C. Hatchery Permits (Section 10 for Summer Chinook and Section 7 Consultation for Bull Trout. (T. Dresser)

D. NNI Funded Projects

1. 2014 Real Time Research Avian Study (C. Dotson)

   Including "Comprehensive Assessment of Total Smolt Mortality in Relation to Avian Predation on the Mid- and Lower Columbia River: Spatial and Temporal Analysis of Reservoir-Specific Smolt Losses"

2. 2015 Real Time Research / Oregon State University – "Evaluation of Foraging Behavior, Dispersal, and Predation on ESA-listed Salmonids from the Upper Columbia River by Caspian Terns Displaced from Managed Colonies in the Columbia Plateau Region" (C. Dotson)

3. Supplementary Tags and Tagging for Assessment of Predation Losses of Subyearling Chinook Salmon in the lower Hanford Reach and Upper McNary Reservoir (C. Dotson)

4. Upper Columbia Fish Screen Monitoring Program Phase I Contract Extension (J. Korth)

5. Upper Columbia Fish Screen Monitoring Program Phase II – (J. Korth)

6. Lower Wenatchee Instream Flow Enhancement Project Phase II – (J. Korth)

7. Mid-Columbia River Intake Screen and Diversion Assessment (T. Dresser)

8. Methow Valley Irrigation District (MVID) Instream Flow Improvement Project (T. Dresser)

E. Committee Reports (D. Rohr)

F. NNI and Habitat Funds Report (D. Rohr)

XIII. Next Meeting – March 25, 2015, (Location to be determined)

<u>Action Items from January 28, 2015 PRCC meeting</u>:

1. Carlon and Dresser will do follow up work and prepare an SOA for May or June 2015 discussion of how to address the 5 year check in language in the Salmon and Steelhead Settlement Agreement.
2. Korth to edit NNI Avian funding portion of Dec 2014 draft minutes. Rohr will gather final approvals.
3. Rohr will research and develop information regarding avian predation funding that has taken place in the Columbia Basin, plus the funding amounts for those involved.
4. Dresser will check with the Grant PUD Lands Department staff regarding information and follow up of 6 inactive points of diversion related to water withdrawals from the PR reservoir.

5. Yeager will answer questions listed in agenda item VII, regarding the Barkley Irrigation Company Permanent Point of Diversion Change and Pressurization.
6. Dotson will review/make corrections to Paragraph 3, Section 3.1 of the 2015 Steelhead/Sockeye Study.
7. Rohr will arrange a joint meeting between the PRCC and PRCC Habitat Subcommittee.

Priest Rapids Coordinating Committee Meeting

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9:00 am – 2:00 pm
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PRCC Representatives

Scott Carlon, Justin Yeager (Alt), NMFS
Bob Rose, YN
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Denny Rohr, D. Rohr & Assoc., Facilitator
Jim Craig, USFWS
Kirk Truscott, CCT
Tom Skiles, CTUIR
Debbie Williams, GCPUD, Administrative Assistant

Attendees

Scott Carlon, NMFS
Tom Skiles, CTUIR (via phone)
Curt Dotson, GCPUD
Tom Dresser (Via phone)
Denny Rohr, Facilitator
Jeff Korth, WDFW
Jim Craig, USFWS
Kirk Truscott, CCT (via phone)
Debbie Williams, GCPUD (Via phone)

Distributed Items:

1. February 25, 2015 Agenda.
2. FCWG & PRFF committee report.
3. Press Release from Ritchie Graves, NMFS, regarding "USACE Final EIS regarding alternative methods to reduce consumption of steelhead and salmon smolts by cormorants from East Sand Island. http://www.nwp.usace.army.mil/Missions/Currentprojects/CormorantEIS.aspx.
4. PRCC Habitat Funds Report of Unencumbered Fund Balances

Decision Summary:

1. **PRCC members approved NNI funding for the Barkley Irrigation Company Permanent Point of Diversion Change and Pressurization – Construction from NNI Fund 601, in the amount of $349,999.50, subject to approval by Rose.**

Action Items:

1. Carlon and Dresser will do follow up work and prepare an SOA for May or June 2015 discussion of how to address the 5 year check in language in the Salmon and Steelhead Settlement Agreement.

2. Rohr will research and develop information regarding avian predation funding that has taken place in the Columbia Basin, plus the funding amounts for those involved.

3. Dresser will check with the Grant PUD Lands Department staff regarding information and follow up of 6 inactive points of diversion related to water withdrawals from the PR reservoir.
4. Rohr will develop an agenda for a combined meeting to be held in May by the PRCC and PRCC Habitat Subcommittee.
5. Dotson will develop a concept paper explaining the rationale behind "Fish Mode" and reduced flow thru the Wanapum Fish Bypass (WFB) evaluation proposal, distribute the Voith-Hill curves used to explain data, as well as distribute historical documents on how fish mode came about. Agenda item for next month.
6. Dotson will send the link to the "Comprehensive Assessment of Total Smolt Mortality in Relation to Avian Predation on the mid and Lower Columbia River: Spatial and Temporal Analysis of Reservoir-Specific Smolt Losses" to Williams for uploading to Box Net). Comments due to Dotson by March 25th.

Final Meeting Minutes

I. Welcome and Introductions – Rohr welcomed all meeting participants.

II. Meeting Minutes Affirmation and Approval (D. Rohr):

A. December, 2014 - Korth suggested that prior to approval, the December 2014 meeting minutes be edited to reflect the PRCC's frustration that NNI funds are being used to conduct avian predation studies because federal action agencies are not doing their part. Approved, subject to Korth redrafting the NNI Avian funding portion of the minutes. Rohr will distribute to PRCC members for review and final approval. Approved with Korth's comments.

B. January 28, 2015 - Approved subject to approval by Rose.

III. Agenda Review (D. Rohr) – No additions were made to the meeting agenda.

IV. Action Items Review – from January 28, 2015 Meeting (D. Rohr)

- Carlon and Dresser will do follow up work and prepare an SOA for May or June 2015 discussion of how to address the 5 year check in language in the Salmon and Steelhead Settlement Agreement. Ongoing – will remain as an action item placeholder, until complete.
- Rohr will research and develop information regarding avian predation funding that has taken place in the Columbia Basin, plus the funding amounts for those involved. Ongoing
- Dresser will check with the Grant PUD Lands Department staff regarding information and follow up of 6 inactive points of diversion related to water withdrawals from the PR reservoir. Ongoing
- Korth to edit NNI Avian funding portion of Dec 2014 draft minutes. Rohr will gather final approvals. Complete
- Yeager will answer questions listed in agenda item VII, regarding the Barkley Irrigation Company Permanent Point of Diversion Change and Pressurization. Complete
- Dotson will review/make corrections to Paragraph 3, Section 3.1 of the 2015 Steelhead/Sockeye Study. Complete

- Rohr will arrange a joint meeting between the PRCC and PRCC Habitat Subcommittee. **Ongoing**

V. **Update of Wanapum Dam Activities (C. Dotson) –** Dresser reported that a caisson barge was placed against spillway 3 in order to allow contractors to work in the dry while replacing 5 feet of fractured concrete in the ogee. Repairs are going faster than anticipated. 3 of the 39 tendons remain to be installed. Engineers estimate April 1st to raise the Wanapum Pool to 571.5'. Approval will be sought from the Board of Consultants and FERC. Modifications (placement of a steel plate) to the left bank fish ladder exit trash rack have worked well; it's undecided if the metal plate will be removed in the dry before the pool raise, or after, by divers.

VI. **ACTION ITEM: NNI Funding Proposal – Barkley Irrigation Company Permanent Point of Diversion Change and Pressurization – Construction, Justin Yeager, NMFS/Habitat Subcommittee Member (D. Rohr) –** On January 30th, Rohr distributed a new spec sheet that included answers posed by PRCC members during the January 28th meeting. **PRCC members approved funding half of this project from NNI Fund 601, in the amount of $349,999.50, subject to approval by Rose.**

VII. **2014-2015 P&I Report (C. Dotson)** - Dresser reported that the P&I report is being reviewed internally and expects that it will be out for 30 day review by Friday, February 27, 2015. The report will be filed with FERC on April 15, 2015.

VIII. **Discussion of Joint Meeting with Habitat Subcommittee (D. Rohr)** – Rohr explained that the HSC agreed to a joint meeting, and both committees will update their NNI funded project list. **Rohr will develop an agenda for a combined meeting to be held in May by the PRCC and PRCC Habitat Subcommittee.** A modified business meeting will be held by both committees at that time.

IX. **Re-evaluation of Out-migration Turbine Operations (C. Dotson) –** Dotson presented a PowerPoint, (which included a proposal request), that gave a high level overview of the "fish-mode" operations that take place at both Wanapum and Priest Rapids dams during the salmonid out-migration. The presentation also presented a timeline that showed the other programs (i.e. fish bypasses, new turbines, avian predation, etc.) that has taken place at Grant PUD since the first fish-mode operations went into place. Dotson stated that today's presentation was just to start the discussion about doing a study to evaluate the "fish-mode program", acknowledging that additional discussion within the PRCC needs to take place (i.e. at the March PRCC meeting). But that following that discussion at next month's meeting, Dotson would be asking for a decision (vote) for approval to evaluate "fish-mode" at Wanapum and Priest Rapids dams. Along with the presentation on "fish-mode", Dotson included the request to do an evaluation of the fish passage efficiency (FPE) of the Wanapum Fish Bypass (WFB) when 15 kcfs of flow, as opposed to the "normal" 20 kcfs flow is run through the WFB. Because of the complex nature of this discussion, **Dotson was asked to develop a concept paper explaining the history as to how "Fish Mode"** was developed and Grant PUD's proposal to re-evaluate "fish-mode" and the FPE of the WFB during the 2015 steelhead and sockeye survival/behavior study. This "concept paper" is to be sent out to the PRCC members prior to the March PRCC meeting. This discussion will be continued next month.

X. Wanapum Fish Bypass Flow Requirements (C. Dotson) – See above discussion regarding “fish-mode”.

This discussion will be continued next month.

XI. Potpourri (D. Rohr) – Dotson reported that both fish ladders at Wanapum Dam are operational. Dotson distributed the final version of the Blue Leaf 2014 Survival and Behavioral report; he will send it via FedEx to members calling into today’s meeting.

XII. Updates

A. Inland Avian Predation Activities (Goose Island / NW Rocks Follow Up) (C. Dotson) – Dotson explained that dissuasion materials will also be placed on NW Rocks Island this year, and that issues with the satellite tagging study have been worked out with the USACOE/BOR management. As of last week, satellite tagging at Crescent Island and Goose Island was approved.

B. Hatchery Activities (T. Dresser)

1. Carlton Acclimation Facility – 130,000 fish on station. One tank of fish had treatment applied for health issues; fish are now doing well.
2. Nason Creek Acclimation Facility – 45,000 spring Chinook on station. No fish health issues.
3. White River – This is the last year juveniles will be transported from LWSNFS (45,000 on station). A portion of the fish had BKD issues. 25,000 fairly healthy fish were moved into acclimation tanks, and should transport ok. The PRCC Hatchery Subcommittee is waiting to see how fish fair before transporting.
4. PR Hatchery Modifications – Grant PUD and WDFW are still working on modifications. 90,000 fall Chinook are expected back to the hatchery in 2015. Last year 79,000 fish returned.
5. Penticton Hatchery – 2.88 million fry on station.

C. Hatchery Permits (Section 10 for Summer Chinook and Section 7 Consultation for Bull Trout – Dresser reported that Grant PUD is reviewing the Section 10 permit, and that representatives from Grant, Chelan, and Douglas PUD met with Rob Jones, NOAA, to reiterate the consistency for all programs as it relates to O&M and M&E.

D. NNI Funded Projects

1. 2014 Real Time Research Avian Study (C. Dotson) – Including “Comprehensive Assessment of Total Smolt Mortality in Relation to Avian Predation on the Mid- and Lower Columbia River: Spatial and Temporal Analysis of Reservoir-Specific Smolt Losses” – Dotson reported that additional funding is being sought to collect tags on the mid and lower Columbia River bird colonies. The “Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River, 2014 Draft Annual Report, is out for review. Information on NNI funded portion of this study was added to the appendices of this report. Dotson will send the link to the “Comprehensive Assessment of Total Smolt Mortality in Relation to Avian Predation on the mid and Lower Columbia River: Spatial and Temporal Analysis of Reservoir-

Specific Smolt Losses" to Williams for uploading to Box Net. Comments due to Dotson by March 25th. Real Time Research is building a model to quantify spatial predation of smolts via JSTAT analysis throughout the lower Columbia River. The model should be complete in March and could be presented to the PRCC in early spring.

2. 2015 Real Time Research / Oregon State University – "Evaluation of Foraging Behavior, Dispersal, and Predation on ESA-listed Salmonids from the Upper Columbia River by Caspian Terns Displaced from Managed Colonies in the Columbia Plateau Region" (C. Dotson) - Nothing to update; ongoing.

3. Supplementary Tags and Tagging for Assessment of Predation Losses of Sub-yearling Chinook Salmon in the lower Hanford Reach and Upper McNary Reservoir (C. Dotson) – See attached email Dotson distributed from Allen Evans.

4. Upper Columbia Fish Screen Monitoring Program Phase I Contract Extension (J. Korth) – Nothing to update.

5. Upper Columbia Fish Screen Monitoring Program Phase II – (J. Korth) – Nothing to update.

6. Lower Wenatchee Instream Flow Enhancement Project Phase II – (J. Korth) – Nothing to update.

7. Mid-Columbia River Intake Screen and Diversion Assessment – (T. Dresser, J. Korth) – Dresser explained Danny Didricksen was able to complete Priest Rapids Reservoir this spring, including underwater work. He has video for two sites on the left bank upstream of Priest Rapids Dam. One site was compliant, the other was not; Dresser was not sure how far out of compliance it was. As it relates to Wanapum, Didricksen is pulling JARPA's that were completed to correct screens in the Wanapum pool. There are two screens in Wanapum pool that had been grandfathered in under old criteria; they will need to be upgraded. He is talking to land owners to get them into full compliance. Skiles asked what Grant PUD's responsibility to monitor screens is. Dresser explained that there is a direct obligation as it relates to land use permits. Under the FERC license, Grant PUD provides information for 1 million gallons a day withdrawal. Other permits (land use or easements of GPUD permits) are older; Grant, WDOE and WDFW work to make sure compliance is completed. WDFW and WDOE are working to get folks into compliance and to complete annual compliance checks.

8. Methow Valley Irrigation District (MVID) Instream Flow Improvement Project (T. Dresser) – Nothing to update.

E. Committee Reports (D. Rohr) – Rohr distributed via email.

F. NNI and Habitat Funds Report (D. Rohr) – Rohr distributed via email. On February 15th, annual funds were deposited into all of the Habitat Funds. NNI Fund 601 - $1,944,780.95, Habitat Supplemental Fund 602 - $1,029,110.58, and Habitat BiOp Fund 603 - $367,582.44.

XIII. Next Meeting (D. Rohr) – March 25, 2015, 9:00 a.m. – Radisson Hotel, SeaTac, WA.

PROGRAM FUNDING

Funding for the work presented here was provided by the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (USACE), and the Grant County Public Utility District/Priest Rapids Coordinating Committee (GPUD/PRCC); see below for the program funding support provided by each agency, by objective and task. In general, funding for work conducted in the Columbia River estuary was from a grant from BPA and a cooperative agreement with USACE – Portland District; funding for work conducted outside the Columbia River Basin was from a cooperative agreement with USACE – Portland District; funding for work conducted in the Columbia Plateau region were from contracts with the USACE - Walla Walla District and the GPUD/PRCC. We thank David Roberts and John Skidmore (BPA), Cindy Studebaker (USACE - Portland District), David Trachtenbarg (USACE - Walla Walla District), and Curt Dotson (GPUD/PRCC) for their assistance in administering these grants, contracts, and cooperative agreements.

	Funding Contribution by Agency			
	BPA	USACE Portland District	USACE Walla Walla District	GPUD/PRCC
Caspian Terns				
1.1. Columbia River Estuary				
1.1.1. Implementation of Management Plan in Columbia River Estuary		x		
1.1.2. Nesting Distribution, Colony Size, and Productivity	x			
1.1.3. Diet Composition and Salmonid Consumption	x			
1.1.4. Salmonid Impacts Based on PIT Tag Recoveries	x	x		
1.2. Columbia Plateau Region				
1.2.1. Implementation of Management Plan in Potholes Reservoir			x	x
1.2.2. Nesting Distribution, Colony Size, and Productivity			x	x
1.2.3. Salmonid Impacts Based on PIT Tag Recoveries			x	x
1.3. Interior OR and Northeastern CA				
1.3.1. Implementation of Management Plan Outside Columbia Basin		x		
1.3.2. Nesting Distribution, Colony Size, and Productivity		x		
1.3.3. Diet Composition		x		
1.3.4. Sucker and Salmonid Impacts Based on PIT Tag Recoveries		x		
1.4. Inter-colony Movements and Dispersal Patterns	x	x	x	x
Cormorants				
2.1. Columbia River Estuary				
2.1.1. Nesting Distribution and Colony Sizes		x		
2.1.2. Salmonid Impacts Based on PIT Tag Recoveries		x		
2.2. Columbia River Plateau Region				x
2.3. Interior OR and Northeastern CA		x		
2.4. Inter-colony Movements and Dispersal Patterns		x		
Gulls and Pelicans				
3.1. Columbia River Estuary	x	x		
3.2. Columbia Plateau				x
3.3. Interior OR and Northeastern CA		x		

Behavior and Survival Analysis of Juvenile Steelhead and Yearling Chinook Salmon through the Priest Rapids Hydroelectric Project in 2014

Kyle B. Hatch, Mark A. Timko, Leah S. Sullivan, and Suzanne E. Rizor
Blue Leaf Environmental, 2301 West Dolarway Road, Suite 3, Ellensburg, WA 98926, USA

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FINAL Report

18 February 2015

Suggested citation:

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Behavior and Survival Analysis of Juvenile Steelhead and Yearling Chinook Salmon through the Priest Rapids Hydroelectric Project in 2014

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FINAL Report

18 February 2015

Abstract

Acoustic telemetry studies were conducted in 2014 during an assessment of juvenile steelhead (*Oncorhynchus mykiss*) downstream migratory survival and behavior through the Priest Rapids Project (Project area refers to the Wanapum and Priest Rapids dams and reservoirs), a hydroelectric Project that is owned and operated by Public Utility District No. 2 of Grant County, Washington on the Mid-Columbia River. Yearling Chinook salmon (*O. tshawytscha*), which were evaluated and found to have met survival performance standards between 2003 and 2005 were re-evaluated in 2014. Juvenile Salmon Acoustic Telemetry System (commonly referred to as JSATS) technology was used to address the study objectives. Acoustic transmitters were surgically implanted into 1,720 steelhead and 1,716 yearling Chinook salmon; fish were released in paired releases within the tailraces of Rock Island, Wanapum, and Priest Rapids dams between 30 April and 28 May 2014. Acoustic tag detections were collected by a series of arrays between Rock Island Dam (RM 453) and the Hanford Reach (RM 337). Array detection efficiencies at all sites were high, estimated between 97.7% and 100%. Additional emphasis was placed on the behavior of fish as they approached and passed downstream of Priest Rapids Dam at or near the new Priest Rapids Fish Bypass (PRFB) with additional two- and three-dimensional autonomous receivers that were arranged to track study fish directly upstream of the PRFB. Downstream survival was estimated at 92.9% (SE 1.4%) for steelhead and 94.5% (SE 1.3%) for yearling Chinook salmon through the Wanapum Development (Wanapum Dam and Reservoir). Survival was higher for both species through the Priest Rapids Development (Priest Rapids Dam and Reservoir) with steelhead at 96.1% (SE 1.0%) and yearling Chinook salmon at 96.1% (SE 0.9%) survival. The overall Project survival (both dams and reservoirs) was estimated at 89.3% (SE 1.6%) for steelhead and 90.8% (SE 1.5%) for yearling Chinook salmon. Steelhead survival estimates in the Wanapum Development fell slightly below the requirements established in the 2008 NMFS Biological Opinion of 93% by 0.06%, but were met in the Priest Rapids Development and the total Project estimates. Compared to previous studies completed in 2008-2010, the Project area was significantly altered by two events during the 2014 telemetry study. First, in the Wanapum Development, a fracture in the spillway of Wanapum Dam required a 28 ft decrease in the Wanapum Reservoir elevation (forebay elevation averaged 543 ft in 2014; typical operating elevation in 2008-2010 studies was 571 ft), resulting in increased spill at the Wanapum Dam and an 80% reduction in flow at the Wanapum Fish Bypass (WFB). The WFB operated at a reduced flow of 4 kcfs in 2014, whereas in previous studies it was typically operated at 20 kcfs. This decrease in flow at the WFB resulted in the bypass being selected by only 9.9% of the steelhead and 7.5% of yearling Chinook salmon that passed the dam in 2014; for comparison, in previous studies, up to 77% of the juvenile steelhead selected the WFB. The second change in the 2014 Project area was the operation of the new PRFB (commenced April 2014), offering smolts a non-turbine passage route that consisted of three spill bays (20-22) that collectively operated at an average total flow of 25.2 kcfs. The PRFB

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collected 47% of steelhead and 38% of yearling Chinook salmon. Tracking densities of tagged fish that passed through the PRFB indicated that most of the bypass collected fish were originally upstream of the powerhouse, near turbine units 1 and 2. Additional approach analysis of fish moving into the forebay at the hazard barrier supported that fish upstream of the spillway were intercepted and passed at spill bays 1-18 while those fish upstream of the powerhouse were more likely to pass through either the powerhouse or the PRFB. Yearling Chinook salmon were more likely to pass through the powerhouse than steelhead, which was anticipated as yearling Chinook salmon in previous three-dimensional tracking studies were shown to travel at deeper depths. Based on the 2014 study results, it is anticipated that the PRFB collection efficiency will increase considerably when the spillway is closed during future spring out migrations.

Introduction

Wanapum and Priest Rapids dams and the two reservoirs upstream of each dam in the Mid-Columbia River define the Priest Rapids Hydroelectric Project (Project), a Project that is owned and operated by Public Utility District No. 2 of Grant County (Grant PUD). Over the past several decades, Grant PUD has been addressing environmental concerns on the Mid-Columbia River related to the survival and condition of fish passing through the physical structures, as well as the riverine environment that has evolved and continues to vary with time. At each of the dams, Grant PUD has improved downstream passage conditions for juvenile salmonids with the installation of new, fish friendly turbines and bypass structures, along with optimization of operations of existing turbines during the spring and summer out-migration period. Grant PUD has also researched, monitored, and sought to facilitate changes in environmental conditions that favor smolt survival through the Project. In addition to water quality monitoring, Grant PUD maintains a northern pikeminnow (*Ptychocheilus oregonensis*) removal program, avian predation hazing, and has installed avian deterrents (bird wires) below each dam to decrease the risk of predation in the tailrace area. Moreover, Grant PUD actively supports and is directly involved with avian predation monitoring at known nesting colonies of Caspian terns (*Hydroprogne caspia)* and various gull species on the Columbia River Plateau. Grant PUD is also involved in piscivorous fish predation studies of species that include walleye (*Sander vitreus*), northern pikeminnow, and smallmouth bass (*Micropterus dolomieu*).

To improve passage at Wanapum Dam, a surface top-spill fish bypass was completed in 2008 to provide safe and effective downstream passage for juvenile migrants. This surface flow alternative, the Wanapum Fish Bypass (WFB), has proved successful in passing up to nearly 80% of the downstream migrants. With parallel objectives to the WFB, the Priest Rapids top-spill fish bypass or PRFB was operational for its inaugural season during the 2014 spring outmigration. Prior to the construction of this top-spill bypass structure, a prototype bulkhead at Priest Rapids Dam was installed, tested and modified annually between 2006 and 2010 to maximize a design that would effectively collect and pass smolts. Passage efficiency results were mixed during early trials (2006 and 2007), but collection efficiency increased annually as fish behavior became better understood and flow was augmented at or near the prototype to attract smolts. In 2010, fish collection at the prototype bypass peaked and collected 57% of migrating steelhead (*Oncorhynchus mykiss)*.

Passage effectiveness was measured at both dams in two ways: by the proportion of fish that selected a particular passage route, and more importantly, by the ultimate survival rate after selecting that passage route (Timko et al. 2007a, 2007b; Sullivan et al. 2009; Timko et al. 2010; Timko et al. 2011). Columbia and Snake River hydropower facilities are federally regulated to meet established survival standards for juvenile salmonids migrating through their respective Projects. More specifically, for Grant PUD, the survival requirements include juvenile passage survival of 95% at each dam (concrete survival), 93% through a single development (one dam and reservoir, e.g., Priest Rapids Reservoir and Dam) and 86.5% through the entire Project (both developments combined). An arithmetic mean of three consecutive years (for each species) is used to determine if the survival standard has been met. These particular Performance Standards (passage survival rates) that need to be met for the Priest Rapids Project were established for Grant PUD under the “Reasonable and Prudent Alternatives” (RPAs) in the National Marine Fisheries

Service (NMFS) 2004 Biological Opinion for the Priest Rapids Project (NMFS 2004) and were adapted into the "Terms and Conditions" of the 2008 NMFS Biological Opinion (BiOp) (NMFS 2008). These same survival standards are required for species of salmonids that are not listed under the ESA but are required under the 2006 Priest Rapids Project Salmon and Steelhead Settlement Agreement (SSSA) (Grant PUD 2006). Both of these documents' (BiOp and SSSA) requirements were incorporated into the Federal Energy Regulatory Commission's (FERC) license that was issued to Grant PUD for the operation of the Priest Rapids Project on 17 April 2008 (FERC 2008).

To measure the survival of downstream migrant juvenile steelhead, Grant PUD conducted annual survival studies between 2008 and 2010 using mark-recapture acoustic telemetry techniques and continued with a related predation study in 2011. Each year, paired smolt releases (treatment and control groups) were introduced into the tailraces of Rock Island, Wanapum, and Priest Rapids dams and survival was evaluated by downstream acoustic tag detection arrays. During these studies, concrete survival (95%) of steelhead was met at both dams; however steelhead survival through both the development (93%) and project survival (86.5%) have yet to be met consistently (Timko et al. 2007a, 2007b; Sullivan et al. 2009; Timko et al. 2010; Timko et al. 2011; Thompson et al. 2012). During three years of consecutive studies in 2003-2005 survival of downstream migrant yearling Chinook salmon (*O. tshawytscha*) were tested, and survival goals were met with a three-year weighted average of 86.6% (86.6% in 2003, 86.4% in 2004, and 86.9% in 2005) (Anglea et al. 2004, 2005a and 2005b). In this 2014 study, the survival standards for yearling Chinook salmon, previously met using passive integrated transmitters (PIT tags), were revisited to confirm that survival standards are still being met.

In this document, we present the findings of Project passage survival and behavior of steelhead and yearling Chinook salmon at the Wanapum and Priest Rapids developments in 2014. Paired-release survival estimates using treatment and control groups are provided for both species at each development, Wanapum Reservoir/Dam and Priest Rapids Reservoir/Dam, and through the entire Project. In addition to comparisons of interspecies survival in the Project, migration rates, forebay residence times, approach patterns, and passage behavior are presented with a focus on passage behavior at the PRFB.

Methods

Study Site

The Project includes Priest Rapids Dam (River Mile, 'RM' hereafter, 397), constructed in 1956-1961, and Wanapum Dam (RM 416), constructed in 1959-1963. The two dams are located on the Mid-Columbia River, between Rock Island Dam (RM 453) and the Hanford Reach (Figure 1). Figure 1 illustrates the position of the Wanapum Reservoir as the pool between Rock Island and Wanapum dams, and the Priest Rapids Reservoir as the pool between Wanapum and Priest Rapids dams. Both hydropower facilities are maintained and managed by Grant PUD.

Wanapum Dam operates 10 Kaplan turbine units that were recently replaced with a new, advanced design by Voith Siemens for the Department of Energy Advanced Hydro Turbine Program, with a generating capacity of 1092 megawatts (MW). During spring and summer migration periods, the turbine units are operated in a 'fish mode' that generally consists of a 15.7 kcfs operation ceiling that minimizes turbine passage injury and mortality. Located south of the powerhouse is the Wanapum Fish Bypass (WFB) which provides a non-turbine passage route for migrating juvenile salmonids. The WFB (completed in 2008) is a 290 ft long chute designed to collect smolts and pass a maximum laminar flow of 20 kcfs over Wanapum Dam, gradually decelerating entrained fish without shear and minimizing total dissolved gas in the tailrace. South of the WFB, the spillway joins to the future turbine unit slots at a 45 degree angle extending to the southwest. The spillway is comprised of 12 Tainter gates that pass submerged flow at 65 ft below the surface of the river (Timko et al. 2010).

Priest Rapids Dam operates 10 Kaplan turbine units along the northeast end of the hydropower structure with a combined generating capacity of 956 MW. The spillway is now comprised of 19 Tainter gates and runs from the southwest end of the dam towards the middle of the river (Figure 2). In 2014, a surface-flow, top-spill bypass, also referred to as the Priest Rapids Fish Bypass, was completed to

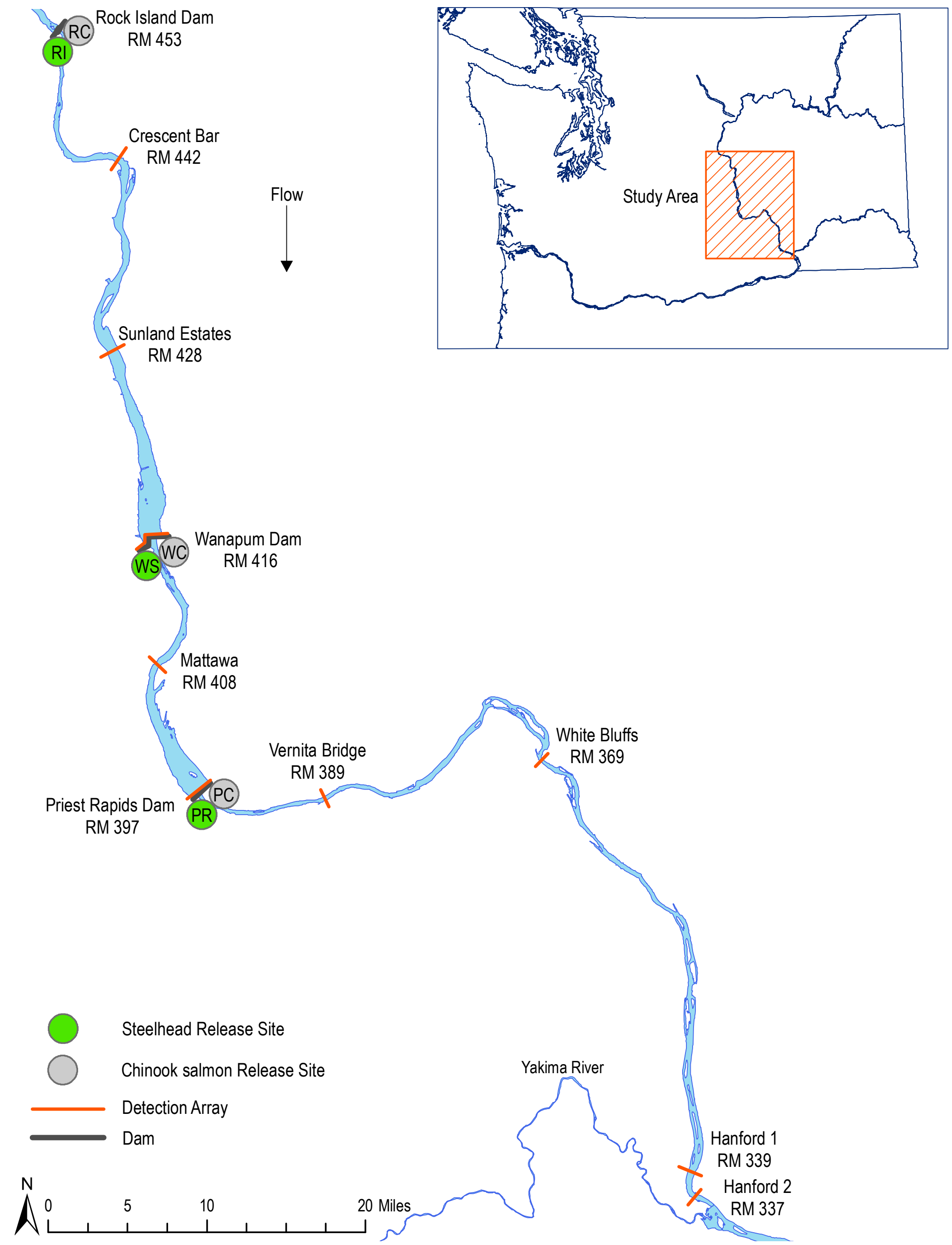


Figure 1. Study area from Rock Island Dam tailrace (RM 453) to RM 337, 45 miles upstream of McNary Dam. Location of steelhead releases are shown in green at Rock Island Dam (RI), Wanapum Dam (WS) and Priest Rapids Dam (PR) tailraces. Yearling Chinook salmon release locations are shown in grey at Rock Island Dam (RC), Wanapum Dam (WC) and Priest Rapids Dam (PC) tailraces. Detection arrays (orange bars), dams (grey bars), as well as array identification and configuration are depicted.

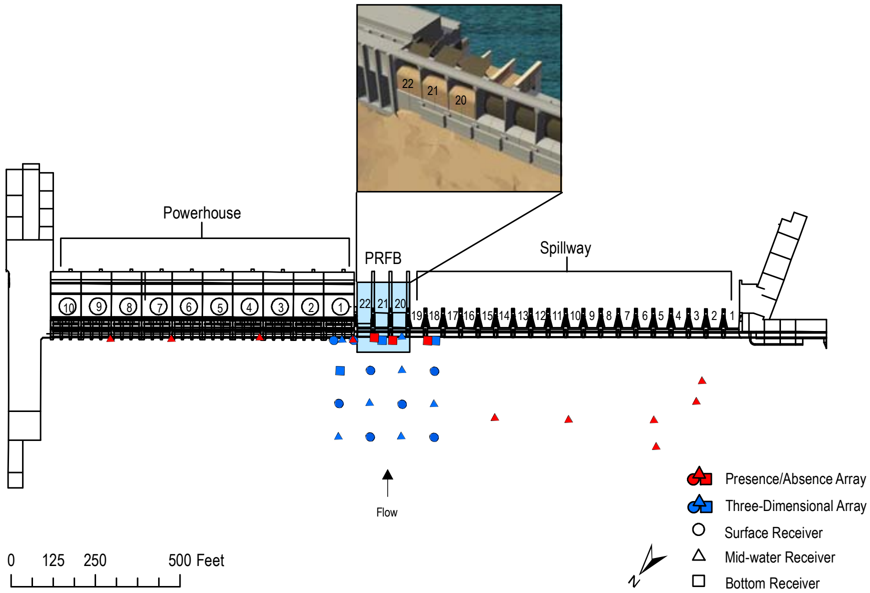


Figure 2. Schematic of Priest Rapids Dam is shown with the corresponding receiver deployment locations. Two independent detection arrays are depicted in red and blue as well as the relative receiver elevation. Fish bypass image courtesy of Jacobs Engineering.

provide a non-turbine passage route for migrating juvenile salmonids. The PRFB was designed to use Tainter gates 20, 21 and 22 which are the three spill bays closest to the powerhouse (Figure 2). The crest height of each spillway was raised approximately 35 ft (depth of water at the crest is just under 14 ft) and the three individual chutes are 40 to 44 ft wide.

JSATS Tags and Data Collection

Salmonids were surgically implanted with a Lotek *Model L-AMT-1.421* JSATS acoustic transmitter (11.1 x 5.5 x 3.7mm, 0.32 g in air, three second burst at 416.7 kHz) and a Biomark PIT tag (12 mm). JSATS acoustic tags were received from the manufacturer in three separate tag lots throughout the study period. To avoid potential effects of variability in the quality of manufactured tag lots, tags were randomly selected from each lot for tag-life testing (proportional to the total number of tags received per lot) and were pre-assigned to tag-life release groups prior to activation. The remaining tags were randomized, assigned to release groups, and subsequently selected for surgical implantation into study fish. Replacement tags were randomized during the study. All tags for each treatment and control release group were activated simultaneously to ensure equal tag activation time across experimental groups.

Nine river-spanning arrays comprised of 84 Teknologic Autonomous Receivers ('receivers' hereafter) collected data from tagged fish during their downstream migration. From upstream to downstream, the arrays included: Crescent Bar (3 receivers), Sunland Estates (4), Wanapum Dam (16), Mattawa (4), Priest Rapids Dam (37), Vernita Bridge (4), White Bluffs (4), Hanford 1 (4), and Hanford 2 (4) (Figure 1; Appendix A, Figures A.2 – A.5). It is noteworthy that various receivers throughout the study area were replaced mid-season due to impaired equipment (e.g., data collection space maximized, battery power expired, or logger damaged by debris (Appendix A, Table A.5).

Acoustic receivers at the in-river arrays were deployed from a research boat by davit arm and were anchored to the river bottom by concrete and rebar anchors. A large zinc-coated ring held the tie-ups to the anchors and served as the attachment point for acoustic release units (InterOceans *Model 111-D* acoustic releases) (Appendix A, Figure A.1). Acoustic releases were controlled by a surface command unit that allowed remote sonic-mechanical release of the anchor system, similar to Thompson et al. 2012. At both dams, receivers were deployed in two separate arrays; one array along the Boat Restricted Zone (BRZ or Hazard Barrier) and the second in the immediate forebay of the dam. Acoustic receivers at the BRZ of each dam were suspended from the hazard barrier between shock-absorbing tethers and large weights at overlapping detection range intervals. Receivers deployed on the dam face were installed either by a diver into a fixed bracket or from the deck on a pier nose cage mount.

The forebay array at Priest Rapids Dam was configured to enable three-dimensional (3D) tracking of tagged fish near the PRFB. The setup consisted of a combination of *Teknologic 2/3D Autonomous Receivers* that were deployed at varied depths offshore of the dam and directly on the upstream face of the dam to provide spatial positioning estimates in the x, y, and z planes (Figure 2). All autonomous 3D receivers were equipped with a beacon tag that transmitted periodic pings that allowed for post hoc synchronization of receiver time and location. All other detection arrays at the dams were designed to provide only presence/absence data rather than spatial positioning.

At the completion of data collection, the receivers were recovered and the raw data were downloaded from each receiver's memory card to a data server using Teknologic software *Autonode uSD Extractor,* where the data was then processed, filtered and analyzed. The filtering methods were based on the US Army Corps of Engineers protocols that have been used on previous JSATS studies by various researchers in the Columbia River Basin (Skalski et al. 2010a, 2010b; Thompson et al. 2012). Three-dimensional positioning in the forebay of Priest Rapids Dam, near the PRFB, was completed by Teknologic Engineering, and the position of tagged fish was estimated in two-dimensions (2D; x, y) and three-dimensions (3D; x, y, z) using Teknologic's 2/3D detection proprietary processing software. Generally speaking, positioning was resolved based on the time of arrival that a tag was detected on five or more nodes with a minimum of two nodes anchored to the face of the dam that were deployed on multiple planes with defined locations (x, y, and z by node pressure sensors or measured during diver installation). The differences in time of arrival in combination with the known deployment locations of each receiver provided sufficient information to solve for the three unknowns (x, y, and z) using a process of simultaneous equations. Positioning was refined with upper and lower elevation boundaries (e.g., the highest forebay elevation during the 2014 study was 489 ft and therefore no fish could have been detected at any higher elevation, i.e., "out of water").

Collection and Surgery

Downstream migrating run-of-river steelhead and yearling Chinook salmon smolts were collected at Wanapum and Priest Rapids dams by dip-netting from the wheel gate slots ('gatewell' hereafter) as in previous studies (Sullivan et al. 2009; Timko et al. 2010, 2011). Gatewells are water-filled vertical columns that extend from the ceiling of each turbine intake to the intake deck of the dam. Since 1977, smolts have been collected from the gatewells in the dams of the Priest Rapids Project, which has been an effective and reliable source of fish for behavioral and survival studies (Park and Farr 1972; Timko et al 2010). Depending on the fish species and particular dam, a documented 1% to 6% of smolts become temporarily entrained in the gatewells (Sullivan et al. 2009; Timko et al. 2010; O'Connor 2012).

In 2014, all gatewell-dipped fish were transported to the west bank of Wanapum Dam for sorting. After initial sorting in a light MS-222 solution by species, size, and physical condition, selected fish were held in recirculating ambient river water for 24 hr prior to surgery to ensure robustness. Immediately before surgery, fish were removed from holding tanks and placed into an anesthetic bath (MS-222 at 60-80 mg/L) until loss of equilibrium occurred, at which time they were transferred to a surgical table and administered MS-222 through a gravity-fed tube for the duration of the surgical procedure. Fish under 15 g were excluded because they were too small to meet the recommended maximum 3% tag burden (tag to body-weight ratio).

Acoustic and PIT tags were implanted into fish through an incision made along the mid-ventral line; incisions were closed by two 5-0 Vicryl PLUS coated sutures. All study fish were held for 24 hr prior to release to ensure post-surgery survival and tag retention. Fish handling was conducted by LGL Limited. Detailed culling and surgical guidelines can be referenced in the LGL Limited Standard Operating Procedures that were provided in Appendix A of Timko et al. 2010.

Release and Study Design

Acoustic-tagged steelhead and yearling Chinook salmon were released by helicopter in the tailraces of Rock Island, Wanapum, and Priest Rapids dams. Steelhead release groups were designated RI, WS, and PR, while yearling Chinook salmon release groups were RC, WC, and PC, respectively (Figure 1). Approximately 1 hr prior to helicopter lift-off, fish were moved into specialized "fly-tanks" supplied with ambient river water, and tags were verified to ensure they were operational. Water flow was stopped 10 min prior to departure, at which time fly-tanks were moved to the flight pad and oxygen tanks attached to the fly-tanks were turned on. Once fly-tanks were transported to the release point, the release of fish was triggered from the cockpit of the helicopter by a thumb switch that was connected to the fly-tank suspended below. Fish were released no higher than 10 ft from the surface of the river; release distance was observed by a person on shore.

To estimate passage survival at Wanapum and Priest Rapids dams (and reservoirs) release-recapture methods were used (Zabel et al. 2005; Skalski et al. 2011; Timko et al. 2011; Thompson et al. 2012). Paired treatment-control groups were released at successive dams and were used in conjunction to measure dam and reservoir (development) passage. Wanapum Dam and Wanapum Reservoir were tested with treatment and control groups released in the tailraces of Rock Island (RI/RC) and Wanapum (WS/WC) dams (Figure 1 and Figure 3). Priest Rapids Dam and Priest Rapids Reservoir were tested with treatment and control groups released in the tailraces of Wanapum (WS/WC) and Priest Rapids (PR/PC) dams (Figure 1 and Figure 3). Steelhead were released in 19 replicate groups (n=1,720) and yearling Chinook salmon were released in 21 replicate groups (n=1,716) at each release location (Appendix B, Table B.1). There were fewer steelhead replicates due to a delay in collecting sufficient steelhead migrants during the early season. Lastly, release quantities varied to mimic the bell shaped curve of the natural migration of fish (more fish were released during the middle of the study as compared to the beginning and end of the study Appendix B, Table B.1).

Survival Analysis

The primary survival analyses cited in this report were conducted by Columbia Basin Research (CBR) and are presented in Skalski et al. (2014). The survival of fish passing through the Wanapum Development included the proportion of fish passing through the Wanapum Reservoir and dam that were detected at either Mattawa or at Priest Rapids Dam. Survival through the Priest Rapids Development included the proportion of fish passing through the Priest Rapids Reservoir and dam that were detected downstream at Vernita Bridge or White Bluffs. Project survival included both dams and reservoirs and was the product of the Wanapum Development survival multiplied by the Priest Rapids Development survival. Reach survivals and tag detection probabilities were estimated by Skalski et al. (2014).

Additionally, *Ricker* survival estimates were calculated to estimate concrete survival at each dam. The *Ricker* survival equation was as follows:

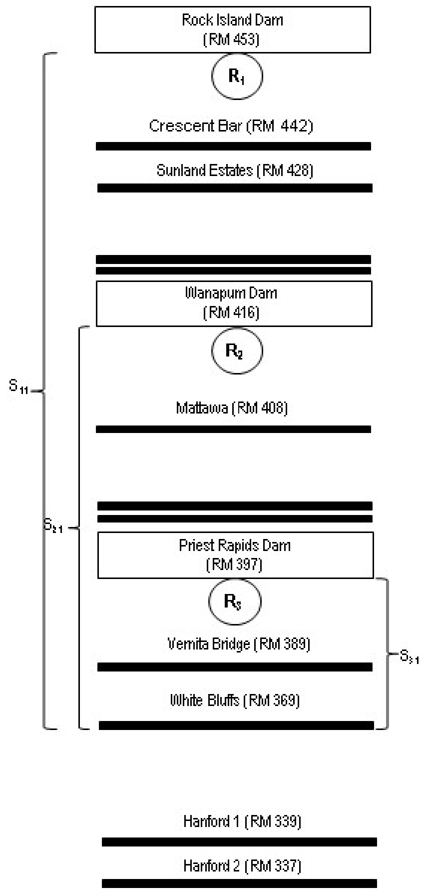
$$\frac{[(\text{\# treatment fish detected downstream}) / (\text{\# treatment fish released}^{1})]}{[(\text{\# control fish detected downstream}) / (\text{\# control fish released})]}$$

In the case of concrete survival, treatment fish were those detected passing the dam and control fish were those released in the tailrace of each dam. For a fish to have survived passage at Wanapum Dam, a positive acoustic detection at Mattawa or Priest Rapids Dam forebay was required. For a fish to have survived passage at Priest Rapids Dam, a positive acoustic detection at Vernita Bridge or White Bluffs was required.

Behavioral Analysis

In addition to estimates of survival, a number of techniques were used to analyze the dataset for behavioral trends. The effectiveness of the fish bypass was measured by fish passage efficiency (FPE), or the ratio of the number of fish selecting the WFB or the PRFB as compared to other passage routes. Passage route designations used a study

[1] Quantities of treatment fish released refers to a 'virtual release' in which fish detected immediately above Wanapum or Priest Rapids dam (i.e. the forebay) were used to populate this equation.



Wanapum survival $S_{WAN} = \frac{S_{11}}{S_{21}}$

Priest Rapids survival $S_{PR} = \frac{S_{21}}{S_{31}}$

Figure 3. Survival study design is illustrated to depict release and detection locations throughout the Project, with particular emphasis on the estimation of survival through each development. Black bars represent detection arrays.

fish's final detection history in conjunction with relative detection amplitudes to conclude route selection.

Two and three dimensional tracking was conducted at Priest Rapids Dam for thorough quantitative assessment of fish passage behavior at or near the PRFB. The position data were used to evaluate Fish Collection Efficiency (FCE), a metric to estimate passage success of fish that enter a defined zone of influence (ZOI). In this case, FCE was defined as the proportion of fish that entered a zone extending 300 ft from the center of the PRFB (arc of 180°) and passed through the PRFB.

To illustrate spatial trends for fish that passed at the PRFB, relative percent passage (RPP) figures and normalized density plots were generated. These figures were created using a two-dimensional grid of 10 ft x 10 ft cells, or bins, in the forebay populated with individual fish that entered each bin, by species and passage route. RPP figures were calculated as the proportion of fish that entered each bin and then passed through the PRFB versus other routes; results were grouped in 10% increments. The RPP figures treat use of a cell and eventual passage route as a proportion, thus removing the weight of the number of individuals present, to provide a clear look at individual approach trends spatially. Alternatively, the normalized density plots illustrate high and low use areas in each cell prior to passage. These bin densities effectively remove milling and holding behavior by only making calculations based on the first use of the cell or bin to display population trends instead of individual behaviors.

Various other analyses were performed to quantify fish behavior including: migration travel rates, approach distribution, and forebay residence times (Timko et al. 2007a, 2007b, 2010, 2011; Sullivan et al. 2009).

Results

Project Operations

The survival and behavior studies conducted in 2014 occurred during atypical Project operations. The Wanapum Reservoir was lowered and the forebay of Wanapum Dam was decreased by approximately 28 ft to an average elevation of 543 ft; typical forebay operation elevations are at an average of 571 ft. The drop in elevation occurred prior to the start of these studies to alleviate water pressure on a spillway fracture that was observed on February 27, 2014. A summary of project operations in the spring of 2014 are shown in Figure 4.

During the 2014 spring field studies, the average flow through the WFB was 4 kcfs, a marked decline from the average flow in 2008-2011 of approximately 20 kcfs (Figure 4). Discharge from the Wanapum Dam powerhouse was also decreased in 2014; the average powerhouse discharge was 114 kcfs, which was approximately 60% of maximum operation. For comparison, between 2006 and 2010, the minimum average spring powerhouse discharge was recorded at 108 kcfs (2010, notably a low water flow year) and a maximum average spring powerhouse discharge was 136 kcfs (2007). During the 2014 study, the average total spill (across all spill bays, but excluding the bypass) was 58 kcfs, which was generally higher than the average spill discharge during prior behavior studies that ranged from 7 kcfs (2009) to 70 kcfs (2006 and 2008). Average total discharge for Wanapum Dam was 179 kcfs in 2014. From 2006 to 2010, the average total discharge during field studies ranged from 134 kcfs in 2009 to 220 kcfs in 2011.

The combined average flow over the PRFB was 25.2 kcfs, with an average of 8.4 kcfs at each of the three spill bays (Figure 4). The average flow at the PRFB in 2014 was similar to the total flow of the prototype bypass configurations that were evaluated in 2010, where the maximum combined average flow through four spill bays was 25 kcfs (Spill Bay 19 and 20 as top-spill and Spill Bay 21 and 22 as bottom-spill). Additionally, the average powerhouse and total project discharge at Priest Rapids Dam in 2014 was 121 and 193 kcfs, respectively. Similar to Wanapum Dam, the discharge at Priest Rapids Dam in 2014 fell within the historic ranges of operation flows during survival and behavior studies conducted in 2006-2010. Average powerhouse discharge ranged from 101 kcfs (2010) to a maximum of 154 kcfs in 2007. The average total spill recorded in 2014 was 70 kcfs, which excludes the bypass. The average total spill for prior field studies ranged from 3-5 kcfs (2007, 2009-2010) to the highest discharges recorded in 2006 and 2008 of 26-27 kcfs. The average total project discharge in 2006-2010 ranged from 132 kcfs (2009) to 209 kcfs (2008).

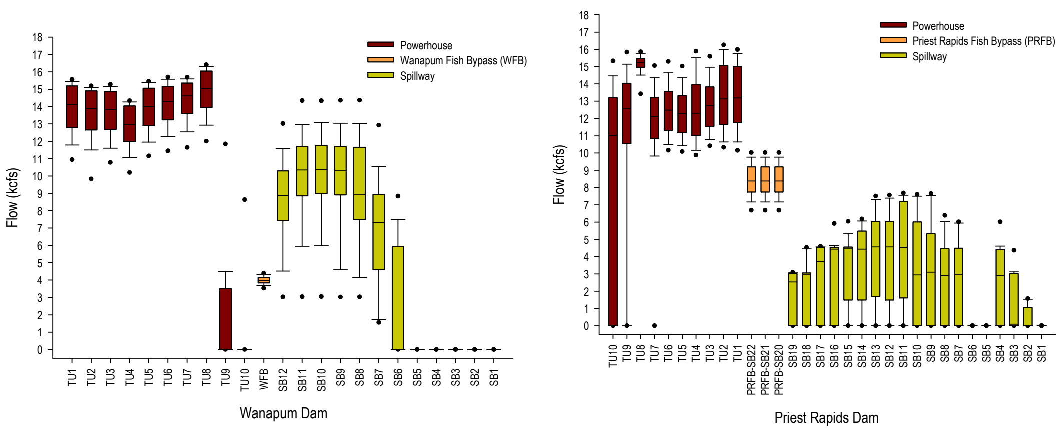


Figure 4. Project operations summarized at each dam, Wanapum Dam (left) and Priest Rapids Dam (right), and categorized by powerhouse (turbine units, TU, 1-10), fish bypass, or spillway (spill bays, SB). Box plots illustrate 5th and 95th percentiles and highlight the median, 25th and 75th percentiles of flow (kcfs).

Environmental Conditions

Environmental conditions including Total Dissolved Gas (TDG) saturation, river flow as a function of tailwater elevation, and temperature were monitored from 28 April to 23 June, 2014 downstream of Rock Island, Wanapum and Priest Rapids dams as well as at Pasco, Washington (RM 330), which is located seven miles downstream of the Hanford 2 detection array. Daily median conditions for 2014 are depicted along with the 10-year average conditions, in Figure 5 and Figure 6, allowing for comparison. Data were procured from the Columbia River DART website and Grant PUD dam operation records. In general, TDG, river flow, and temperature at all sites were higher in 2014 than the 10-year average. However, there was a sharp decline in TDG and flow at all sites in early June followed by a return to 10-year average conditions by the end of the month.

TDG saturation peaked at all sites between 29 May and 3 June, 2014. The highest TDG saturation was recorded downstream of Wanapum Dam on 1 June at 126% with peaks at Rock Island and Priest Rapids dams (at 123%) aligned with peaks in river flow. The highest recorded TDG saturation at Pasco, WA during the study period was 117%. For comparison, the 10-year average TDG saturation at all sites was consistently below 120%.

River flow in 2014 was consistently above the 10-year average. Peak flow in 2014 was 233 kcfs below Rock Island Dam, 216 kcfs below Wanapum Dam, 241 kcfs below Priest Rapids Dam, and 237 kcfs at Pasco, WA. Flows peaked at all sites on 1 June. These peaks were followed by a sharp decline to a low occurring on 15 June at all sites, ranging from 116 kcfs at Rock Island Dam to 123 kcfs at Pasco, WA. In contrast, the 10-year average flow trend was upward throughout the study period, ranging from 132 kcfs downstream of Rock Island Dam in late April to 238 kcfs at Pasco, WA in late June.

Water temperatures in 2014 were slightly above the 10-year average, ranging from 7.7 to 16.8°C over the course of the field study. The 10-year average values over the same period of time were similar and ranged from 7.9 to 15.5 °C.

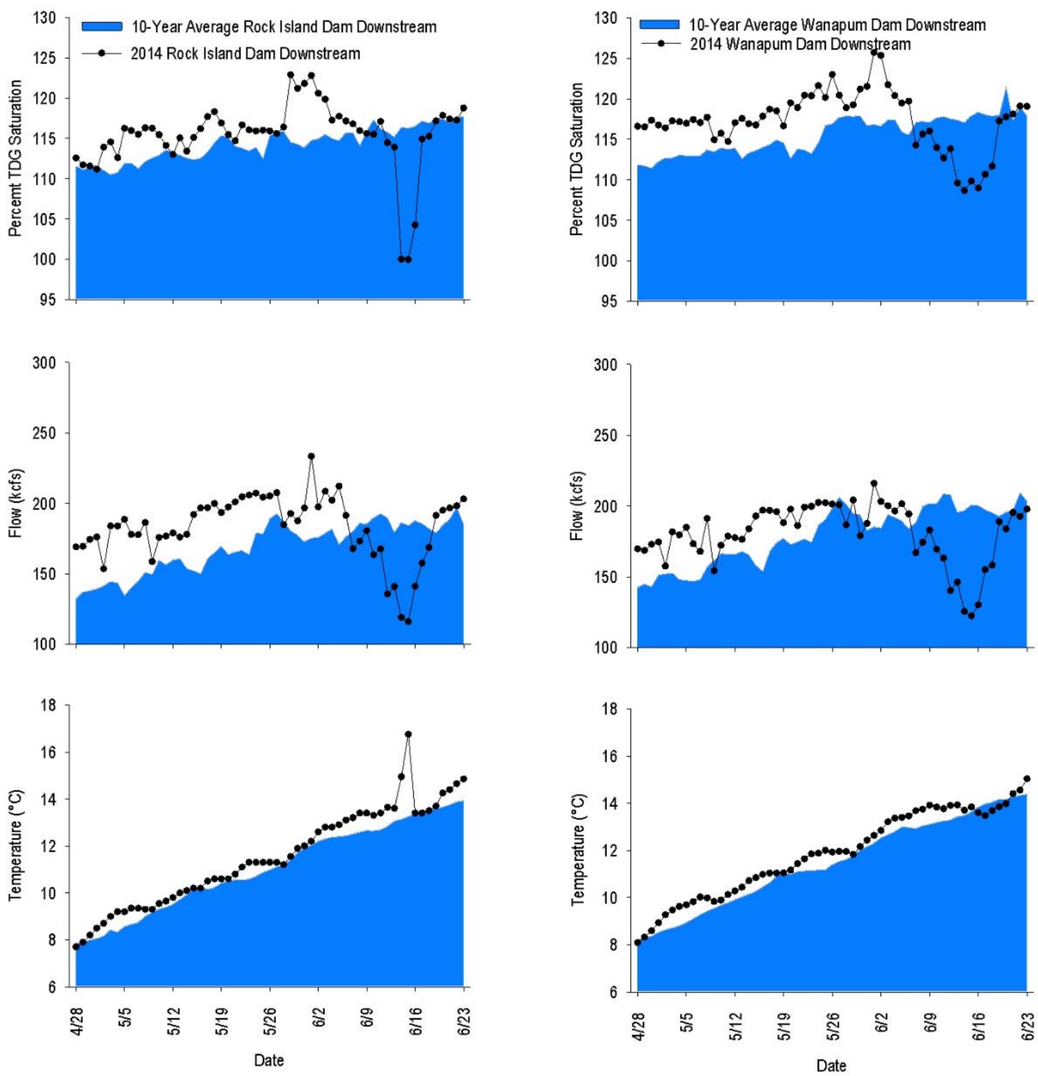


Figure 5. Daily median water quality values downstream of Rock Island and Wanapum dams are shown from 28 April – 23 June, 2014 along with the 10-year average which is depicted in blue (data source*: www.cbr.washington.edu/dart/dart.html* and *Grant PUD dam operations*).

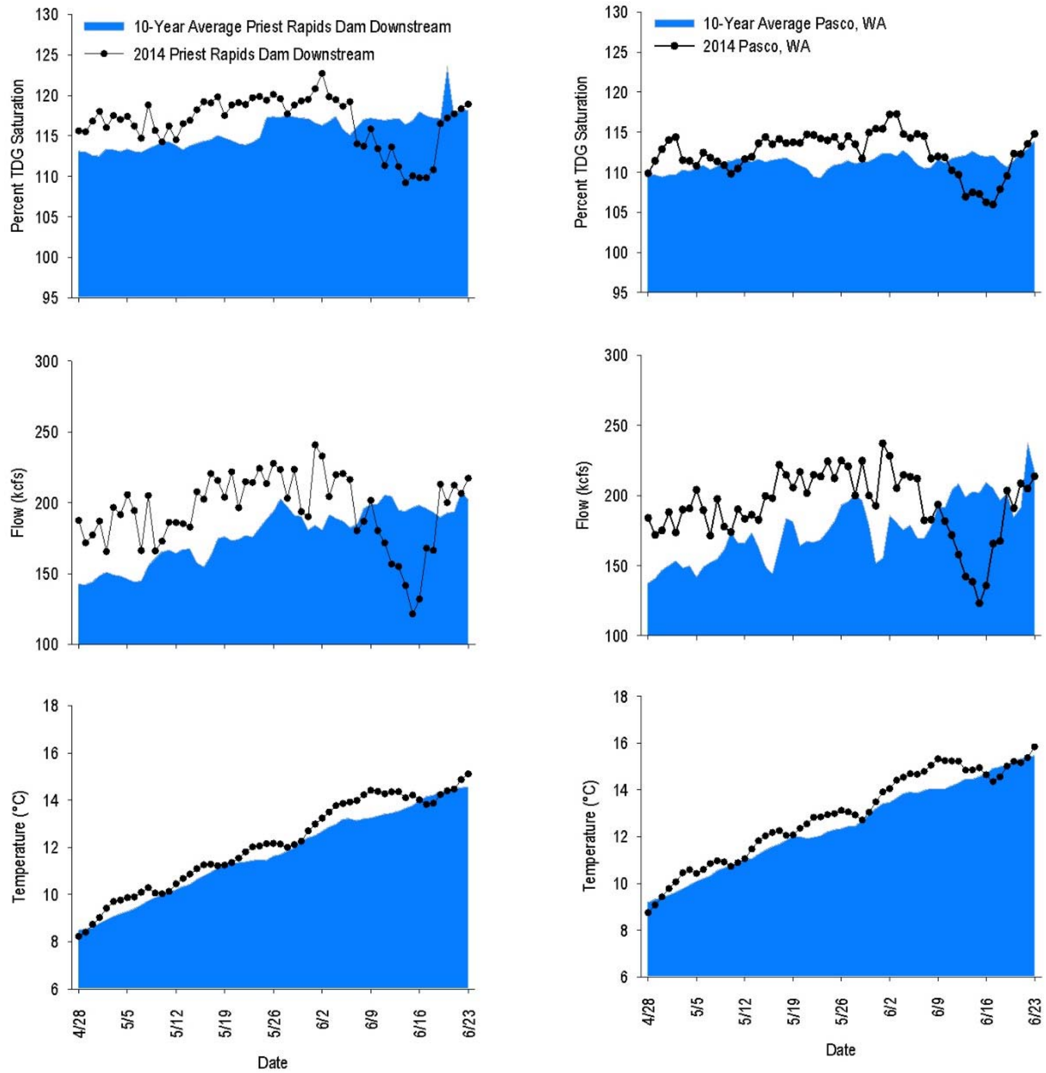


Figure 6. Daily median water quality values downstream of Priest Rapids Dam and at Pasco, WA (RM 330) are shown from 28 April – 23 June, 2014 along with the 10-year average which is depicted in blue. Flow data for the Pasco, WA 10 year average is limited to data from 2006, 2010 and 2013 (*data source: www.cbr.washington.edu/dart/dart.html and Grant PUD dam operations*).

Fish Characteristics

A total of 1,720 juvenile steelhead and 1,716 yearling Chinook salmon run-of-river smolts were tagged with JSATS transmitters and evaluated in the 2014 survival and behavioral studies. During the study, 14 tags were found to be inactive at the time of release and were excluded from survival data analysis (eight transmitters implanted in steelhead and six transmitters implanted in yearling Chinook salmon). Seven other fish excluded from the data included two holding mortalities released with active tags (yearling Chinook salmon), three release process mortalities (one steelhead and two yearling Chinook salmon, one of which was released with an active tag), as well as two recapture mortalities (one steelhead and one yearling Chinook salmon).

Adipose clipped juvenile steelhead comprised 67% of the total steelhead tagged and released between 7-28 May 2014. The quantity of steelhead released varied by site with 399 released below Rock Island dam, 771 below Wanapum dam and 550 below Priest Rapids dam (Figure 1). Between 30 April and 24 May 2014, the vast majority of acoustic-tagged yearling Chinook salmon had been clipped at the adipose fin (94%). Yearling Chinook salmon release quantities also varied by site with 398 released below Rock Island dam, 769 below Wanapum dam, and 549 below Priest Rapids dam. Based on the 2014 Rock Island Dam run-timing smolt index (Columbia River DART website), all tagged steelhead were released between the 8th and 92nd percentile of the steelhead run-timing while yearling Chinook salmon were released between the 12th and 89th percentile of the yearling Chinook salmon run-timing.

As analyzed by Skalski et al. 2014, the length, weight and condition factor distributions of fish released in the tailraces of Rock Island, Wanapum, and Priest Rapids dams were comparable, suggesting no opportunity for size bias to affect the survival estimates. The study fish length distributions were proportional to those of the run at large (BRNW 2014; Evans *unpublished data*). Steelhead fork lengths ranged from 128-217 mm (median, 184 mm) and weight ranged from 21-88 g (median, 57 g) (Appendix B, Figure B.1 and B.2). Yearling Chinook salmon fork lengths ranged from 108-200 mm (median, 140 mm) and weight ranged from 16-83 g (median, 30 g) (Appendix B, Figure B.1 and B.2).

The average tag burden for steelhead was 0.6% (range 0.4-1.5%) while the average yearling Chinook salmon tag burden was 1.1% (range 0.4-1.9%). The JSATS tags used in 2014 weighed an average of 0.32 g in air and were significantly lighter in weight than acoustic transmitters used in previous survival studies conducted in 2008-2010 where acoustic transmitters ranged from 0.75-1.50 g in air.

Acoustic Battery Life Testing

To determine tag life, 50 tags were randomly selected from three tag lots, activated, and monitored for battery failure. Tag life tags were deployed into a flow through tank supplied with ambient river water over the study period. Water conditions such as temperature and dissolved oxygen were monitored daily. The number of tags per release group followed a bell curve distribution, and the average tag life was 23.7 days for lots 1 and 2 and 22.7 days for lot 3 (range 10.1-31.2 days).

Data Collection

All acoustic receivers were deployed and operational by 24 April 2014. Data collection commenced on 30 April 2014, after the first yearling Chinook salmon group was released below Rock Island Dam. The last tag detection, a steelhead, was recorded on 14 June 2014 at the Hanford arrays (RM 337). Over the study period, nearly seven million unique detections of acoustic tags were recorded on all detection arrays. The tag detection probabilities remained high at all detection arrays, ranging from 0.9873-1.000 for steelhead and 0.9769-1.000 for yearling Chinook salmon. A summary of tag detection probabilities by release group are shown in Table 1.

The majority of the deployed receivers successfully collected acoustic data for the duration of the study although there were exceptions. Fifteen of the 84 deployed receivers had mid-season disturbances in data collection: six receivers became detached from river-bottom anchors; five receivers reached data storage capacity on internal SD cards and ceased writing new data, and three receivers malfunctioned. Of these fifteen, four where replaced immediately with supplemental receivers. The remaining eleven weren't replaced due to sufficient overlap in detection coverage or late recognition of the issue (Appendix A, Table A.5).

A small portion of the 2014 PIT-tagged steelhead and yearling Chinook salmon were also detected outside the Project study area by PIT tag readers at McNary (RM 292, 5.1% steelhead and 11.3% yearling Chinook salmon), John Day (RM 216, 7.8% steelhead and 8.2% yearling Chinook salmon), and Bonneville (RM 146, 6.4% steelhead and 7.4% yearling Chinook salmon) dams as well as the Columbia River estuary experimental towing site (RM 19, 1.6% steelhead and 0.8% yearling Chinook salmon) (Appendix A, Table A.7). Of the PIT-tagged steelhead and yearling Chinook salmon that were detected at downstream PIT arrays, 99.8% were detected passing through one or more of the Grant PUD acoustic detection arrays (0.2% of tagged steelhead and 0.1% of tagged yearling Chinook salmon were not detected at any of the 2014 JSATS detection arrays).

Table 1. Array detection probabilities by species and release site at each of the acoustic tag detection arrays between Rock Island Dam (RM 453) and the Hanford Reach (RM 337).

	Array Detection Probability Estimates (Standard Error)							
Release Locations	Crescent Bar	Sunland Estates	Wanapum	Mattawa	Priest Rapids	Vernita Bridge	White Bluffs	Hanford
Steelhead								
Rock Island Tailrace	0.9873 (0.0056)	1.000 (0.0000)	1.000 (0.0000)	1.000 (0.0000)	1.000 (0.0000)	0.9939 (0.0043)	1.000 (0.0000)	1.000 (0.0000)
Wanapum Tailrace				1.000 (0.0000)	1.000 (0.0000)	0.9971 (0.0020)	1.000 (0.0000)	1.000 (0.0000)
Priest Rapids Tailrace						0.9881 (0.0048)	0.9959 (0.0029)	0.9978 (0.0022)
Yearling Chinook								
Rock Island Tailrace	0.9769 (0.0076)	1.000 (0.0000)	1.000 (0.0000)	0.9973 (0.0027)	0.9972 (0.0028)	0.9915 (0.0049)	1.000 (0.0000)	0.9940 (0.0042)
Wanapum Tailrace				1.000 (0.0000)	1.000 (0.0000)	0.9972 (0.0020)	1.000 (0.0000)	0.9971 (00.0021)
Priest Rapids Tailrace						0.9944 (0.0032)	1.000 (0.0000)	1.000 (0.0000)

Migration Rate

In 2014, steelhead migration rates upstream of Wanapum Dam were faster relative to historical rates, while downstream migrations more closely resembled previous trends. Migration rates in 2014 are shown in Figures 7 and 8. Figure 7 highlights the faster migration rates of steelhead between Rock Island and Wanapum Dam compared to previous studies conducted in 2006-2011, while Figure 8 illustrates the cumulative travel times of fish through the Project area and between reaches. Migration rates between reaches in Figure 8 are not likely linear based on changing hydraulic conditions, infrastructure, and varied distances between detection arrays.

The cumulative median migration rate of steelhead from the tailrace of Rock Island Dam to Wanapum Dam was 20.7 hr, a more than 50% decrease over the average median in 2006-2010/11[2]. Migration rates between Mattawa and Priest Rapids Dam also decreased within the Priest Rapids Reservoir, albeit less drastically (∆-18.0% at 13.2 hr). Migration to in-river sites immediately below the dams varied; migration to Vernita Bridge decreased (∆-14.3%, 1.8 hr), while Mattawa more closely followed historical trends (∆-1.8% at 2.6 hr). In the lower reaches, median migration rates of 5.4 hr (Vernita Bridge to White Bluffs) and 8.5 hr (White Bluffs to the Hanford arrays) were recorded though no previous data exists for this area (Appendix C, Table. C.2).

In general, the migration rate of yearling Chinook salmon in 2014 was similar to the recorded median averages in 2006-2010 (Figure 7 and Figure 8). Migration from Wanapum Dam to Mattawa slightly increased by 4.8% at 3.3 hr, while migration from Priest Rapids Dam to Vernita Bridge did not appear to deviate (∆0.0% at 2.0 hr). The only notable variation was between Mattawa and Priest Rapids Dam where a 13.0% increase at 23.4 hr was documented. Median migration rates in the lowest reaches of the study were documented at 7.1 hr (Vernita Bridge to White Bluffs) and 19.2 hr (White Bluffs to the Hanford arrays). The timing of steelhead and yearling Chinook salmon arrival and passage appeared to be confounded with release timing; no additional trends in diel passage were exhibited in the data at Wanapum and Priest Rapids dams.

Forebay Residence Times

In 2014, forebay residence times were estimated using two methods; the first estimate was derived from applying the first and last detections from the BRZ and forebay[3] receivers *combined*, while the second was calculated using detections at the forebay receivers *alone*. The second method, in theory, is most similar to historical analyses although not equivalent due to differing acoustic technology and a notably less expansive array in 2014. Therefore for comparative purposes it can only be concluded that the BRZ method is likely to overestimate residence time while the forebay method is likely to underestimate.

Nonetheless, median forebay residence times in 2014 for both species at both dams were under 1 hour, regardless of the method of measurement (Table 2). At Wanapum Dam, steelhead median forebay residence time was 28.5 min from the BRZ to forebay and 8.1 min in the immediate forebay area. Yearling Chinook salmon had a slightly shorter median residence time at Wanapum Dam; 20.3 min BRZ-forebay and 3.6 min in the immediate forebay. Median residence time at Priest Rapids Dam was longer than that at Wanapum Dam for both species; steelhead resided a median of 43.2 min within the BRZ to forebay area, and only 8.1 min in the immediate forebay. Furthermore, yearling Chinook salmon median residence time was a similar 42.8 min in the BRZ to forebay area and 3.6 min in the immediate forebay. Detailed median residence times by species, dam, and passage route are compiled in Appendix C; Table C.6 and C.7.

[2] 2011 migration rate data was limited to steelhead between Wanapum and Priest Rapids dams, thus not all median averages were calculated with this data included.

[3] Forebay receivers were deployed either directly on the upstream face of the dam or within the immediate vicinity of the upstream face of the dam (see Appendix A for further details).

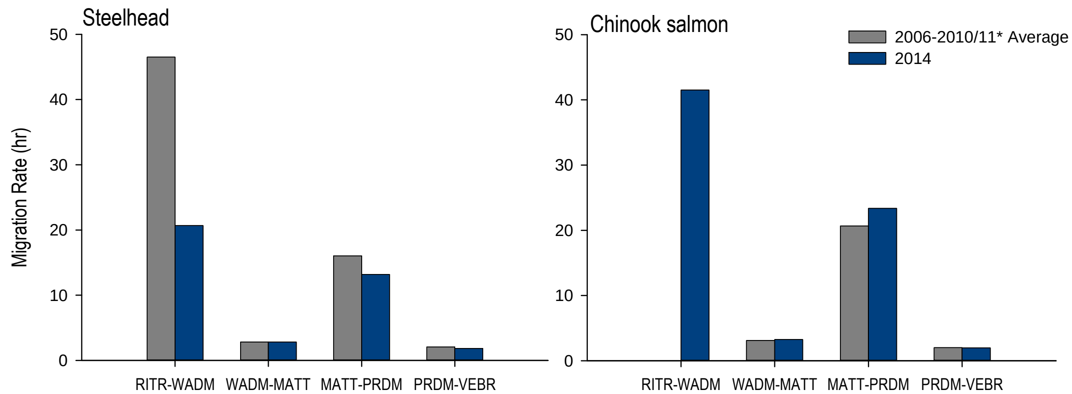


Figure 7. Steelhead and yearling Chinook salmon median migration rates compared to average median migration rates from 2006-2010/11 acoustic data. The asterisk indicates that the 2011 acoustic study solely recorded steelhead migration data between Wanapum and Priest Rapids dams, thus all other categories are void of that year's information. Further migration rate data are presented in Appendix C Table C.1, C.2.

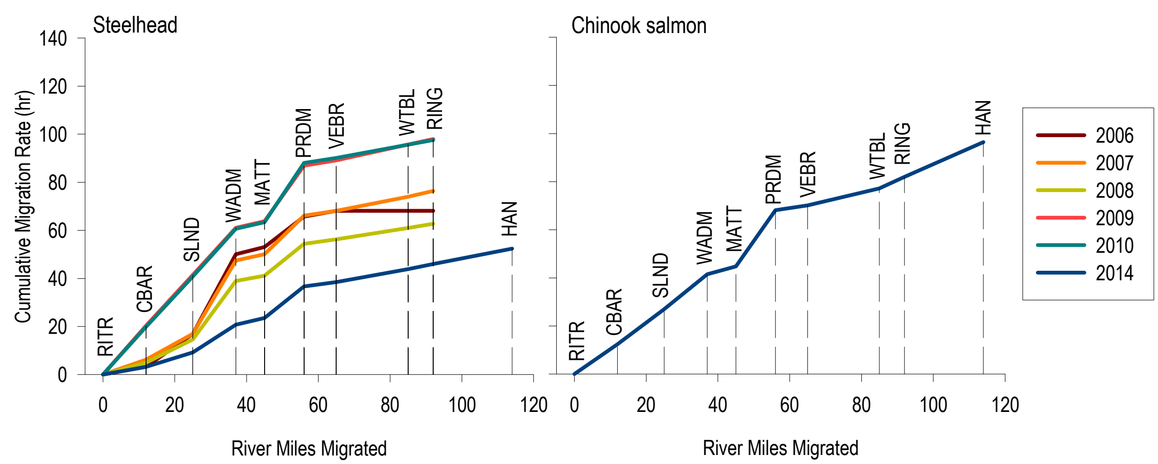


Figure 8. Cumulative median migration rates between each detection array by river mile for (left) steelhead and (right) yearling Chinook salmon. Steelhead data include relatable information from 2006-2010 and 2014 results; yearling Chinook salmon data include only 2014.

Table 2. Annual comparison of median forebay residence time at Wanapum and Priest Rapids dams (min) by species, steelhead and yearling Chinook salmon. Fish that were entrained in the gatewells, had an unknown passage location, or were last recorded with net upstream movement were excluded from this dataset.

Wanapum Dam		
Steelhead	2014BRZ	28.5
	2014Forebay	8.1
	2010	144.6
	2009	79.2
	2008	29.4
	2007	42.6
	2006	34.2
Yearling Chinook salmon	2014BRZ	20.3
	2014Forebay	3.6
	2008	14.4
Priest Rapids Dam		
Steelhead	2014BRZ	43.2
	2014Forebay	8.1
	2010	90.0
	2009	57.6
	2008	14.4
	2007	20.4
	2006	20.4
Yearling Chinook salmon	2014BRZ	42.8
	2014Forebay	6.7
	2008	13.8
	2007	16.8
	2006	18.0

Survival Analysis

The survival estimates for steelhead and yearling Chinook salmon in 2014 were analyzed in Skalski et al (2014). The survival estimate of steelhead through the Wanapum Development was 0.9294 (0.0140) and through the Priest Rapids Development was 0.9613 (0.0098). The joint Wanapum-Priest Rapids Project survival of steelhead was 0.8934 (0.0162). Yearling Chinook salmon survival through the Wanapum Development was estimated at 0.9448 (0.0128) and through the Priest Rapids Development at 0.9612 (0.087), with a joint Wanapum-Priest Rapids Project survival of 0.9082 (0.0145). The survival estimates of steelhead in 2008, 2009, 2010 and 2014 are shown with standard errors in Figure 9.

All survival estimates for both species yielded acceptable and smaller than required standard errors (NMFS 2004; NMFS 2008; Grant PUD 2006). The detailed paired-release survival analysis of steelhead and yearling Chinook salmon smolts through Wanapum and Priest Rapids dams is presented in a separate report (Skalski et al. 2014).

Reach Survival

Reach survival represents survival estimates per individual river segments between detection arrays; the complete analysis is in Skalski et al (2014). Steelhead reach survival ranged from 0.9575 to 0.9986 and yearling Chinook salmon survival ranged from 0.9599 to 0.9951 (Table 3). Low standard errors were measured for both species, ranging from 0.0036 to 0.0103. Reach survival estimates were weighted by relative reach lengths to equate what proportion of fish failed to survive per river mile (RM). Steelhead mortality per RM peaked in the initial reaches downstream of Wanapum Dam (0.326% per RM, WADM-MATT) and Priest Rapids Dam (0.402% per RM, PRDM-VEBR). Steelhead also incurred higher mortality per RM in the reach directly above Wanapum Dam (0.354% per RM, SLND-WADM). Similar to steelhead, yearling Chinook salmon exhibited the lowest survival by RM directly downstream of Wanapum (0.288% per RM, WADM-MATT) and Priest Rapids dams (0.446% per RM, PRDM-VEBR).

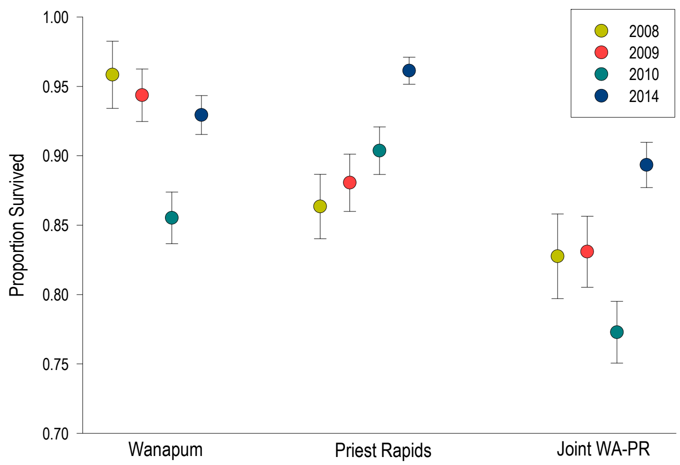


Figure 9. Comparative paired-release survival estimates of steelhead at the Wanapum Development (reservoir and dam), the Priest Rapids Development (reservoir and dam), and the Joint Wanapum-Priest Rapids Project (both developments combined).

Table 3. Survival estimates, adjusted by tagger effect and tag life (Skalski et al. 2014), are presented by reach and are complemented with standard errors. Furthermore, reach survivals are weighted by total reach length (RM) for comparisons of relative percent losses per RM.

	Steelhead			Yearling Chinook Salmon		
Reach	*Survival*	*SE*	*% Loss by RM*	*Survival*	*SE*	*% Loss by RM*
RITR-CBAR	0.9986	0.0049	0.012	0.9875	0.0060	0.104
CBAR-SLND	0.9957	0.0036	0.033	0.9933	0.0045	0.052
SLND-WADM	0.9575	0.0102	0.354	0.9877	0.0063	0.103
WADM-MATT	0.9739	0.0083	0.326	0.9770	0.0077	0.288
MATT-PRDM	0.9742	0.0086	0.235	0.9979	0.0039	0.019
PRDM-VEBR	0.9638	0.0101	0.402	0.9599	0.0103	0.446
VEBR-WTBL	0.9794	0.0078	0.103	0.9951	0.0041	0.024
WTBL-HAN	0.9765	0.0085	0.076	0.9887	0.0064	0.036

Avian Predation

Similar to previous survival studies, an annual investigation of avian predation with PIT tags recovered and/or detected at piscivorous bird colonies within the Columbia Plateau and Mid-Columbia River was conducted by NOAA Fisheries, USGS-Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, and Real Time Research. Preliminary detection records from this research group tallied a total of 109 PIT tags, released during the spring 2014 Grant PUD survival study, were detected among a variety of avian colonies on the Columbia Plateau and main stem, Mid-Columbia River. A total of 101 steelhead and eight yearling Chinook salmon were detected at either Banks Lake (Twinning Island), Potholes Reservoir (Goose Island Northwest Rocks), Island 20 (RM 332), Crescent Island (RM 317), Central Blalock Island (RM 274), or Little Miller Island (RM 205). Of the total PIT tags recovered, they comprised 5.9% of the total steelhead and 0.5% of the total yearling Chinook salmon that were released in the Project area.

In 2014, 12 PIT tags from steelhead that were released during the 2014 survival study were detected at the Caspian tern colony at Potholes Reservoir. Based on paired acoustic tag detection histories, all steelhead whose PIT tags were detected at the Caspian tern colony at Potholes Reservoir were consumed between release and the White Bluff detection array. This number appears to be a decrease in recovered steelhead PIT tags when compared to the 98 tags released and re-detected during the 2010 survival study (Timko et al 2011), representing a respective loss of 0.7% in 2014 and 5.0% in 2010. However, tag detection and deposition probabilities have not been applied to the raw data and are required to provide an appropriate estimate of predation (and consumption) of juvenile steelhead by Caspian terns that nested at Potholes Reservoir in 2014. A detailed analysis of predation by avian predators will be released in a separate report by Real Time Research (Evans et al. *in progress*).

Dam Survival

Based on acoustic tag detection histories, the Ricker survival estimates for steelhead and yearling Chinook salmon at Wanapum and Priest Rapids dams were calculated for treatment fish released above each dam paired with control fish released 0.5 km downstream of each dam. Table 4 lists steelhead and yearling Chinook salmon concrete survival estimates by year, with estimates above 97% for both species at both dams.

Steelhead concrete survival at Priest Rapids Dam followed trends set by historical data, with 2014 survival point estimates ranging between 97.8% and 98.5% (Table 4). On the other hand, at Wanapum Dam, variation in concrete survival is slightly more evident as estimates have marginally reduced from nearly 100% in 2008-2010 to 97.8% in 2014. Yearling Chinook salmon concrete survival estimates have not been calculated in recent years although 2014 estimates of 98.8% at Wanapum Dam and 97.1% for Priest Rapids Dam are similar to those calculated for steelhead in previous years at both dams.

Passage Route Efficiency

In 2014, the proportion of steelhead and yearling Chinook salmon that selected non-turbine passage routes through Wanapum Dam was lower than previous studies (55.2% and 35.0%, respectively) (Figure 10; Appendix D. Table D.1). In other words, the proportion of fish that selected the bypass or spillway at Wanapum Dam has decreased since 2008-2010 for steelhead and 2008 for yearling Chinook salmon resulting in a lower non-turbine passage route efficiency (PRE) (Figure 12). At Wanapum Dam in 2014, the proportion of steelhead that passed through the WFB was 9.9%, a decrease of 67.4% compared to 2010 (PRE at the WFB in 2010 was 77.3%). Yearling Chinook salmon PRE at the WFB was 7.5%, representing a decrease from 29.5% passage estimates in 2008, the last year yearling Chinook salmon PRE was estimated for Wanapum Dam.

At Priest Rapids Dam in 2014 higher PRE was documented through the powerhouse than the spillway for both study species; 30.9% of steelhead and 34.9% of yearling Chinook salmon passed via the powerhouse. However, the majority of both species utilized the PRFB with 47.2% of steelhead and 38.1% of yearling Chinook salmon selecting this route. Within the group that selected the PRFB, the majority passed through Spill Bay 22, the bay closest to the powerhouse (Figure 11). In contrast, yearling Chinook salmon PRE at the PRFB in 2014 was higher than previously recorded for the top-spill bypass in 2006 - 2008 when PRE ranged from 12.4% to 24.4%. A detailed list of passage percentages and annual comparisons from 2006-2014 can be referenced in Appendix D.

Table 4. Summary of dam (concrete) Ricker survival estimates by species at Wanapum and Priest Rapids dams. Asterisk indicates where treatment fish (i.e. fish detected in the forebay of Wanapum Dam passing downstream) survived at higher rates than control fish released 0.5km downstream of the dam.

	Ricker Survival Estimates	
Year	Wanapum	Priest Rapids
Steelhead		
2014	0.978	0.985
2010	*1.013	0.997
2009	*1.025	0.983
2008	0.995	0.952
Yearling Chinook salmon		
2014	0.988	0.971

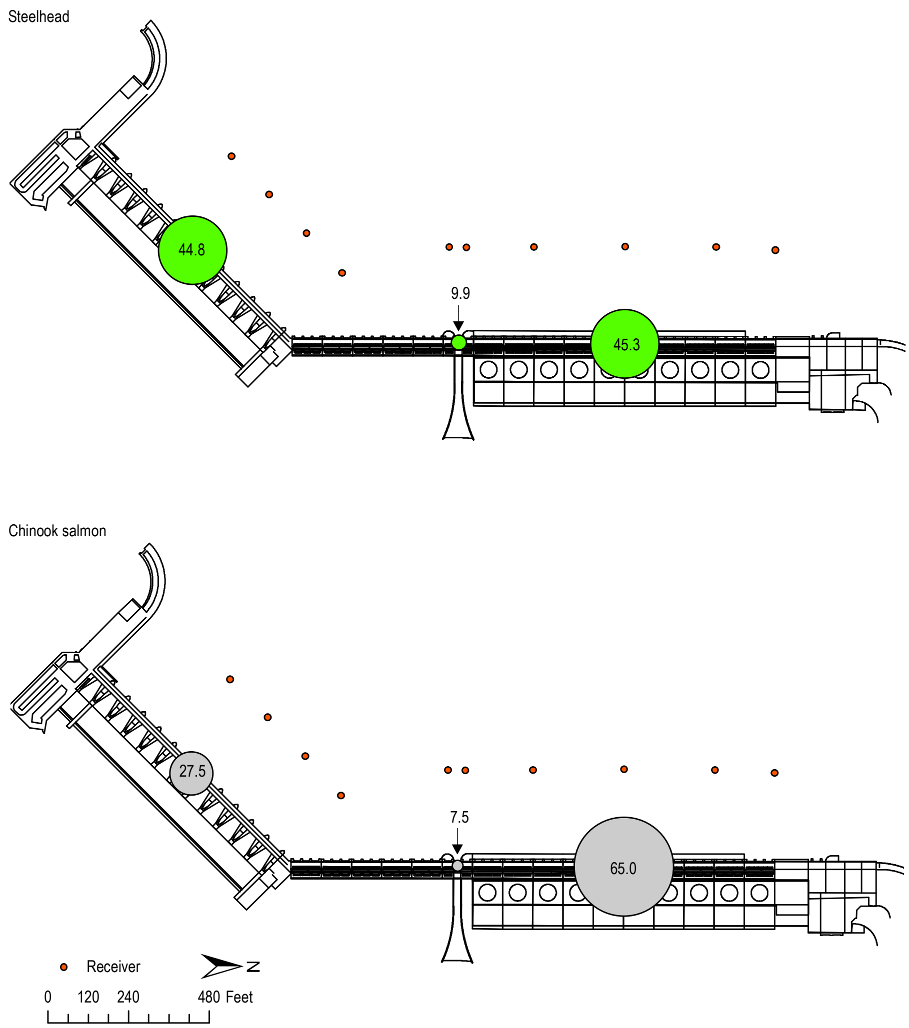


Figure 10. Passage percentages at Wanapum Dam in the spring of 2014; the top figure presents steelhead (green) and the bottom figure presents yearling Chinook salmon (gray). Detailed passage percentages shown by circles are proportional to percentages. Passage events that could not be identified are not depicted.

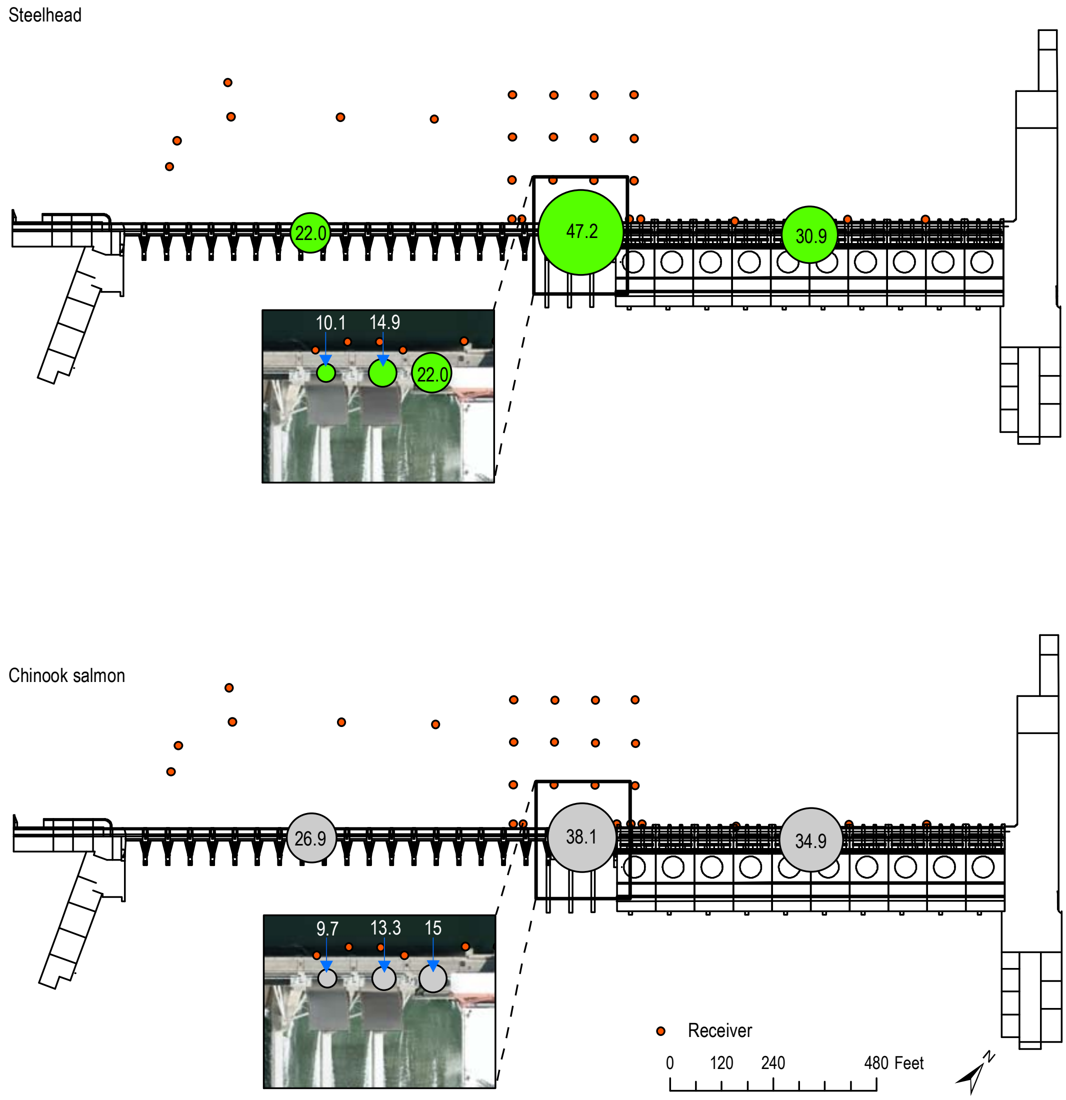


Figure 11. Passage percent at Priest Rapids Dam in 2014 for steelhead (top panel, green) and yearling Chinook salmon (bottom panel, gray) has been rounded to the nearest tenth. Detailed passage percentages are depicted as circles of diameter proportional to percentage. Passage events that could not be identified are not shown. Two fish of each species passed via the PRFB at unidentified bays and were excluded from the bay-specific analysis, 0.2% and 0.1% of steelhead and yearling Chinook salmon, respectively.

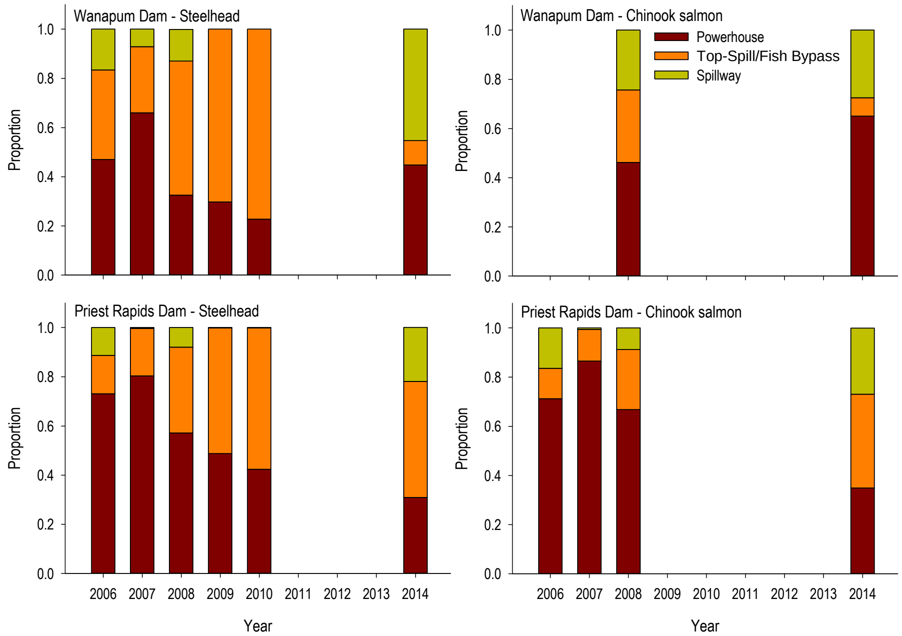


Figure 12. Historical passage proportion at Wanapum (top) and Priest Rapids dams (bottom) for steelhead (left) and yearling Chinook salmon (right) by passage route: powerhouse passage (maroon), top-spill/fish bypass passage (orange), and spillway (green). Data are representative of years when the given species were released.

Relative Route-Specific Survival

Similarly to the methods employed in previous passage studies, paired releases through a specified route were not conducted, but acoustic-tagged steelhead and yearling Chinook salmon known to have successfully arrived and passed downstream of Wanapum and Priest Rapids dams were used to estimate route-specific relative survivals through each dam (Timko et al. 2010, 2011). At both dams survival was quantified as relative to fish that passed through the spillway, deemed a ‘benign route’, for comparative purposes and where results were significantly different from 1.0, p-values were <0.05. Steelhead that passed through the WFB had similar survival estimates as spillway fish, and steelhead that passed through the powerhouse at Wanapum Dam had nearly 5% lower survival estimates (Skalski et al. 2014). At Priest Rapids Dam, relative route-specific survival rates were significantly higher for steelhead that passed through the PRFB when compared to the spillway (Δ of 2.7%) and were significantly lower for powerhouse compared to the spillway (Δ of 3.6%) (Skalski et al. 2014).

Yearling Chinook salmon that passed via the WFB or the powerhouse did not experience significantly different survival rates than those that passed through the spillway. However, at Priest Rapids Dam yearling Chinook salmon that passed through the PRFB had significantly higher survival estimates than those that passed through the spillway (Δ of 1.8%) (Skalski et al. 2014). Conversely, yearling Chinook salmon that passed through the powerhouse decreased in survival by nearly 5% when compared to those that passed through the spillway.

Additional details on juvenile steelhead and yearling Chinook salmon relative-route specific survival can be referenced in a separate report by Skalski et al. (2014).

Based on acoustic tag detection histories, 100% of steelhead that migrated past Wanapum Dam through the WFB were detected downstream, compared to the 94.1% of steelhead that selected the powerhouse and 99.4% that selected the spillway (Table 5). Yearling Chinook salmon that passed via the WFB measured 96.3% detected, compared to 98.2% that selected the powerhouse and 97.0% that selected the spillway. However, it is noteworthy that due to low sample size at the WFB direct comparisons of these detection histories become less powerful. Downstream of Priest Rapids Dam, 99.8% of bypass route steelhead were detected, while 93.8% of powerhouse fish were detected and 97.0% of spillway fish were detected. Similarly, 99.8% of yearling Chinook salmon passing via the PRFB were detected, compared to 92.6% detected from the powerhouse and 98.0% detected from the spillway.

Passage Proportions Relative to Migration Rates

Downstream median migration rates of steelhead and yearling Chinook salmon were divided by passage route and then statistically analyzed with the Kruskal-Wallis ranked test of variance followed by a *post-hoc* Dunn's test ($P<0.05$). In general, in 2014, median migration rates for both species, through both dams, yielded a similar pattern. Powerhouse fish migrated downstream at the slowest rate, while fish that passed through the spillway and bypass routes migrated at comparable rates (Appendix C, Table C.3 and C.4).

Fish that passed through the powerhouse at Wanapum Dam (WADM-PRDM) migrated at a rate that was statistically slower than fish that passed through the spillway and WFB; fish that passed through the spillway and WFB had comparable migration rates that were not statistically different (Figure 13). Below Priest Rapids Dam (PRDM-HAN), steelhead that passed through the PRFB migrated downstream at a rate that was statistically faster than all other fish that passed through the dam at the powerhouse and spillway. Yearling Chinook salmon that passed through the powerhouse moved downstream at a rate that was statistically slower than fish that passed through the spillway.

Passage Proportions Relative to Forebay Residence Times

The median forebay residence times of steelhead and yearling Chinook salmon at Wanapum and Priest Rapids dams in 2014, defined as the first and last detections at the BRZ and forebay arrays, were grouped by route selection and analyzed statistically with a Kruskal-Wallis ranked test of variance followed by a Dunn's *post-hoc* analysis ($P<0.05$) (Figure 14).

In the Wanapum Dam forebay, steelhead and yearling Chinook salmon that selected the powerhouse for passage had statistically shorter residence times than fish that selected the spillway or WFB. Steelhead that passed through the WFB yielded comparable residence times to fish that passed at the spillway and were not statistically different. However, yearling

Table 5. Number of tags that passed at each dam by species (steelhead or yearling Chinook salmon) and by route, with the corresponding percentage of tags that were detected downstream in 2014. The percentage of tags listed for all routes reflects concrete passage survival for all passage routes, including unknown passage locations and gatewell dipped fish; however, fish with upstream movement during last detection were excluded.

	Wanapum Dam				Priest Rapids Dam			
	Steelhead		Yearling Chinook		Steelhead		Yearling Chinook	
Passage Route	n	%	n	%	n	%	n	%
All Routes	377	97.1	382	97.9	1100	97.1	1120	96.9
Bypass	36	100.0	27	96.3	507	99.6	415	99.8
Spillway	164	99.4	99	97.0	236	97.0	293	98.0
Powerhouse	152	94.1	225	98.2	276	93.8	352	92.6

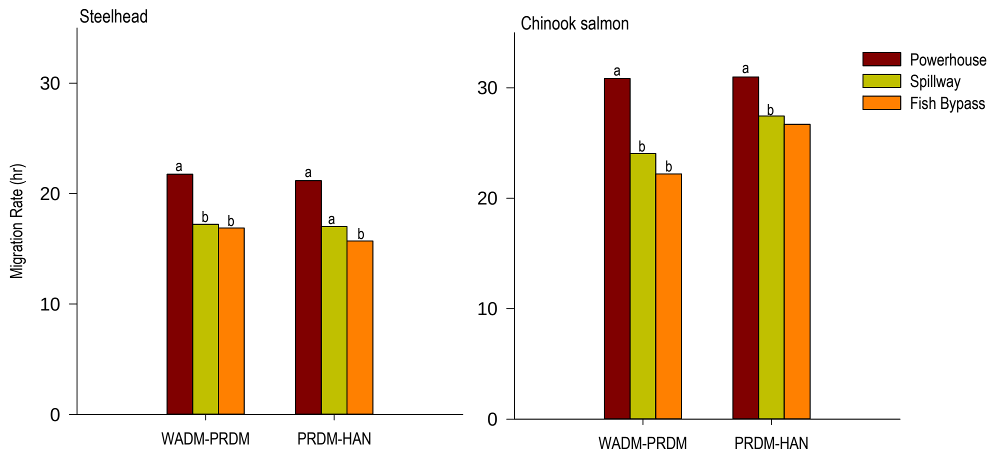


Figure 13. Median migration rates for steelhead (left) and yearling Chinook salmon (right) from Wanapum Dam to Priest Rapids Dam (WADM-PRDM) and Priest Rapids Dam to Hanford arrays (PRDM-HAN) separated by passage route (powerhouse, spillway or bypass). Letter labels above columns refer to which routes were statistical significant by reach, e.g. route “a” was statistically different than route “b” or “c” (significantly different from 1.0 where p-values were <0.05).

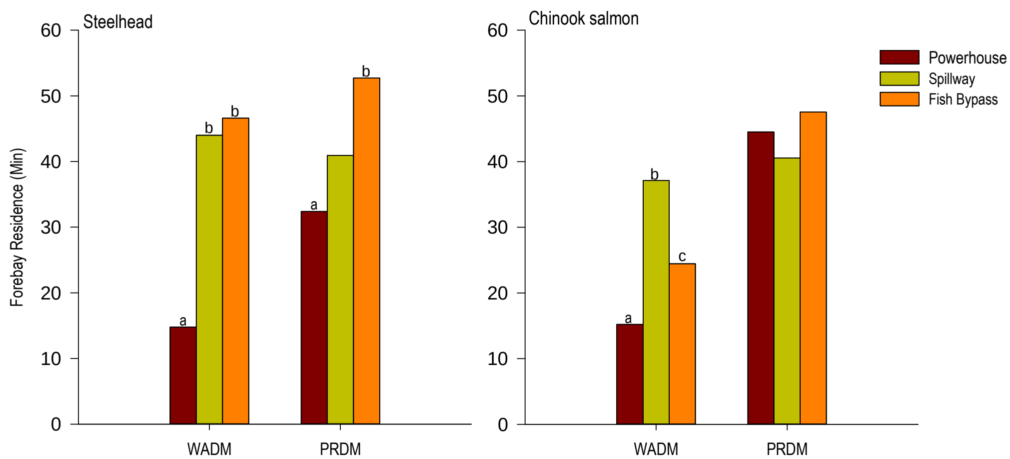


Figure 14. Median forebay residence times in minutes for steelhead and yearling Chinook salmon at Wanapum and Priest Rapids dams separated by passage route (powerhouse, spillway or bypass). Letter labels above columns refer to which routes were statistical significant by reach, e.g. route “a” was statistically different than route “b” or “c” (significantly different from 1.0 where p-values were <0.05).

Chinook salmon that passed at the WFB had statistically shorter forebay residence times compared to those that passed through the spillway. At Priest Rapids Dam, the forebay residence times of steelhead were statistically shortest for fish that selected the powerhouse and longest for the fish that selected the PRFB for downstream passage. Yearling Chinook salmon had similar forebay residence times for all eventual routes, none of which were statistically significant.

At both dams, the hazard barrier is closer to the powerhouse than the spillway and is likely confounding these results. Yet, if milling is occurring directly upstream of the powerhouse at either dam, it is minimal as the total duration of time spent in the vicinity of the powerhouse is significantly shorter than observed in previous acoustic tag studies. For example, the average forebay residence times of steelhead that passed at the Wanapum Dam powerhouse in 2010 was more than 4 hr while in 2014 it was less than 15 min (Appendix C; Table C.6 and C.7).

Passage Proportions Relative to Approach Position

The approach position of each tagged fish was estimated at the hazard barrier, based on the acoustic receiver the tagged fish was nearest to as it entered the immediate forebay of each dam (first detection at Wanapum Dam on Figure 15 and Priest Rapids Dam on Figure 16). Tracking of fish movement in the forebay was not conducted at Wanapum Dam in 2014. The data in Figure 15 does not reflect movement pathways or assume that fish move in a linear pathway between the hazard barrier to the point of passage, in fact in previous studies schooling or milling behavior that is more prevelant by steelhead with prolonged residence times was observed. Nonetheless, as fish approached Wanapum Dam, the highest proportion of steelhead and yearling Chinook salmon passed through the hazard barrier near the center of the reservoir, at the north eastern side of the dam, near the end of the powerhouse (Figure 15). Fish that entered the forebay closest to the powerhouse were more likely to pass at the powerhouse. Conversely, fish that passed through the hazard barrier on the opposite side of the forebay appeared to be more likely to pass at the spillway. This trend was more pronounced for yearling Chinook salmon when compared to juvenile steelhead. However, fish that ultimately passed through the spillway and WFB were from detections of fish, especially steelhead, which entered the immediate forebay region of the dam in all approach positions (Figure 15).

At Priest Rapids Dam, similar trends were presented as those described at Wanapum Dam but were more pronounced. One interpretation of the data illustrated in Figure 16 is that fish were being collected at the PRFB that had entered the forebay from all locations, including the north, closest to the powerhouse (Figure 16). Yearling Chinook salmon seemed less likely to be captured at the PRFB than juvenile steelhead that entered the forebay from the north, also just upstream of the powerhouse.

Priest Rapids Fish Bypass Passage Densities

At Priest Rapids Dam, steelhead and yearling Chinook salmon were tracked in the immediate forebay area between turbine unit 2 and Spill Bay 16. Relative percent passage (RPP) densities by species that selected the PRFB, i.e. the binned proportion of fish that passed through the PRFB versus those that passed through the spillway or powerhouse, are shown in Figure 17. Normalized bin density plots per species depicting the highest areas of use by individual PRFB route fish were also illustrated in Figure 18. For both species, fish that passed downstream through the PRFB were at the highest RPP directly upstream of the PRFB. Steelhead had higher RPP extending in front of the powerhouse than yearling Chinook salmon and both species had higher RPP that angled towards the spillway side (Figure 17). Steelhead also appeared to be more likely to be collected from directly upstream of the powerhouse than yearling Chinook salmon (Figure 18).

In previous tracking studies, fish that passed downstream of Priest Rapids Dam through the prototype bypass at Spill Bay 19 and 20 were at the highest RPP on the spillway side of the prototype bypass, within the 300 foot radius from the center of the prototype bypass entrance, and in front of the spillway between Spill Bay 6 and Spill Bay 18 (Timko et al. 2010, 2011). More specifically, in 2010, RPP for steelhead that passed through the prototype bypass were high (70-100%) in front of the powerhouse units. This trend is also exhibited in the 2014 RPP for steelhead.

The 2014 tracking results, illustrated in Figure 17 and Figure 18, demonstrate that steelhead passing downstream of the dam through the PRFB were likely being collected from the areas directly upstream of turbine units 1 and 2. The collection of fish at the PRFB from fish transiting across the spillway was marginally captured in the 2014 data set, and was likely a result of two things. First, tracking coverage at the spillway was decreased, and second, high spill volumes throughout the study between spill bays 1 and 18 likely collected and passed fish (an estimated 22% steelhead and 27% of yearling Chinook salmon).

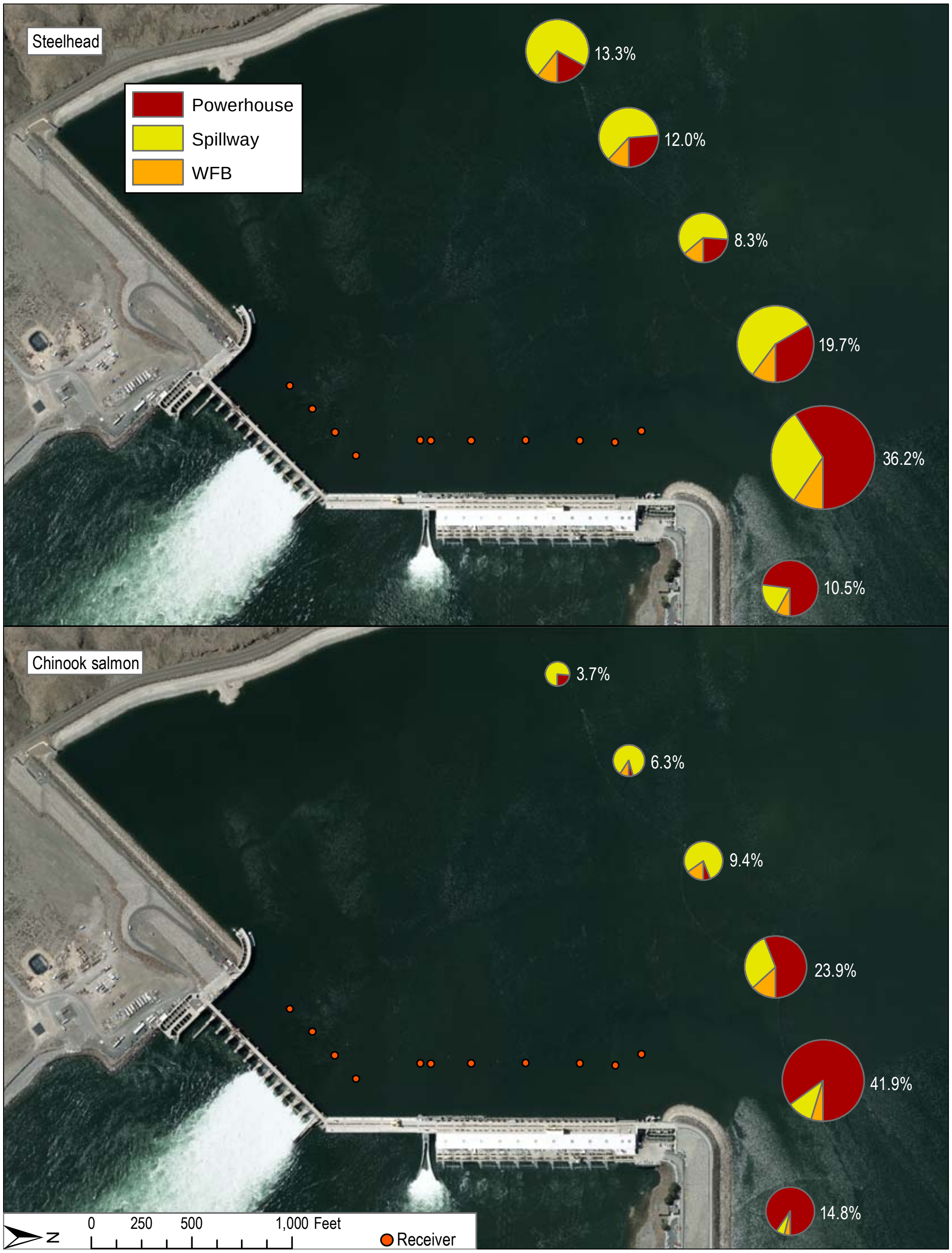


Figure 15. Proportion of juvenile steelhead (top) and yearling Chinook salmon (bottom) passing downstream at the hazard barrier of Wanapum Dam; the pie size is relative to the proportion of fish detected at each logger as fish entered the forebay (first detection). The pie composition indicates the relative passage route proportions (red = powerhouse, yellow = spillway, and orange = WFB or bypass of fish detected in proximity to the closest receiver by species.

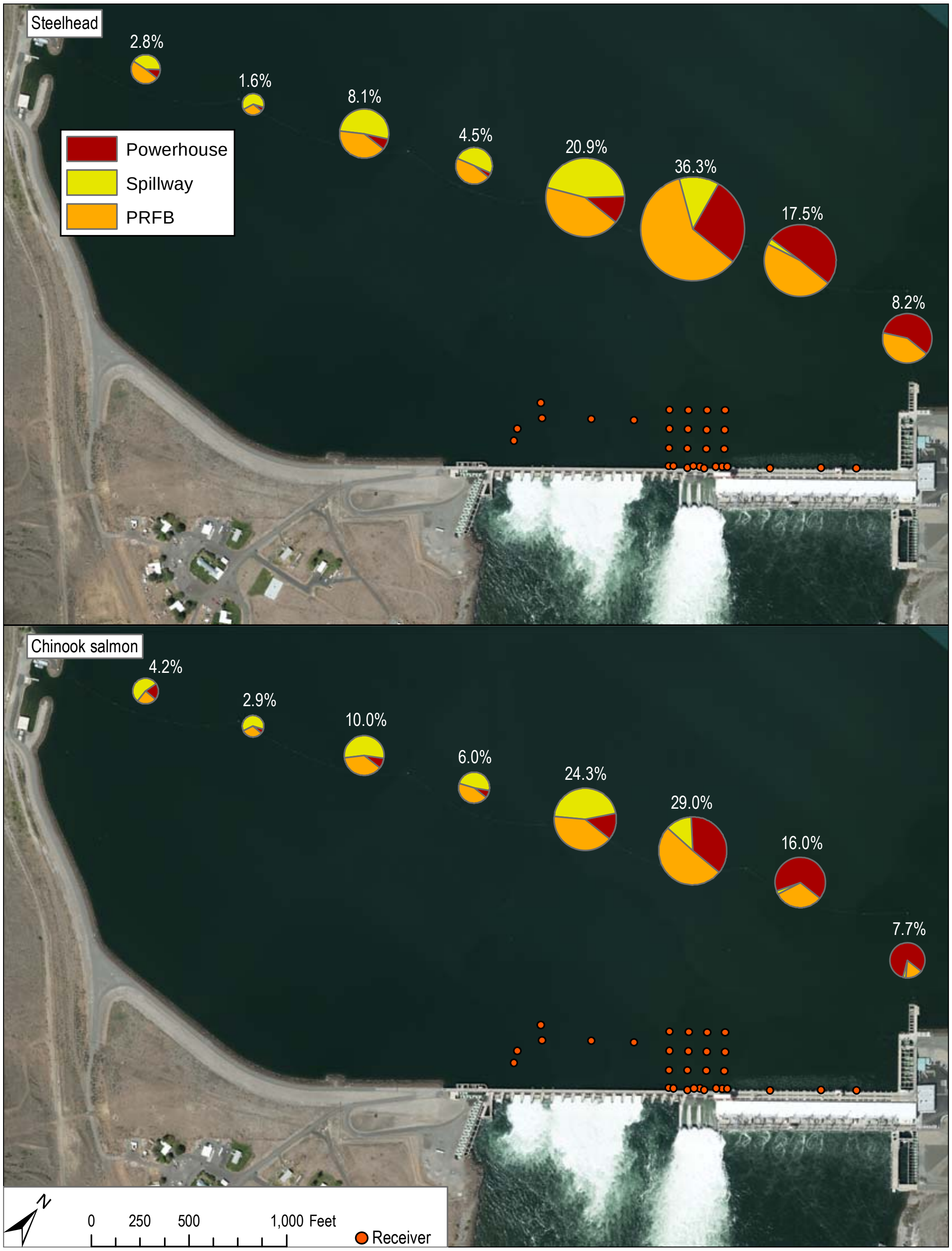


Figure 16. Proportion of juvenile steelhead (top) and yearling Chinook salmon (bottom) passing downstream at the hazard barrier of Priest Rapids Dam; the pie size is relative to the proportion of fish detected at each logger as fish entered the forebay (first detection). The pie composition indicates the relative passage route proportions (red = powerhouse, yellow = spillway, and orange = PRFB or bypass) of fish detected in proximity to the closest receiver by species.

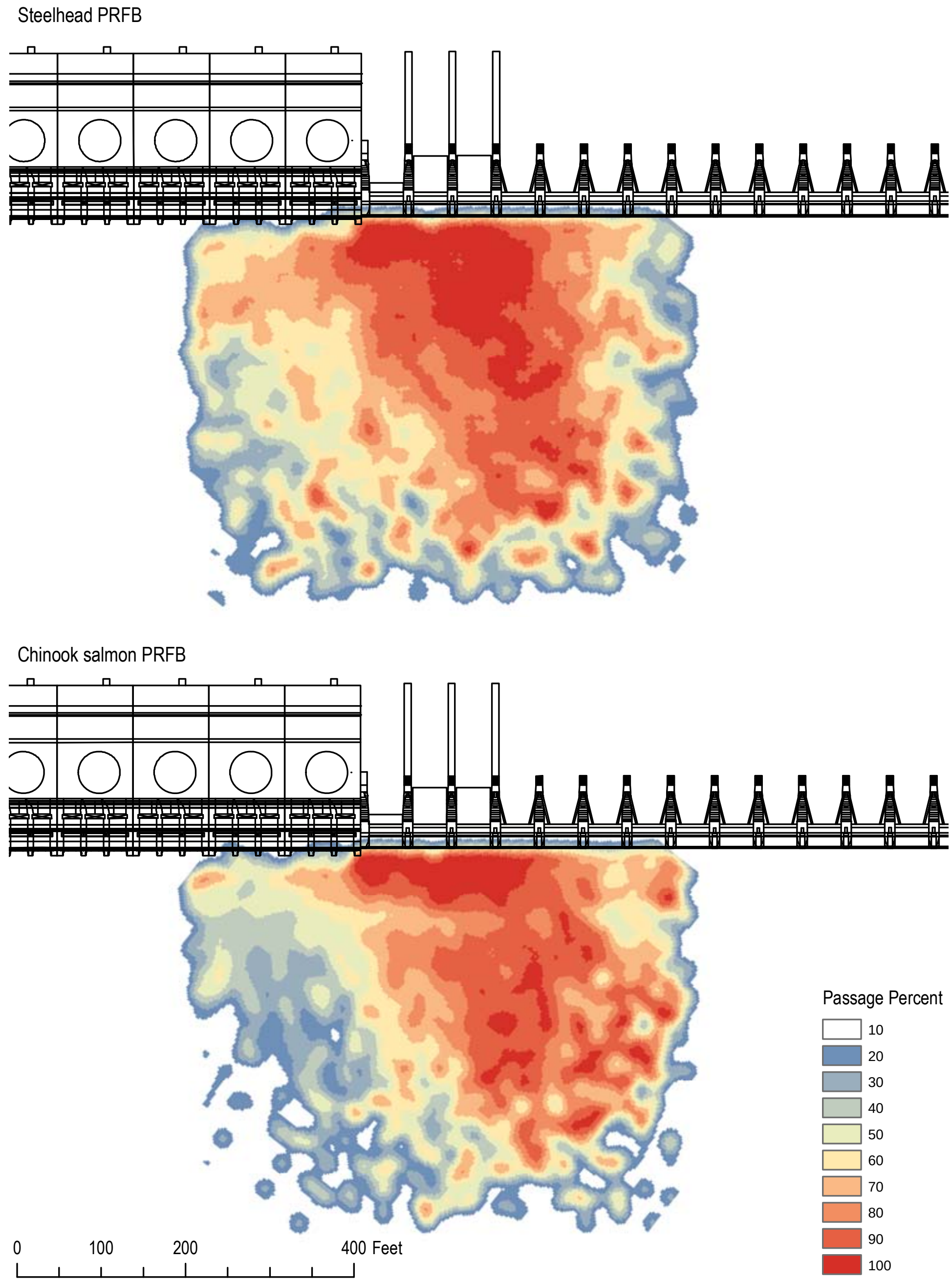


Figure 17. Relative passage percent locations of steelhead (top) and yearling Chinook salmon (bottom) that passed downstream through the Priest Rapids Fish Bypass (PRFB). Relative percent passage (RPP) was calculated using the eventual passage route of each fish, which was based on total fish by species that entered each 10 ft x 10 ft bin and passed through the PRFB.

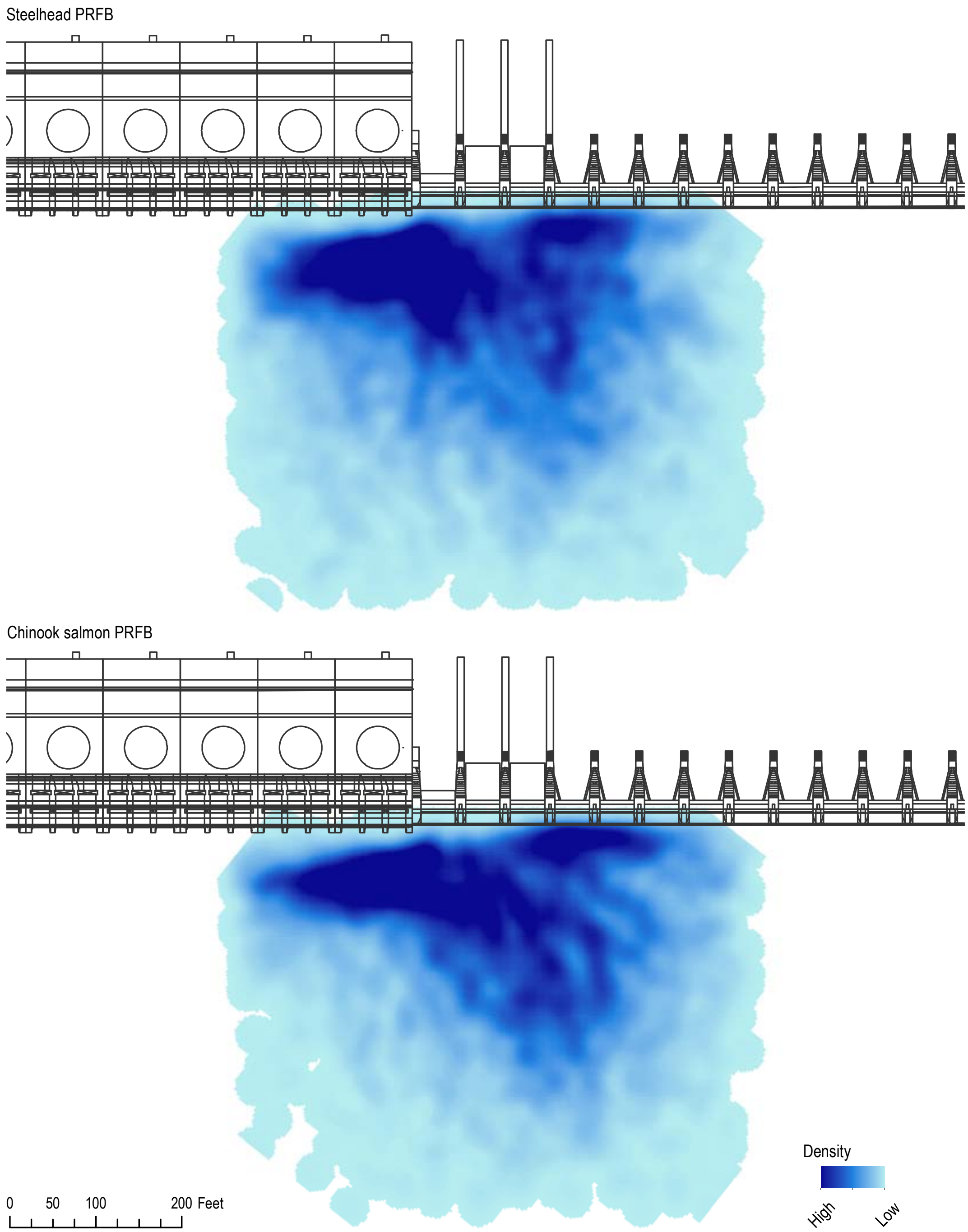


Figure 18. Normalized densities of steelhead (top) and yearling Chinook salmon (bottom) that passed downstream through the Priest Rapids Fish Bypass (PRFB) were created using a grid of 10 ft x 10 ft two-dimensional cells or bins in the forebay. Relative density was determined by the number of individual fish that entered each bin to illustrate where fish were in the forebay before passage selection occurred.

Bypass Non-Selection

Steelhead and yearling Chinook salmon that approached within 300 ft of the PRFB, but did not pass over it, were termed “non-selection” fish. At the PRFB, non-selection steelhead and yearling Chinook salmon two-dimensional positions, shown in Figure 19, were evaluated for trends in forebay positions. For the most part, both species that did not select the PRFB but passed through the powerhouse were most heavily concentrated near the powerhouse, directly upstream of turbine Unit 1 and the upstream transition between the powerhouse and bypass structure. Furthermore, non-selection fish that passed via the spillway followed this same trend and were concentrated near the spillway.

Zone Entrance Efficiency

Zone entrance efficiency (ZEE) was measured as the ratio of fish which encounter the PRFB (to within 300 ft of the entrance) to the total population of fish approaching the dam. In 2014, nearly three quarters of all steelhead and 65% of all yearling Chinook salmon entered the PRFB zone of influence (Figure 20). ZEE in 2014 was 72.5% for steelhead and 65.2% for yearling Chinook salmon (Table 6).

Fish Collection Efficiency

Fish collection efficiency (FCE) was measured as the ratio of fish that passed via the PRFB to the quantity of fish that entered the 300 ft zone of influence (i.e., how many fish passed through the PRFB after swimming within 300 ft of its entrance). In 2014, FCE was higher for steelhead (64%) than yearling Chinook salmon (57%) (Table 6). In 2014, there was greater than 95% collection efficiency at 50 ft from PRFB; both species had an estimated 98%, with decreasing efficiency at greater distances (Figure 21). (Reference Appendix D, Table D.5 for FCE at incrementally further distances from the PRFB, starting at 50 ft to 300 ft upstream of the bypass).

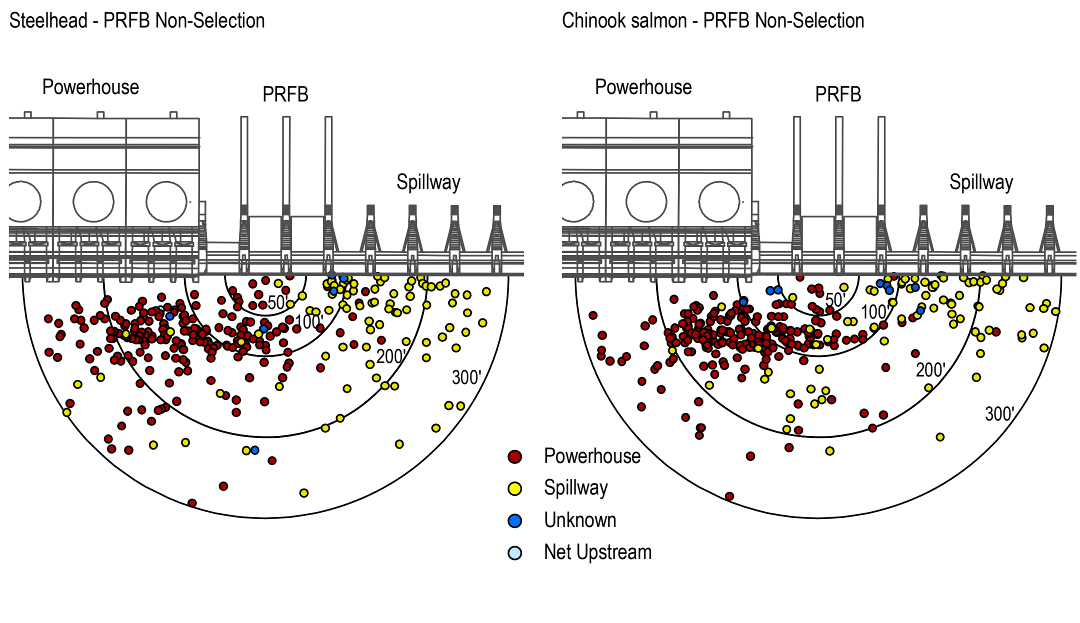


Figure 19. Juvenile steelhead (left) and yearling Chinook salmon (right) that entered the 300 ft radial zone of influence in front of the Priest Rapids Fish Bypass (PRFB) but were not captured are presented. Each point represents the closest estimated approach location to the PRFB in two-dimensions before non-selection occurred.

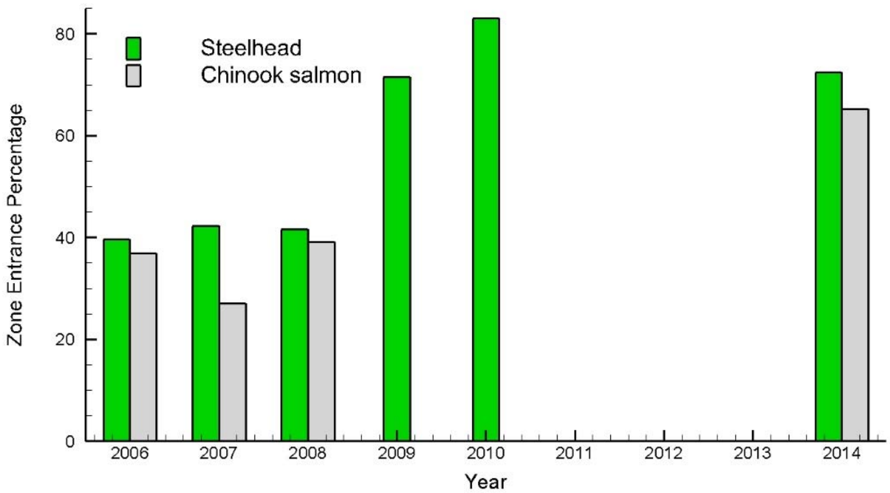
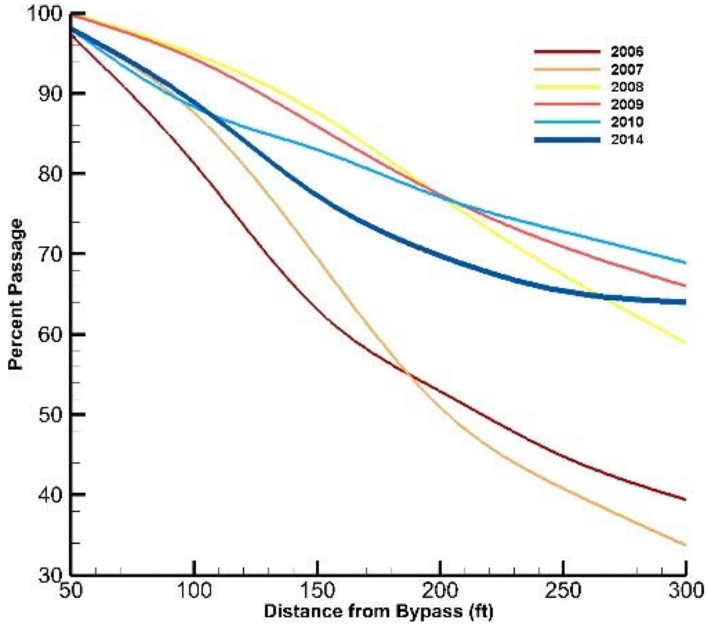


Figure 20. Percent of fish by species (steelhead and yearling Chinook salmon) and year at Priest Rapids Dam that entered a 300 ft radius from the center of the bypass (PRFB) divided by the total number of fish that passed the dam (defined as zone entrance efficiency) in the 2006-2014 field studies. Behavioral studies were not conducted in 2011-2013 at Priest Rapids Dam; yearling Chinook salmon were not studied in 2009-2010.

Table 6. Priest Rapids Dam Fish Bypass (PRFB) passage route efficiency by year and species listed by two metrics, first as a product of zone entrance efficiency (ZEE) and fish collection efficiency (FCE), and second as a proportion of the number of fish in the forebay that passed through the PRFB by species. The difference between the passage route efficiency (PRE) product (or the predicted PRE) and the proportion (or actual PRE) is likely due to the annual environmental and hydraulic variability between the two variables, ZEE and FCE.

				PRE_{Bypass}	
Species	Year	ZEE	FCE	Product	Proportion
Steelhead	*Priest Rapids Dam Fish Bypass (PRFB)*				
	2014	0.73	0.64	0.47	0.47
	Priest Rapids Dam Prototype Bulkhead Testing				
	2010	0.78	0.69	0.54	0.57
	2009	0.72	0.66	0.47	0.51
	2008	0.42	0.59	0.25	0.33
	2007	0.42	0.34	0.14	0.19
	2006	0.40	0.39	0.16	0.15
Yearling Chinook Salmon	*Priest Rapids Dam Fish Bypass (PRFB)*				
	2014	0.65	0.57	0.37	0.38
	Priest Rapids Dam Prototype Bulkhead Testing				
	2008	0.39	0.31	0.12	0.15
	2007	0.27	0.29	0.08	0.12
	2006	0.36	0.33	0.12	0.12



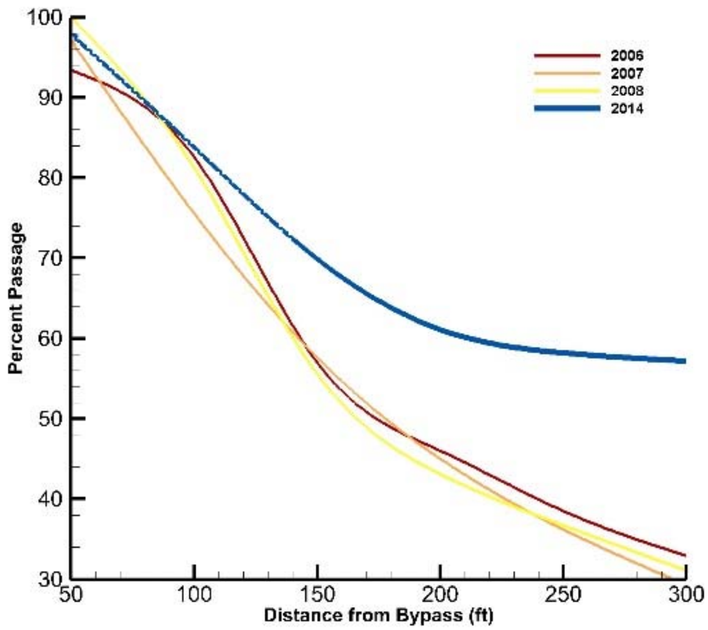


Figure 21. Percent passage of steelhead (top) and yearling Chinook salmon (bottom) through the Priest Rapids Fish Bypass (PRFB) that were detected within 50, 100, 150, 200, 250, and 300 ft increments from the prototype bypass (steelhead 2006-2010, 2014; yearling Chinook salmon 2006-2008, 2014).

Discussion

Survival of juvenile steelhead and yearling Chinook salmon was estimated throughout the Project in 2014. For yearling Chinook salmon, Grant PUD was required in 2014 to assess whether survival standards were being maintained after they were met during PIT tag evaluation studies in 2003, 2004, and 2005. Yearling Chinook salmon that passed through the Project in 2014 comfortably met the survival standards (Skalski et al. 2014). Yearling Chinook salmon survival through the Project increased by 4.2% (90.8%) compared to the three-year Project survival average in 2003-2005 of 86.6%.

In 2014, juvenile steelhead BiOp and SSSA performance standards were met in two of the Project areas; survival standards were met through the Priest Rapids Development and the entire Project area but were not met in the Wanapum Development (Figure 22). The survival standard for steelhead of 93% through the Wanapum Development was narrowly missed by a margin of 0.06% (Skalski et al. 2014). Although survival through the Wanapum Development increased slightly by 1.0% (from the three-year $\hat{S}$ average of 91.9% in 2008-2010 to a $\hat{S}$ of 92.9% in 2014), the Priest Rapids Development and overall Project survival increased moderately at 7.9% and 8.3%, respectively (Figure 22).

The distinct increase in steelhead survival, predominantly through the Priest Rapids Development, was difficult to correlate to one, single variable. One possible variable was the increased regional effort to reduce avian predator populations. In comparison to previous years, the detections of Grant PUD study fish from 2014 at Potholes Reservoir has decreased (BRNW *in review*). Although study fish were detected at the Potholes Reservoir nesting colony, the decrease in overall PIT tags detected could be a function of the decreased number of nesting breeding pairs in comparison to 2010. Evans et al. (*in progress*) are preparing a separate report of a retrospective analysis on avian predation in 2014 and further insights from their study contributions will be gained.

Juvenile salmon migration rates have also been well correlated with survival, as well as flow and spill, where increased survival was documented in

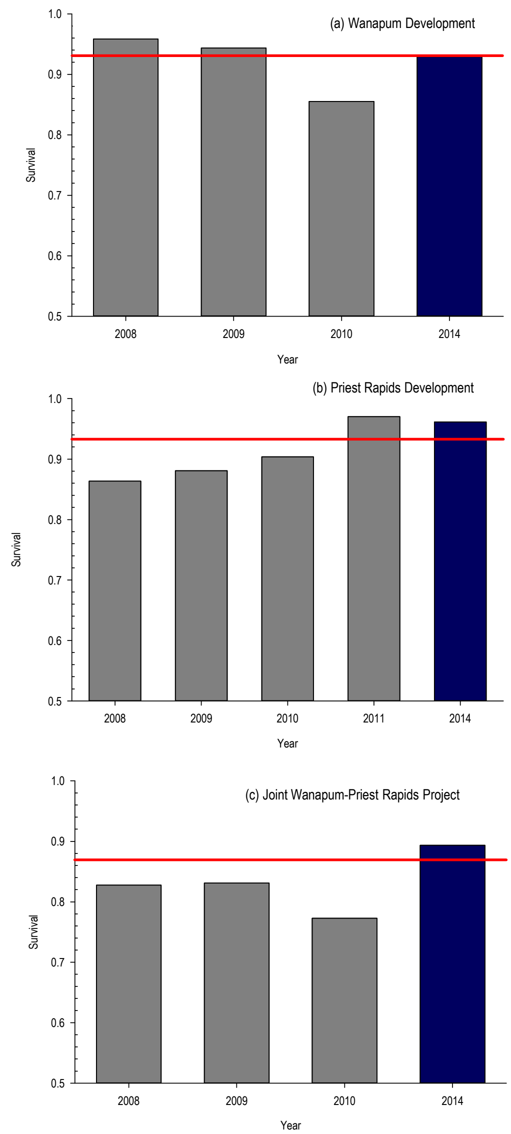


Figure 22. Paired release recapture survival estimates of juvenile steelhead through the (a) Wanapum Development, (b) Priest Rapids Development, and (c) Joint Wanapum-Priest Rapids Project, 2008-2010 and 2014. The target performance standard for steelhead is 93% in each development and 86.5% in the Joint Wanapum-Priest Rapids Project (shown by red line). In 2011, Steelhead survival was estimated in the Priest Rapids Development through a single release recapture design.

years with faster migration (Anglea et al. 2005b; Faulkner et al. 2007; Muir et al. 2001; Thompson et al. 2012). In 2014, steelhead migration rates above Wanapum Dam were considerably faster than the 2006-2010 average (∆+55.5%). The faster migration rates were likely related to low forebay and reservoir elevations in the Wanapum Development that were 28 ft below the typical elevation; thus creating a more channelized river system. However, 2014 steelhead survival through the Wanapum Development deviated little from the 2008-2010 average, in fact the 2014 survival estimate of 92.9% was lower than that estimated in 2008 (95.8%) and 2009 (94.4%) (Figure 22). Downstream of Wanapum Dam, migration rates of steelhead and yearling Chinook salmon were more comparable to the 2008-2010/11 average, implying that changes in the environmental conditions that affected salmonid migration in 2014 were isolated to the Wanapum Reservoir.

Migrating juvenile salmonids with extended forebay residence times, *i.e.* 'milling' behavior, likely experience an increase in predatory exposure and concurrent decreased survival estimates. When 2014 residence times were compared to historical times it yielded few definitive conclusions and was likely a result of changes in array structure and acoustic technology used. Nonetheless, upon extending the forebay to include BRZ loggers, both species were found to have resided in the forebay for less than one hour; thus milling behavior did not appear prevalent at either dam during the 2014 study.

It has been well established that passage through the powerhouse of hydroelectric dams can be harmful to migrating juvenile salmonids (Muir et al. 2001, Mighetto and Ebel 1994, Raymond 1979). The 2014 migratory season marked the first year in which both bypass systems were in operation to increase non-turbine passage throughout the Project. In particular, 2014 was the inaugural operating season of the PRFB. Assessing each bypass's efficiency was conducted through the examination of survival by passage route (relative route specific survival) weighted by the bypass's ability to collect fish. Steelhead relative route specific survival through Wanapum Dam matched historical trends as fish that passed through the powerhouse were statistically measured at lower survival than fish that passed through the spillway or WFB. Yearling Chinook salmon deviated from hypothesized trends and showed no route specific improvements to survival; all routes yielded high survival at Wanapum Dam. Steelhead and yearling Chinook salmon that passed downstream of Priest Rapids Dam through the PRFB yielded statistically higher survival rates through the proceeding downstream reach than fish that passed through either the spillway or powerhouse. In addition to incurring the lowest survival at both dams, both species that passed through the powerhouse also had the slowest downstream migration rates relative to alternative passage routes.

Passage proportions at Wanapum Dam in 2014 were likely affected by low reservoir elevations. Only 10% of steelhead passed downstream through the WFB in 2014 compared to nearly 77% in 2010. Additionally in 2014, powerhouse route selection increased by 22% with the remaining 44% passing through the spillway; no steelhead passed through the spillway in 2010. It is reasonable to speculate that the changes in passage route proportions at Wanapum Dam may have negatively affected the estimated steelhead 2014 concrete survival. The 2014 steelhead concrete survival estimate was 97.8%, where 2009 and 2010 yielded virtually 100% survival with more steelhead passed through the WFB in previous years. Yearling Chinook salmon WFB collection decreased by 22% and powerhouse collection increased by 18% in 2014 relative to 2008, while spillway proportions remained similar (∆+3%). The ubiquitous decrease in 2014 WFB selection is a direct result of the Wanapum Reservoir drawdown that decreased the flow at the bypass to 80% below normal, which resulted in less attraction flow and ultimately decreased selection of that passage route.

Passage proportions of steelhead at Priest Rapids Dam match previous results more closely, though notable differences remain. The proportion of steelhead that passed through the powerhouse in 2014 decreased by 12% when compared to 2010. For comparison, yearling Chinook salmon passage at the powerhouse in 2014 also decreased noticeably compared to 2008 (∆-33%). Yet in 2014 the PRFB collected 11% fewer steelhead relative to 2010 and 13% fewer yearling Chinook salmon relative to 2008. The confounding factor likely driving these changes in PRFB passage was the additional inadvertent spill in 2014. Less than 1% of 2010 steelhead passed through the spillway as it was sparsely operated, but in 2014, 22% of the steelhead passed through the spillway as it was operated during the majority of the study. The dam operations at each facility are dynamic from year to year, however the additional route for passage altered the anticipated Priest Rapids Dam passage dynamic, expressed predominantly by diminished PRFB selection than observed in previous years with a prototype bulkhead top-spill.

Further approach analysis corroborates with this hypothesis. Relative percent passage figures confirm that fish encountering the PRFB entrance from the spillway end are sufficiently attracted to pass at the PRFB. However, results from the normalized bin density figures confound this effect because a lower density of fish encountered the PRFB from the spillway, relative to the opposite side of the PRFB at the junction of the powerhouse. The normalized bin densities at Priest Rapids Dam also demonstrated that there was some attraction for fish to pass at the PRFB when they were in the forebay, directly upstream of turbine units 1 and 2. Based on the approach analysis from the BRZ, fish that entered the forebay near the spillway (south end of the BRZ) were more likely to have passed through the spillway and never encountered the PRFB entrance. Therefore, we suspect that if the spillway had been closed in 2014, the PRFB would have likely collected a significant portion, if not all, of the steelhead that had entered the Priest Rapids Dam forebay at or near the spillway.

In summary, the 2014 yearling Chinook salmon met all survival performance standards in the Project and steelhead survival estimates met *nearly* all performance standards, narrowly missing the mark at the Wanapum Development. This increase in survival estimate and ability to meet performance standards is pivotal because previous steelhead survival estimates in the Wanapum and Priest Rapids developments have failed to consistently meet BiOp and SSSA performance standards.

Providing a quantitatively robust identification of a single factor that accounts for the increase in survival is convoluted, especially considering the ecological complexity of the Mid-Columbia River system, yet several modifications to the river ecosystem suggest possible explanations. Grant PUD has put considerable effort into the management of piscivorous fish and birds, which has likely resulted in decreased mortality from predation throughout the entire Project area. Additionally, the change in forebay elevation at Wanapum Dam has resulted in a riverine (and less reservoir-like) passage environment with faster migration rates that likely assisted in the increased survival. In turn, the decrease in elevation of the Wanapum Reservoir also contributed to the lower WFB selection which may have led to an overall decreased Project survival. Another considerable change in Project operations in 2014 was the addition of the PRFB, allowing 2014 steelhead a safer alternative to powerhouse or spillway passage. The addition of this non-turbine route, however, did not considerably increase dam survival in 2014 relative to 2008-2010 results. Yet, it is feasible that less spill may increase PRFB selection in future years, and based on 2014 relative route-specific survival, increased passage at the PRFB would increase overall dam survival estimates similar to the WFB's effect on survival at Wanapum Dam in 2009-2010.

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Acoustic Array Positioning and System Detection Efficiency

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Table A.1. The 2014 receiver deployment configurations for Wanapum Dam. Table includes the array deployed at the Boat Restricted Zone (BRZ) and the array installed in the forebay. Unique system ID, unique receiver identification numbers, elevation, and position (NAD 83 HARN Washington State Plane South Feet) are provided. The forebay array also includes location relative to the dam (PH = powerhouse, WFB = Wanapum Fish Bypass, SP = spillway). Receivers that detached, leaked, or had SD card malfunctions are indicated by an asterisk.

System ID	Number	Receiver Location	Northing	Easting	Elevation (ft)
Wanapum Dam BRZ					
W416_3A	331	BRZ	562996.0	1770418.0	533.0
W416_3B	332	BRZ	563352.0	1770847.6	533.0
W416_3C	333	BRZ	563724.4	1771346.9	533.0
W416_3D	334	BRZ	564084.6	1771874.8	533.0
W416_3E	335	BRZ	564322.0	1772439.5	533.0
W416_3F	336	BRZ	564158.2	1773090.2	533.0
Wanapum Dam Forebay					
W416_1A	301	SP	561666.2	1772087.0	515.0
W416_1B	302	SP	561778.2	1772200.7	515.0
W416_1C	303	SP	561890.1	1772316.5	515.0
W416_1D	304	SP	561996.7	1772434.3	515.0
W416_1E	305	WFB	562315.5	1772356.7	510.0
W416_1F	306	WFB	562367.4	1772357.8	510.0
W416_1G	307	PH	562568.0	1772357.0	515.0
W416_1H*	308	PH	562840.2	1772354.8	515.0
W416_1I	309	PH	563110.9	1772355.9	515.0
W416_1J*	310A	PH	563287.0	1772364.4	515.0
W416_1J	310B	PH	563417.0	1772309.6	515.0

Table A.2. The 2014 receiver deployment configurations for Priest Rapids Dam. Table includes the array deployed at the Boat Restricted Zone (BRZ) and the array installed in the forebay. Unique system ID, unique receiver identification numbers, elevation, and position (NAD 83 HARN Washington State Plane South Feet) are provided. The forebay array also includes location relative to the dam (PH = powerhouse, PRFB = Priest Rapids Fish Bypass, SP = spillway). Receivers that detached, leaked, or had SD card malfunctions are indicated by an asterisk.

System ID	Number	Receiver Location	Northing	Easting	Elevation (ft)
Priest Rapids Dam BRZ					
P397_4A	531	BRZ	478452.6	1784995.4	475.0
P397_4B	532	BRZ	478658.8	1785536.5	475.0
P397_4C	533	BRZ	478900.6	1786073.0	475.0
P397_4D	534	BRZ	479126.5	1786614.2	475.0
P397_4E	535	BRZ	479358.6	1787158.4	475.0
P397_4F	536	BRZ	479579.3	1787688.0	475.0
P397_4G	537	BRZ	479800.0	1788217.7	475.0
P397_4H	538	BRZ	479835.3	1788895.1	475.0
Priest Rapids Dam Forebay					
P397_1A*	501A	SP	478159.7	1787659.8	447.1
P397_1AS	501B	SP	478218.5	1787635.2	455.0
P397_1B*	502A	SP	478339.7	1787699.4	450.1
P397_1BS	502B	SP	478397.1	1787645.1	455.0
P397_1C	503	SP	478496.5	1787898.6	444.1
P397_1D	504	SP	478628.5	1788072.7	441.1
P397_1E*	505	SP	478572.7	1788376.5	426.0
P397_1F*	506	PRFB	478637.4	1788458.1	425.5
P397_1G	507	PRFB	478664.5	1788505.4	436.6
P397_1H	508	PRFB/PH	478708.6	1788547.0	454.5
P397_1I	509	PH	478875.9	1788767.2	450.0
P397_1J	510	PH	479042.5	1788970.0	450.0
P397_1K	511	PH	479154.3	1789111.0	450.0

Table A.3. The 2014 receiver deployment configurations for Priest Rapids Dam 3D array. Unique system ID, unique receiver identification numbers, elevation, and position (NAD 83 HARN Washington State Plane South Feet) are provided. Location relative to the dam (PH = powerhouse, PRFB = Priest Rapids Fish Bypass, SP = spillway) is included. Receivers that detached, leaked, or had SD card malfunctions are indicated by an asterisk.

System ID	Number	Receiver Location	Northing	Easting	Elevation (ft)
Priest Rapids 3D Array					
P397_1AA	551	SP	478558.4	1788358.5	423.8
P397_1AB	552	SP/PRFB	478611.1	1788438.2	455.3
P397_1AC*	553	PRFB	478656.6	1788482.7	423.2
P397_1AD	554	PRFB/PH	478708.6	1788547.0	474.2
P397_1AE*	568	PH	478728.4	1788571.8	462.1
P397_1AF	555	PH	478745.1	1788592.9	476.0
P397_2AA*	556	SP	478630.3	1788301.8	476.0
P397_2AB	557	SP/PRFB	478688.6	1788376.5	455.0
P397_2AC	558	PRFB	478747.0	1788451.4	476.0
P397_2AD	559	PH	478804.2	1788524.4	410.0
P397_2AE	560	SP	478708.3	1788240.6	455.0
P397_2AF	561	SP/PRFB	478767.4	1788315.8	476.0
P397_2AG	562	PRFB	478824.7	1788391.7	455.0
P397_2AH	563	PH	478882.2	1788464.6	476.0
P397_2AI	564	SP	478785.0	1788180.1	476.0
P397_2AJ	565	SP/PRFB	478844.2	1788256.3	455.0
P397_2AK	566	PRFB	478902.7	1788330.0	476.0
P397_2AL	567	PH	478960.9	1788401.4	455.0

Table A.4. The 2014 receiver deployment configuration at each of the in-river detection sites (Crescent Bar, Sunland Estates, Mattawa, Vernita Bridge, White Bluffs, Hanford 1 and Hanford 2). Unique system ID, unique receiver identification numbers, and receiver position (NAD 83 Washington State Plane South Feet) are provided. All in-river receivers were attached to an acoustic release and deployed on the river bottom. Receivers that failed, intermittently or permanently, to collect data are indicated by an asterisk. Receiver 703R was installed as a replacement after the original receiver (703) broke free from its mount.

System ID	Receiver	Northing	Easting
Crescent Bar			
W441_5A	101	689415.4	1761800.6
W441_5B	102	689703.5	1761903.8
W441_5C	103	689991.7	1762003.8
Sunland Estates			
W428_2A	201	625132.5	1758901.5
W428_2B	202	625296.5	1759237.7
W428_2C*	203	625459.3	1759571.5
W428_2D	204	625620.9	1759902.9
Mattawa			
P408_4A	401	521626.1	1774599.8
P408_4B	402	521312.0	1774882.0
P408_4C	403	521001.9	1775122.8
P408_4D	404	520787.4	1775365.9
Vernita Bridge			
M388_6A	601	476247.4	1830873.7
M388_6B*	602	476498.6	1830768.2
M388_6C	603	476754.8	1830662.8
M388_6D	604	477032.7	1830545.5
White Bluffs			
M368_5A	701	489104.8	1902501.1
M368_5B	702	489243.8	1902684.2
M368_5C*	703	489382.7	1902867.4
M368_5C	703R	489382.7	1902867.4
M368_5D*	704	489521.6	1903063.1
Hanford 1			
M339_0A	801	352472.1	1952070.4
M339_0B	802	352323.5	1952550.7
M339_0C	803	352106.3	1953177.0
M339_0D	804	351933.0	1953736.3
Hanford 2			
M337_0A*	901	343642.8	1953544.4
M337_0B*	902	343912.3	1953776.5
M337_0C	903	344119.5	1953965.6
M337_0D	904	344377.4	1954187.5

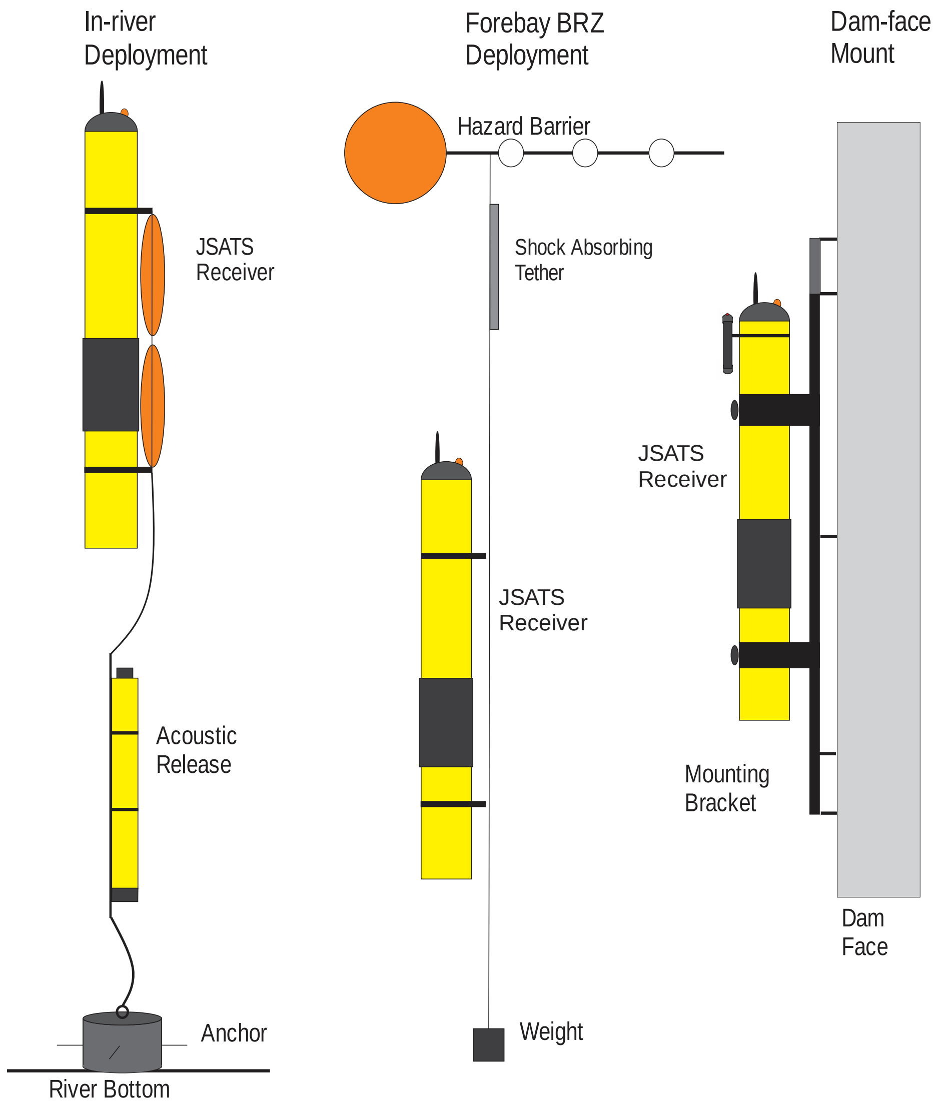

Figure A.1. Deployment schematic of in-river JSATS receivers fixed to the river bottom (left) with a concrete weight (approximately 75 lb.). Receivers were tethered to the release anchor assembly with 15' of 3/8" aircraft cable. Receivers attached to the hazard barrier of the BRZ at Wanapum and Priest Rapids dams (center) were suspended between large pelican clips attached to the pad-eye of hazard barrier crown buoys and 20 lb. lead weights. Shock absorbing tethers were affixed to 15' of 3/8" aircraft cable to reduce shock load to receivers during periods of heavy weather. Receivers attached to the face of Priest Rapids Dam (right) were attached via a metal bracket secured with rock bolts.

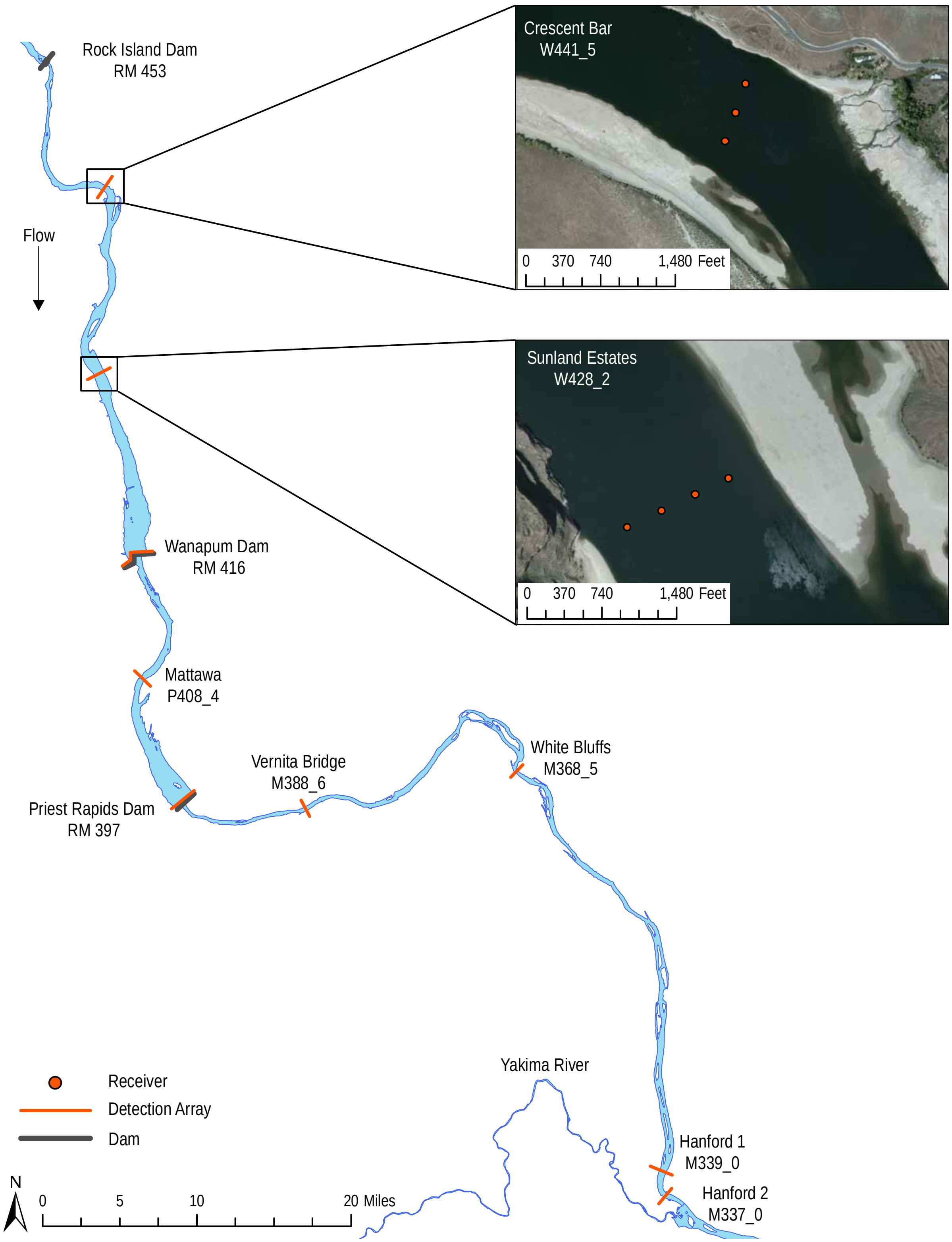

Figure A.2. Position of arrays deployed for the survival study including a detailed view of the cross-river detection arrays at Crescent Bar and Sunland Estates. Digital imagery courtesy of Grant PUD taken in March 2014.

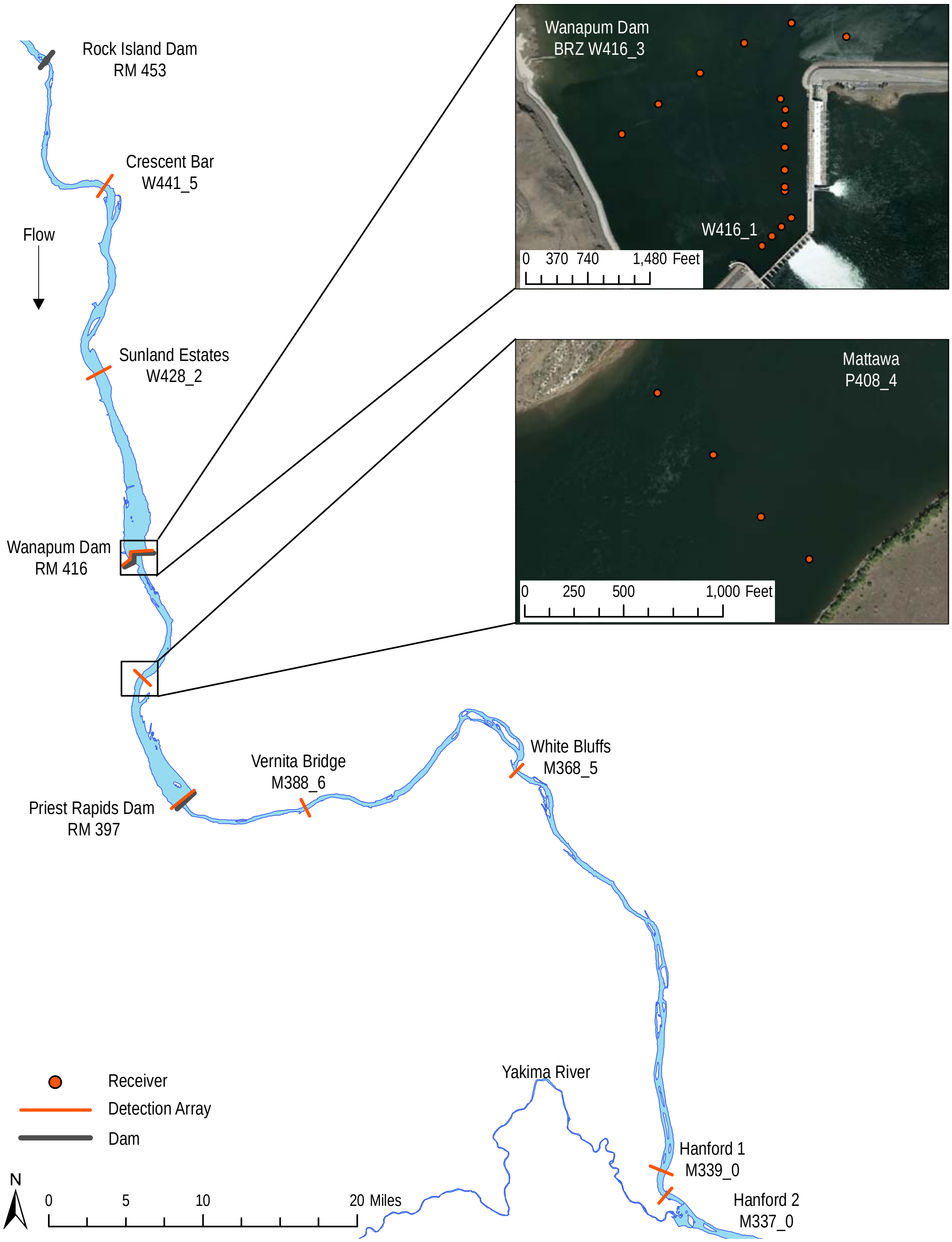

Figure A.3. Position of arrays deployed for the survival study including a detailed view of the detection array at Wanapum Dam and cross-river detection array at Mattawa. Digital imagery courtesy of Grant PUD taken in March 2014.

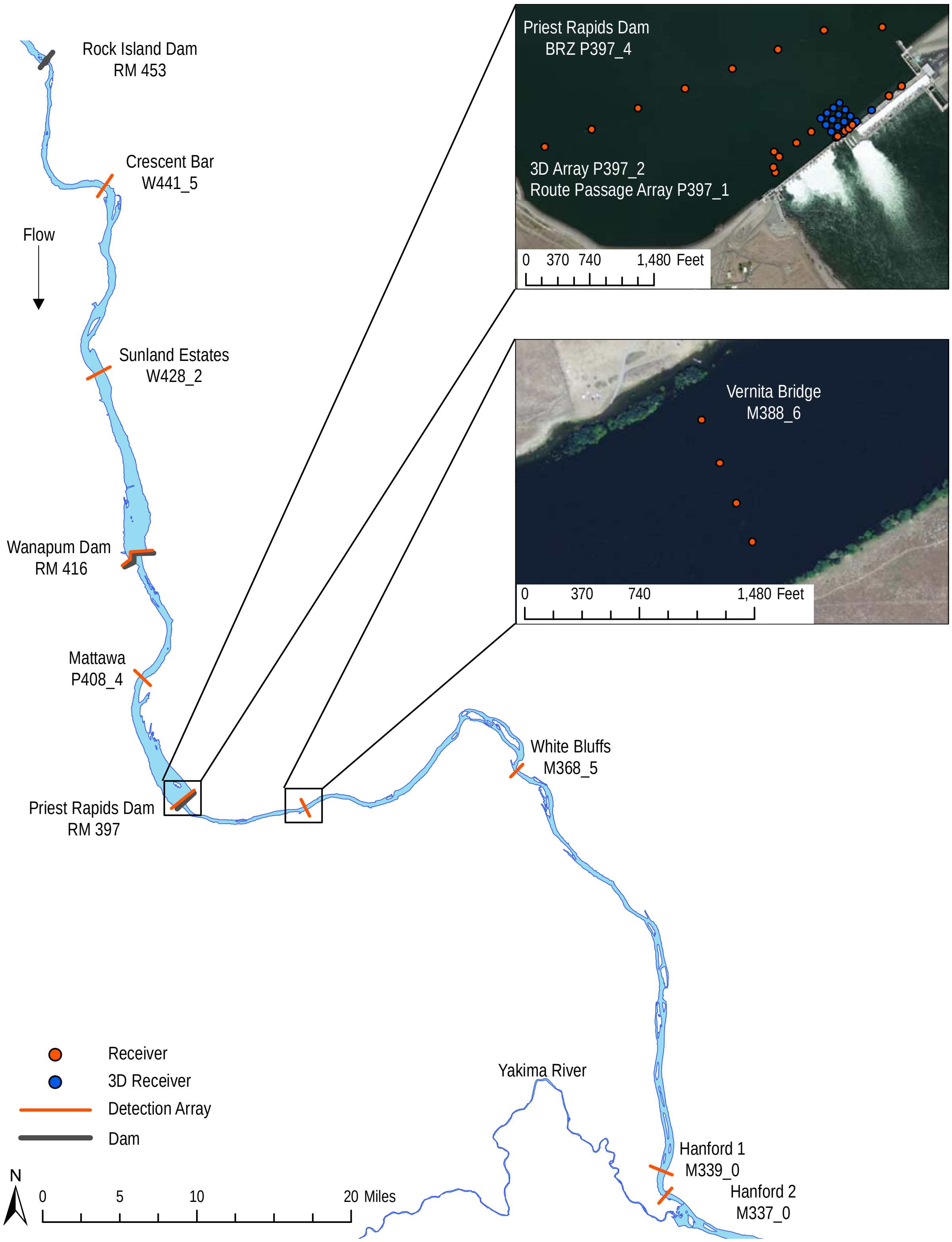

Figure A.4. Position of arrays deployed for the survival study including a detailed view of the detection array at Priest Rapids Dam and cross-river detection array at Vernita Bridge. Digital imagery of Priest Rapids Dam courtesy of Grant PUD taken in March 2014. Digital imagery of Vernita Bridge is the 2013 National Agriculture Imagery Program Mosaic for Benton County (http://datagateway.nrcs.usda.gov/gdgorder.aspx).

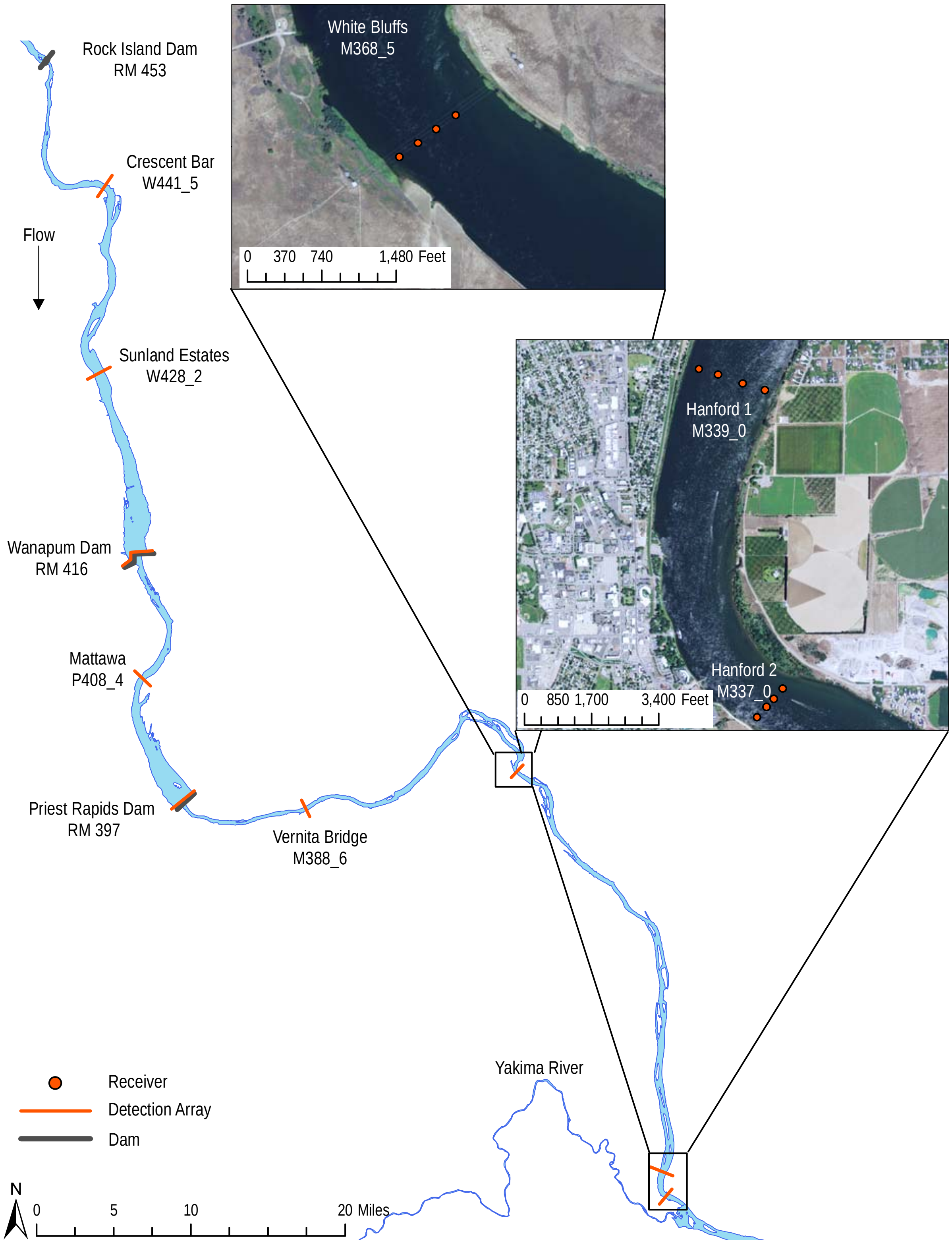

Figure A.5. Position of arrays deployed for the survival study including a detailed view of the cross-river detection array at White Bluffs, Hanford 1 and Hanford 2. Digital imagery is the 2013 National Agriculture Imagery Program Mosaic for Franklin County (http://datagateway.nrcs.usda.gov/gdgorder.aspx).

Table A.5. Summary of data collection failure events by detection array is listed with last valid detection date and time, and a brief explanation of lost data collection.

Array	System ID	Number	Receiver Location	Last Detection	Comments
Full SD Cards and Flooded Receivers					
Priest Rapids FB	P397_1A	501A	SP	5/12/2014 3:20:38 AM	SD card full
Priest Rapids FB	P397_1B	502A	SP	5/29/2014 10:41:46 PM	SD card full
Priest Rapids FB	P397_1F	506	PRFB		Flooded receiver
Priest Rapids 3D	P397_1AC	553	PRFB	5/24/2014 2:41:48 AM	Flooded receiver
Priest Rapids 3D	P397_2AA	556	SP		SD card full
Failed Receivers or SD Cards					
Priest Rapids FB	P397_1D	504	SP		Receiver malfunction
Priest Rapids FB	P397_1E	505	SP	5/11/2014 5:32:59 AM	Receiver malfunction
Priest Rapids 3D	P397_1AE[1]	568	PH		Power lost
Vernita Bridge	M388_6B	602	Vernita Bridge	Unknown	SD card unreadable
Hanford 2	M337_0B	902	Hanford 2	Unknown	SD card unreadable
Damaged/Detached Receiver					
Sunland Estates	W428_2C	203	Sunland Estates	5/27/2014 7:22:10 AM	Detached, not replaced
Wanapum FB	W416_1H	308	PH	5/28/2014 7:09:34 AM	Detached, not replaced
Wanapum FB	W416_1J	310A	PH	5/13/2014 9:28:57 PM	Detached, replaced
Wanapum FB	W416_1J	310B	PH	5/28/2014 7:02:01 AM	Detached, not replaced
Vernita Bridge	M388_6B	602	Vernita Bridge	Unknown	Detached, not replaced
White Bluffs	M368_5C	703	White Bluffs	6/3/2014 8:39:41 PM	Detached, replaced
White Bluffs	M368_5D	704	White Bluffs	5/31/2014 11:44:44 AM	Detached, not replaced
Hanford 2	M337_0A	901	Hanford 2	5/17/14 5:52:07 PM	Physical damage

[1] Receiver was cabled to the surface and wrote data files to an external hard drive.

Table A.6. Total number of valid acoustic tag detections at each detection array deployed in the study area in 2014. First and last valid acoustic detection date and time are also listed.

Detection Array	First Detection	Last Detection	Number of Detections
Crescent Bar	4/30/14 1:16:21 PM	5/27/14 5:27:00 PM	35,003
Sunland Estates	4/30/14 8:41:18 PM	5/27/14 10:41:55 PM	163,396
Wanapum BRZ	5/1/14 8:45:16 PM	5/28/14 7:04:11 AM	174,183
Wanapum Forebay	5/1/14 9:05:07 PM	5/28/14 7:12:49 AM	215,728
Mattawa	5/1/14 11:55:02 PM	6/4/14 9:18:24 PM	236,059
Priest Rapids BRZ	5/2/14 10:47:00 PM	6/1/14 11:14:15 PM	1,112,135
Priest Rapids 3D	5/2/14 10:55:30 PM	6/1/14 11:23:27 PM	1,472,805
Priest Rapids Forebay	5/2/14 10:56:38 PM	6/1/14 11:23:24 PM	2,439,699
Vernita Bridge	5/3/14 4:04:31 AM	6/3/14 4:09:09 PM	214,399
White Bluffs	5/3/14 11:29:21 AM	6/3/14 8:40:21 PM	468,503
Hanford 1	5/3/14 11:19:50 PM	6/14/14 3:18:47 PM	247,184
Hanford 2	5/3/14 11:49:01 PM	6/14/14 3:53:41 PM	173,703
		Total Number of Detections:	6,952,797

Table A.7. The 2014 PIT tag quantities of steelhead and yearling Chinook salmon detected downstream of the study area including McNary, John Day, and Bonneville dams along with an experimental estuary detection tow. Release site is in the tailrace of each dam, approximately 0.5 km downstream of each dam. The quantity of PIT tags detected was reported by PTAGIS (http://www.ptagis.org/).

Species	Release Site	McNary	John Day	Bonneville	Estuary	Total Detected
Steelhead	Rock Island	15	34	26	7	82
	Wanapum	43	44	41	13	141
	Priest Rapids	31	57	44	8	140
Yearling Chinook salmon	Rock Island	38	31	30	6	105
	Wanapum	81	61	66	3	211
	Priest Rapids	77	50	32	4	163

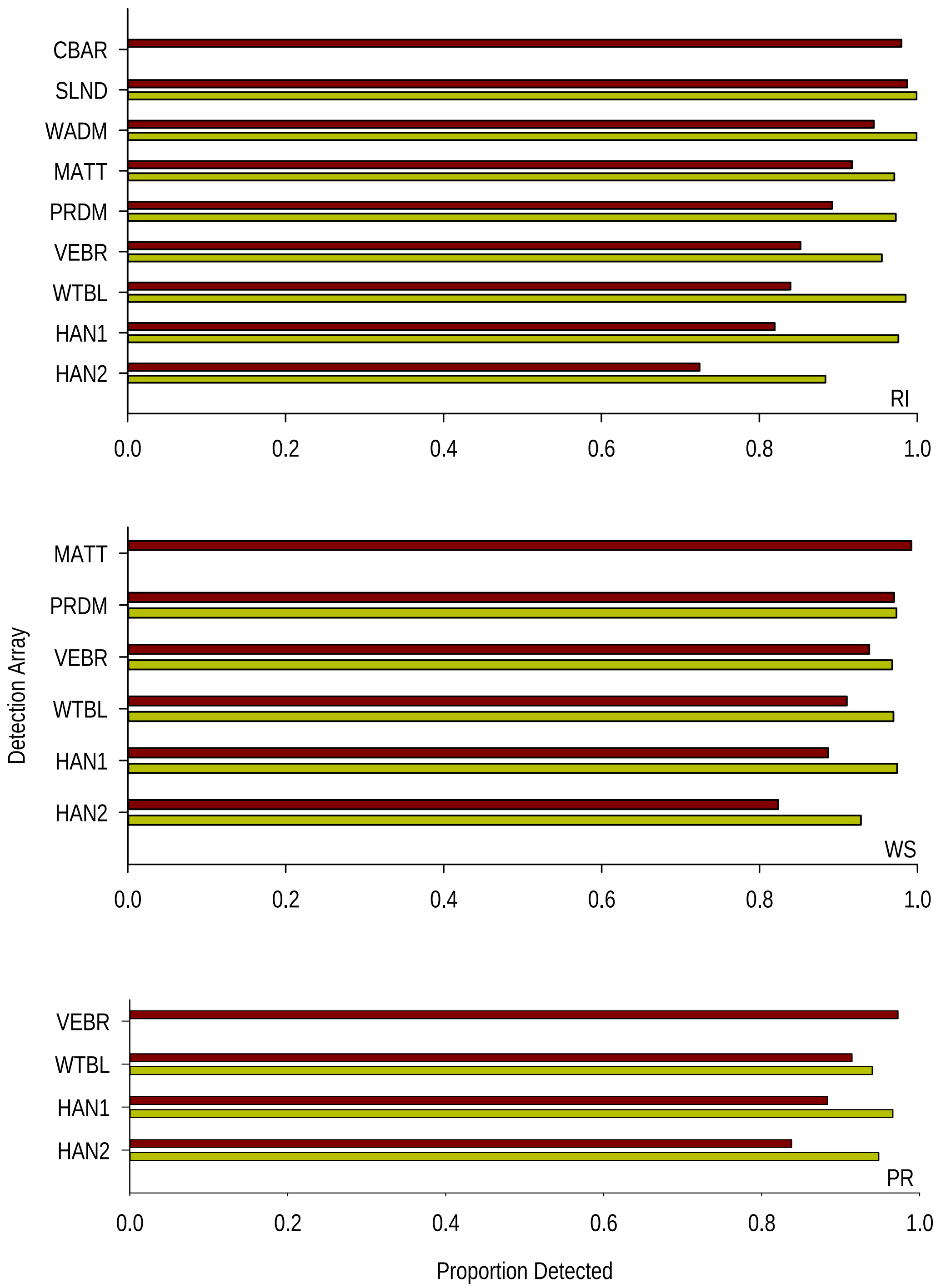

Figure A.6. The 2014 absolute detection rate of steelhead by release group (RI = Rock Island, WS = Wanapum, and PR = Priest Rapids dams). Red bars present the calculation from total released in the tailrace of each dam to each detection array, and the yellow bars present the proportion detected between arrays—the positive detection at the upstream array to the positive detection at the nearest downstream array.

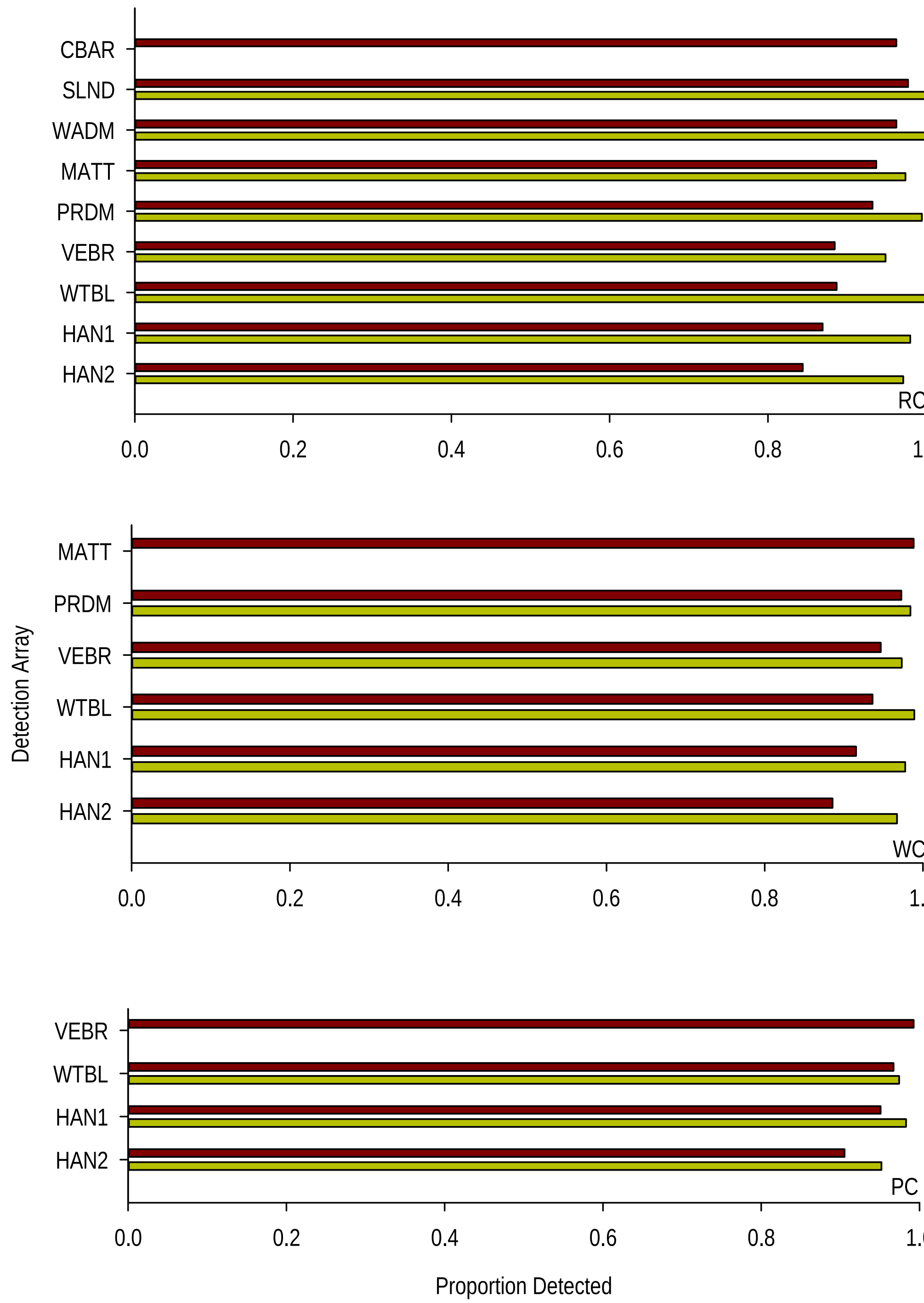

Figure A.7. The 2014 absolute detection rate of yearling Chinook salmon by release group (RC = Rock Island, WC = Wanapum, and PC = Priest Rapids dams). Red bars present the calculation from total released in the tailrace of each dam to each detection array, and the yellow bars present the proportion detected between arrays—the positive detection at the upstream array to the positive detection at the nearest downstream array.

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Appendix B

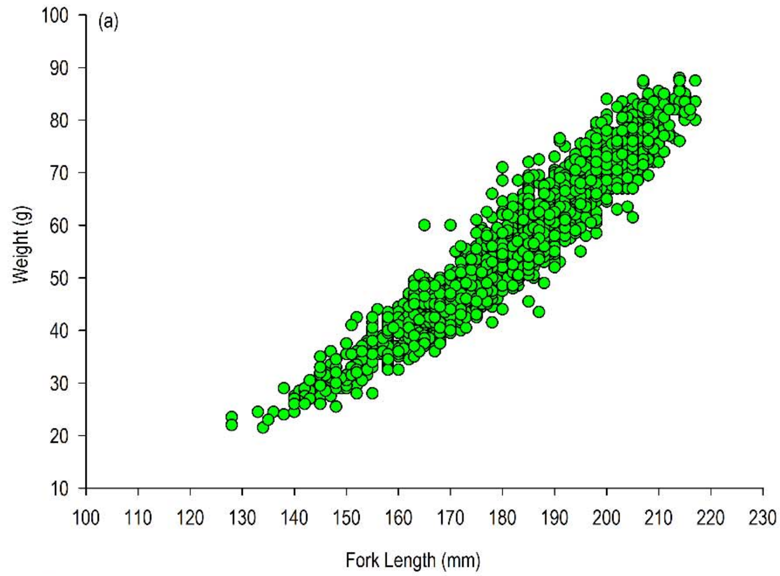
Fish Handling and Release Characteristics

List of Tables

List of Figures

Table B.1. The quantity of steelhead and yearling Chinook salmon that were collected, tagged, and released by release groups during the spring of 2014. RCO5, WC05, and PC05 were not successfully released on May 4. RI=399, WS=771, PR=550, RC=398, WC=769, and PC=549.

Release Groups and Number of Fish Released														
Steelhead						Chinook salmon						Date		
RI	n_{RI}	WS	n_{WS}	PR	n_{PR}	RC	n_{RC}	WC	n_{WC}	PC	n_{PC}	Collection	Surgery	Release
						CH RC01	18					28-Apr	29-Apr	30-Apr
						CH RC02	18					29-Apr	30-Apr	1-May
						CH RC03	18	CH WC01	27			30-Apr	1-May	2-May
						CH RC04	18	CH WC02	31	CH PC01	19	1-May	2-May	3-May
								CH WC03	32	CH PC02	20	2-May	3-May	4-May
						CH RC06	18	CH WC04	33	CH PC03	22	3-May	4-May	5-May
						CH RC07	18			CH PC04	23	4-May	5-May	6-May
ST RI01	20					CH RC08	19	CH WC06	34			5-May	6-May	7-May
ST RI02	20					CH RC09	17	CH WC07	35	CH PC06	24	6-May	7-May	8-May
ST RI03	20	ST WS01	29			CH RC10	20	CH WC08	40	CH PC07	25	7-May	8-May	9-May
ST RI04	20	ST WS02	32	ST PR01	22	CH RC11	20	CH WC09	41	CH PC08	28	8-May	9-May	10-May
ST RI05	20	ST WS03	34	ST PR02	23	CH RC12	20	CH WC10	43	CH PC09	28	9-May	10-May	11-May
ST RI06	20	ST WS04	35	ST PR03	23	CH RC13	20	CH WC11	44	CH PC10	31	10-May	11-May	12-May
ST RI07	21	ST WS05	37	ST PR04	25	CH RC14	20	CH WC12	43	CH PC11	32	11-May	12-May	13-May
ST RI08	21	ST WS06	40	ST PR05	26	CH RC15	20	CH WC13	43	CH PC12	32	12-May	13-May	14-May
ST RI09	21	ST WS07	42	ST PR06	27	CH RC16	20	CH WC14	40	CH PC13	31	13-May	14-May	15-May
ST RI10	22	ST WS08	45	ST PR07	28	CH RC17	19	CH WC15	39	CH PC14	30	14-May	15-May	16-May
												15-May	16-May	17-May
ST RI11/12	44	ST WS09/10	99	ST PR08/09	63	CH RC18/19	38	CH WC16/17	75	CH PC15/16	57	16-May	17-May	18-May
ST RI13	22	ST WS11	53	ST PR10	33	CH RC20	19	CH WC18	36	CH PC17	27	17-May	18-May	19-May
ST RI14	22	ST WS12	49	ST PR11	35	CH RC21	19	CH WC19	35	CH PC18	27	18-May	19-May	20-May
ST RI15	22	ST WS13	45	ST PR12	35	CH RC22	19	CH WC20	33	CH PC19	25	19-May	20-May	21-May
ST RI16	22	ST WS14	42	ST PR13	33			CH WC21	31	CH PC20	23	20-May	21-May	22-May
ST RI17	21	ST WS15	43	ST PR14	32			CH WC22	34	CH PC21	24	21-May	22-May	23-May
ST RI18	20	ST WS16	42	ST PR15	32					CH PC22	21	22-May	23-May	24-May
ST RI19	21	ST WS17	38	ST PR16	31							23-May	24-May	25-May
		ST WS18	34	ST PR17	29							24-May	25-May	26-May
		ST WS19	32	ST PR18	27							25-May	26-May	27-May
				ST PR19	26							26-May	27-May	28-May



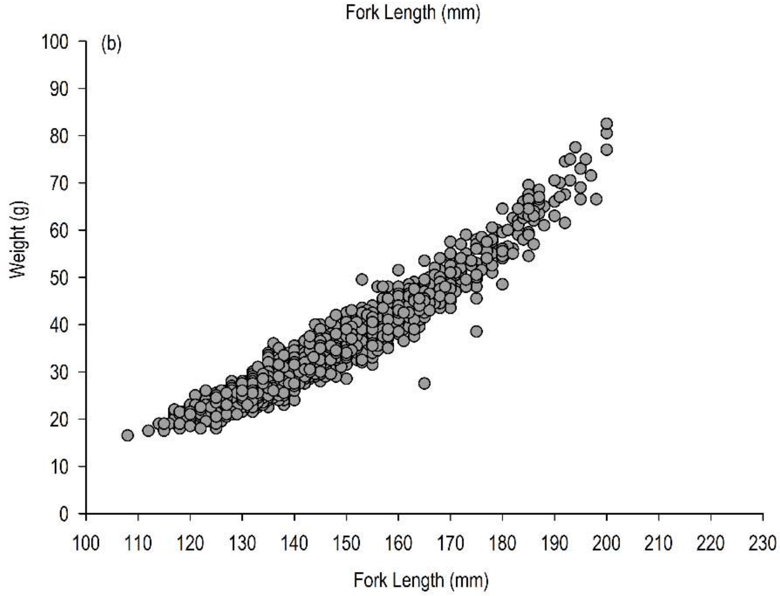


Figure B.1. Size distribution of tagged (a) steelhead (n=1,720, green) and (b) yearling Chinook salmon (n=1,716, gray) released for the 2014 Grant PUD survival and behavioral analyses.

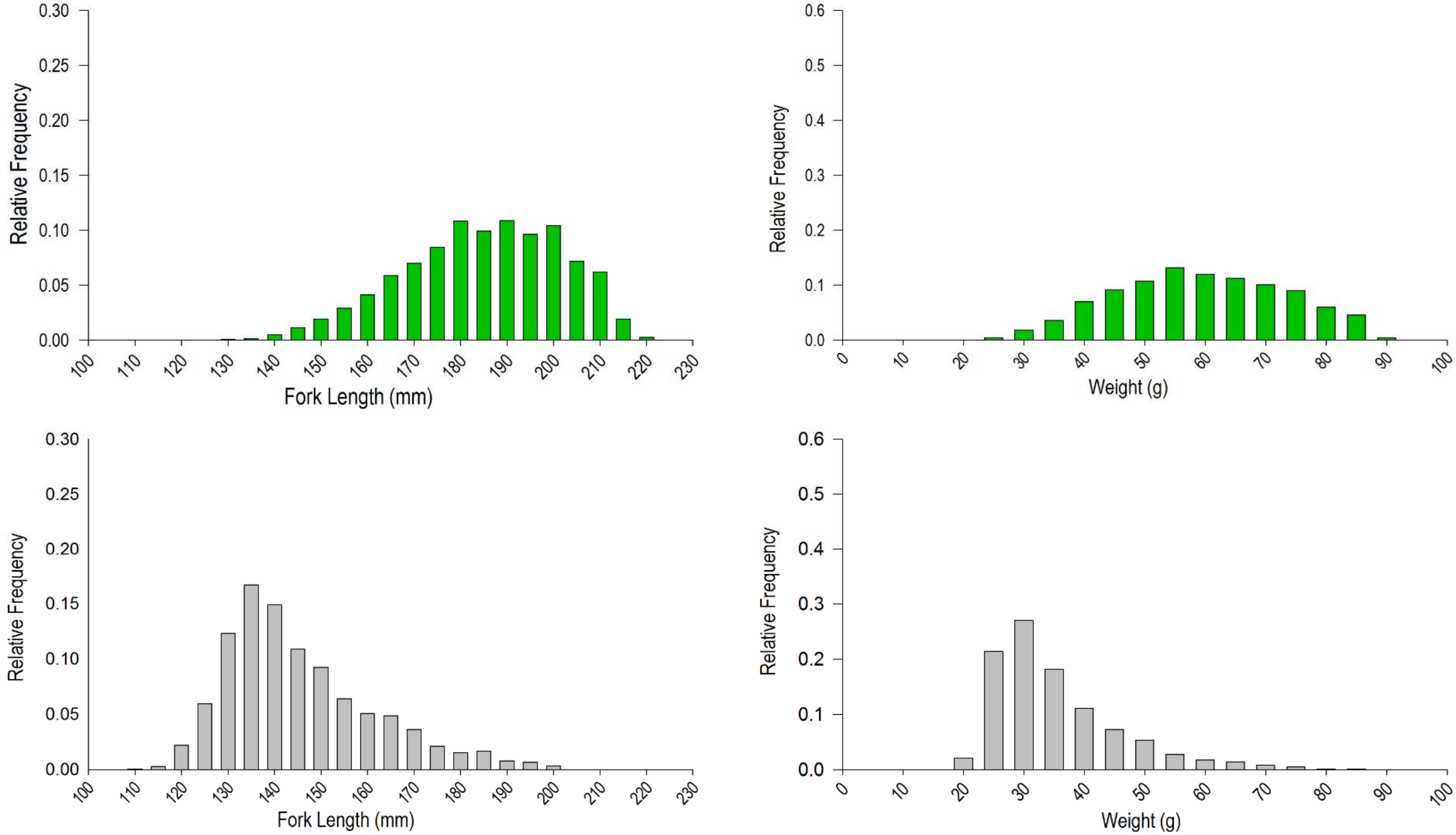


Figure B.2. Relative frequency of length and weight of tagged steelhead (shown in green, n=1,720) and yearling Chinook salmon (shown in grey, n=1,716) released in the 2014 Grant PUD survival and behavioral analyses. The fork length in millimeters of (a) steelhead and (c) yearling Chinook salmon as well as the weight in grams of (b) steelhead and (d) yearling Chinook salmon are shown above. The median steelhead fork length was 184 mm (range 128.0-217.0 mm) and weight was 57.0 g (range 21.5-88.0 g). The median yearling Chinook salmon fork length was 140 mm (range 108.0-200.0 mm) and weight was 30 g (range 16.5-82.5 g).

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Appendix C

Migration Rates and Forebay Residence Times

List of Tables

Table C.1. Summary of 2014 median migration rates (measured in hours) for all release groups listed by species (steelhead and yearling Chinook salmon) and independent reach. Median travel times were measured from either the time of release (in the tailrace of each dam) or last detection at the previous array, to the first detection at the next downstream array. Cumulative travel times, measured from the time of release to first detection at a given array, are indicated in parenthesis. Fish entrained in the gatewells were not included in this measurement.

		Detection Arrays							
Species	Release Site	CBAR	SNLD	WADM	MATT	PRDM	VEBR	WTBL	HAN
Steelhead	Rock Island Dam	3.2	6.0 (9.2)	11.5 (20.7)	2.5 (23.2)	13.7 (36.9)	1.8 (38.7)	4.4 (43.1)	8.0 (51.1)
	Wanapum Dam				3.0	12.7 (15.7)	1.8 (17.5)	4.4 (21.9)	8.7 (30.6)
	Priest Rapids Dam						1.9	7.4 (9.3)	8.7 (18.0)
Yearling Chinook salmon	Rock Island Dam	5.0	12.0 (17.0)	24.5 (41.5)	2.9 (44.4)	20.4 (64.8)	1.9 (66.7)	5.2 (71.9)	17.2 (89.1)
	Wanapum Dam				3.6	26.4 (30.0)	1.9 (31.9)	5.9 (37.8)	19.7 (57.5)
	Priest Rapids Dam						2.1	10.2 (12.3)	20.7 (33.0)

Table C.2. Annual median migration rates (measured in hours) for all release groups listed by species, reach and study year. Median travel times were measured from either the time of release or last detection at the previous array to the first detection at the next downstream detection array. Yearling Chinook salmon travel data from 2009-2010 were sourced from Chelan County PUD memorandum 2012 (O'Connor 2012 Memo), while all steelhead and remaining yearling Chinook salmon data were taken from 2006-2011 GCPUD acoustic survival reports (Timko; Sullivan; Thompson et al. 2006-2012). Fish entrained in the gatewells were not included in this analysis.

Species	Year	WADM	MATT	PRDM	VEBR	WTBL	HAN
Steelhead	2014	20.7	2.8	13.2	1.8	5.4	8.5
	2011		3.6	9.8			
	2010	60.7	2.7	24.6	2.1		
	2009	61.1	2.7	23.1	2.2		
	2008	39	2.2	13.2	1.9		
	2007	47.5	2.6	16	2		
	2006	50.1	3	12.6	2.4		
Yearling Chinook salmon	2014	41.5	3.3	23.4	2.0	7.1	19.2
	2010		2.9	21.1	2.2		
	2009		3.1	24.2	2.2		
	2008		2.1	17.1	1.9		
	2007		4	24	1.9		
	2006		3.2	14.4	1.9		

Table C.3. Annual median migration rates (measured in hours) of steelhead and yearling Chinook salmon from Wanapum Dam to each detection array by passage route. Yearling Chinook salmon were not monitored at Wanapum Dam during 2006-2011 acoustic studies. Furthermore, there were no steelhead detected passing through the Wanapum Dam spillway in 2009 or 2010.

		Powerhouse		WFB		Spillway	
Species	Year	MATT	PRDM	MATT	PRDM	MATT	PRDM
Steelhead	2014	2.8	16.1	2.4	11.6	2.2	14.7
	2010	3	24.5	2.4	25		
	2009	3.2	23	2.5	22.1		
	2008	2.5	15.6	2.1	13.9	2.1	9.1
	2007	2.8	16.2			2.3	16.9
Yearling Chinook salmon	2014	3.1	23.4	3.1	15.0	2.5	19.6
	2008	2.3	18.5	2.2	18.2	1.8	12.7

Table C.4. Annual median migration rates (measured in hours) of steelhead and yearling Chinook salmon (referenced below as Chinook) from Priest Rapids Dam to each detection array are presented by passage route. There was only one steelhead detected passing through the Priest Rapids Dam spillway in 2009 and 2010 and there is no yearling Chinook salmon passage data available for 2009 or 2010.

		Powerhouse				PRFB				Spillway			
Species	Year	VEBR	RING	WTBL	HAN	VEBR	RING	WTBL	HAN	VEBR	RING	WTBL	HAN
Steelhead	2014	1.9		4.5	8.6	1.7		4.4	8.3	1.9		4.4	8.9
	2010	2.1	7.1			2.1	6.9			2.3	6.2		
	2009	2.2	7.3			2.2	7.5			2.0	6.5		
	2008	1.9	6.5			1.8	6.5			1.8	6.4		
	2007	2.0	6.4			2.0	6.4			5.6	8.0		
Chinook	2014	2.0		5.4	20.4	1.9		5.7	18.7	2.0		5.3	17.9
	2008	1.9	6.8			1.9	6.8			1.8	6.3		

Table C.5. Annual comparison of median residence times (in minutes) for steelhead and yearling Chinook salmon at Crescent Bar, Sunland, Mattawa, Vernita Bridge, White Bluffs, and Hanford detection arrays. Data in these locations was not collected for yearling Chinook salmon in previous years, while steelhead data was collected in only a subset of these locations in 2008-2010.

Species	Year	CBAR	SLND	MATT	VEBR	WTBL	HAN
Steelhead	2014	84	372	180	102	156	174
	2010			180	216		
	2009			288	288		
	2008			324	180		
Yearling Chinook salmon	2014	90	468	216	120	174	192

Table C.6. Annual median forebay residence times at Wanapum Dam (in minutes) for steelhead and yearling Chinook salmon. The 2014 residence times were quantified in two ways: 1) BRZ Residence Time (BRZ), the time elapsed between the first detection at the BRZ and the last detection in the Wanapum forebay, and 2) Forebay Residence Time (Forebay), the time elapsed between the first and last detection on only those receivers in the immediate Wanapum forebay. The second approach is the most similar to historical measurements although not equivalent due to differing technology and array placement. Fish entrained in the gatewells, last detected with net upstream movement, or with unknown passage route were excluded from forebay residence time analyses.

Species	Year	All Routes	Powerhouse	Bypass	Spillway
Steelhead	2014[BRZ]	28.5	14.8	46.6	44.0
	2014[Forebay]	8.1	3.0	15.6	20.4
	2010	144.6	289.2	121.8	
	2009	80.4	43.8	87.0	
	2008	30.0	10.2	58.2	18.0
	2007	29.4	27.0		61.2
	2006	26.4	22.8		49.8
Yearling Chinook salmon	2014[BRZ]	20.3	15.2	24.4	37.1
	2014[Forebay]	3.6	1.8	9.0	12.0
	2008	0.2	14.4	14.4	14.4

Table C.7. Annual median forebay residence times at Priest Rapids Dam (in minutes) for steelhead and yearling Chinook salmon. The 2014 residence times were quantified in two ways: 1) BRZ Residence Time (BRZ), the time elapsed between the first detection at the BRZ and the last detection in the Wanapum forebay, and 2) Forebay Residence Time (Forebay), the time elapsed between the first and last detection on only those receivers in the immediate Priest Rapids forebay. The second approach is the most similar to historical measurements although not equivalent due to differing technology and array placement. Fish entrained in the gatewells, last detected with net upstream movement, or with unknown passage route were excluded from forebay residence time analyses.

Species	Year	All Routes	Powerhouse	Bypass/Top-Spill	Spillway
Steelhead	2014[BRZ]	43.2	32.4	52.7	40.9
	2014[Forebay]	8.1	7.8	12.6	6.0
	2010	91.8	52.8	147.0	21,322.8[2]
	2009	57.6	45.6	42.6	44.4
	2008	14.4	13.2	13.2	10.2
	2007	20.4	19.8	22.2	9.6
	2006	19.8	19.8	40.8	7.8
Yearling Chinook salmon	2014[BRZ]	42.8	44.5	47.5	40.6
	2014[Forebay]	6.7	8.4	7.8	4.2
	2008	13.8	12.6	15.6	13.8
	2007	16.8	16.2	21.0	9.0
	2006	18.0	19.2	30.6	9.0

[2]In 2010, one acoustic-tagged steelhead was last detected at the spillway after spending 14.8 days in the forebay (tag code 4566.21, release group WS14), first detected on 5/25/2010 7:56:35 – 6/9/2010 3:19:28. The tag was detected downstream at Vernita Bridge (6/9/2010 5:36:46 am) and Ringold (6/9/2010 11:52:02). Migration rates between sites fit typical egress for juvenile steelhead and did not exhibit typical predation suspected detection histories; the tagged fish is an outlier but could not excluded from the data set.

Appendix D

Passage Route Efficiency, Zone Entrance Efficiency, and Fish Collection Efficiency

The passage route efficiency (PRE) at Wanapum and Priest Rapids dams are listed in Tables F.1 and F.2, respectively, (2006-2010 and 2014). Zone entrance efficiency (ZEE) at the Wanapum Dam Fish Bypass (WFB) and Priest Rapids Dam Fish Bypass (PRFB) are shown in Table F.3. Fish collection efficiency (FCE) at Wanapum Dam and Priest Rapids Dam are listed in Tables F.4 and F.5, respectively (2006-2010 and 2014). All tables have data segregated by species.

List of Tables

Table D.1. The passage route efficiencies (PRE) of downstream migrant steelhead through Wanapum Dam in 2014 are shown below with 2006-2010 results for comparison (*from* Timko et al. 2011)[3]. At each dam, powerhouse passage includes fish that were entrained in the gatewells. Passage events that could not be identified or fish last detected with upstream movement were not included in PRE estimates. In 2006-2007, a prototype fish bypass was used for surface passage of smolts at the sluiceway along with a top-spill bulkhead at Spill Bay 12.

Year	Passage Route	n_i	n_{total}	PRE_i
Wanapum Dam				
2014	Powerhouse	162	362	44.8%
	Fish Bypass	36	362	9.9%
	Spillway	164	362	45.3%
	Non-Turbine Passage	*200*		*55.2%*
2010	Powerhouse	128	563	22.7%
	Fish Bypass	435	563	77.3%
	Spillway	0	563	0.0%
2009	Powerhouse	218	731	29.8%
	Fish Bypass	513	731	70.2%
	Spillway	0	731	0.0%
2008	Powerhouse	179	550	32.5%
	Fish Bypass	300	550	54.5%
	Spillway	71	550	12.9%
2007	Powerhouse	749	1135	66.0%
	Top-Spill (SB12)/Sluiceway	305	1135	26.9%
	Spillway	81	1135	7.1%
2006	Powerhouse	150	319	47.0%
	Top-Spill (SB12)/Sluiceway	116	319	36.4%
	Spillway	53	319	16.6%

[3] Analysis has been refined thus numbers reported in this table differ slightly than reported in prior years (Timko et al. 2011).

Table D.2. The passage route efficiencies (PRE) of downstream migrant steelhead through Priest Rapids Dam in 2014 are shown below with 2006-2010 results for comparison (*from* Timko et al. 2011)[4]. At each dam, powerhouse passage includes fish that were entrained in the gatewells. Passage events that could not be identified or fish last detected with upstream movement were not included in PRE estimates.

Year	Passage Route	n_i	n_{total}	PRE_i
Priest Rapids Dam				
2014	Powerhouse	332	1075	30.9%
	Fish Bypass	507	1075	47.2%
	Spillway	236	1075	22.0%
	Non-Turbine Passage	*743*		*69.1%*
2010	Powerhouse	469	1105	42.4%
	Top-Spill Prototype Bypass	635	1105	57.5%
	Spillway	1	1105	0.1%
2009	Powerhouse	612	1254	48.8%
	Top-Spill Prototype Bypass	641	1254	51.1%
	Spillway	1	1254	0.1%
2008	Powerhouse	607	1062	57.2%
	Top-Spill Prototype Bypass	370	1062	34.8%
	Spillway	85	1062	8.0%
2007	Powerhouse	785	976	80.4%
	Top-Spill Prototype Bypass	187	976	19.2%
	Spillway	4	976	0.4%
2006	Powerhouse	446	610	73.1%
	Top-Spill Prototype Bypass	95	610	15.6%
	Spillway	69	610	11.3%

[4] Analysis has been refined thus numbers reported in this table differ slightly than reported in prior years (Timko et al. 2011).

Table D.3. The passage route efficiencies (PRE) of downstream migrant yearling Chinook salmon through Wanapum and Priest Rapids dams in 2014 are shown below with 2006-2010 results for comparison (*from* Sullivan et al. 2009)[5]. At each dam, powerhouse passage includes fish that were entrained in the gatewells. Passage events that could not be identified or fish last detected with upstream movement were not included in PRE estimates.

Year	Passage Route	n_i	n_{total}	PRE_i
Wanapum Dam				
2014	Powerhouse	234	361	65.0%
	Fish Bypass	27	361	7.5%
	Spillway	99	361	27.5%
	Non-Turbine Passage	*126*		*35.0%*
2008	Powerhouse	455	984	46.2%
	Fish Bypass	290	984	29.5%
	Spillway	239	984	24.3%
Priest Rapids Dam				
2014	Powerhouse	380	1088	34.9%
	Fish Bypass	415	1088	38.1%
	Spillway	293	1088	26.9%
	Non-Turbine Passage	*708*		*65.1%*
2008	Powerhouse	600	898	66.8%
	Top-Spill Prototype Bypass	219	898	24.4%
	Spillway	79	898	8.8%
2007	Powerhouse	738	853	86.5%
	Top-Spill Prototype Bypass	110	853	12.9%
	Spillway	5	853	0.6%
2006	Powerhouse	326	458	71.2%
	Top-Spill Prototype Bypass	57	458	12.4%
	Spillway	75	458	16.4%

[5] Analysis has been refined thus numbers reported in this table differ slightly than reported in prior years (Sullivan et al.2009; Timko et al. 2010, 2011).

Table D.4. The percent zone of entrance efficiency (ZEE) of the Priest Rapids Dam Fish Bypass (2014) and top-spill configuration (2006-2010) for steelhead and yearling Chinook salmon.

Year	Steelhead	Yearling Chinook salmon
2014	72.50%	65.20%
2010	77.80%	
2009	71.50%	
2008	41.60%	39.10%
2007	42.20%	27.10%
2006	39.60%	36.90%

Table D.5. Fish collection efficiency (FCE) of steelhead and yearling Chinook salmon smolts at the Priest Rapids Dam Fish bypass (2014) and top-spill configuration (2006-2010). The collection zone in 2008-2010 was defined as the radius extending 300 ft from the center of the top-spill configuration (at the junction of Spill Bay gates 20 and 21). The top-spill configuration included the prototype top-spill bulkhead at Spill bays 19 and 20 along with Tainter gates 21 and 22, sluiceway (top-spill in 2008-2009, bottom-spill in 2010). In 2006-2007, the collection zone was defined as the radius extending 300 ft from the center of the prototype top-spill bulkhead (at the junction of Spill Bay gates 19 and 20).

Collection Zone (ft)	2014	2010	2009	2008	2007	2006
Steelhead						
50	98.1%	98.0%	99.8%	100.0%	97.9%	97.3%
100	88.9%	88.3%	94.3%	94.9%	87.6%	81.3%
150	77.3%	83.0%	85.9%	87.6%	69.5%	63.1%
200	69.8%	77.1%	77.4%	77.2%	50.9%	52.9%
250	65.4%	72.8%	70.9%	67.4%	40.8%	44.8%
300	64.0%	68.9%	66.0%	58.9%	33.7%	39.4%
Yearling Chinook salmon						
50				100.0%	97.1%	93.4%
100				81.3%	75.6%	82.6%
150				55.6%	57.6%	57.0%
200				43.1%	45.0%	46.0%
250				36.7%	36.2%	38.5%
300				31.1%	29.3%	32.9%

Fish - mode is an operational scheme that is programmed into the turbine unit control system at each control room of WAN and PRD

Fish-mode was implemented at Wanapum Dam in 1997, following balloon-tag testing at the dam

Fish-mode was implemented at Priest Rapids Dam in 2005, following balloon-tag testing at PRD

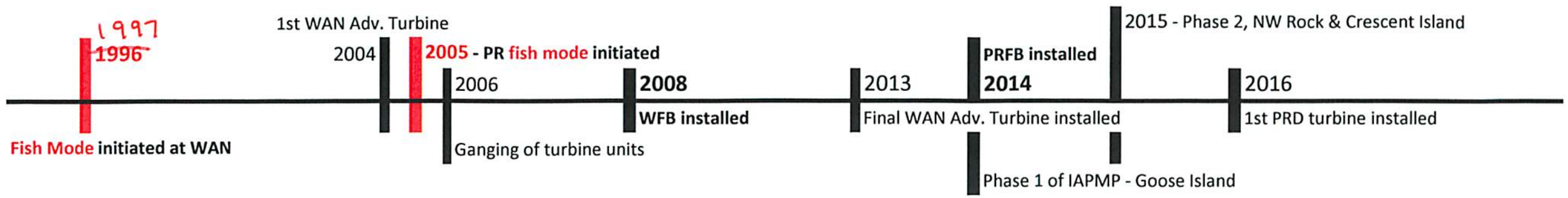
Flow range of a Priest Rapids turbine is up to approx. 18.2 kcfs

- Fish-mode flow range at Priest Rapids is 11.2 - 17.5 kcfs

Flow range of a Wanapum turbine is approx. 18.8 kcfs

- Fish-mode flow range at Wanapum is 11.8 - 15.7 kcfs

Fish Passage Advancements at the Priest Rapids Project:



	WAN - 2014*		WAN - 2010		WAN - 2009		WAN - 2008	
	Steelhead		Steelhead		Steelhead		Steelhead	
	FPE	survival rate	FPE	survival rate	FPE	survival rate	FPE	survival rate
Powerhouse:	40.3%	94.1%	21.1%	91.4%	27.8%	92.9%	32.5%	
Bypass:	9.5%	100%	78.9%	98.9%	72.2%	99.0%	54.5%	
Spillway:	43.5%	99.4%	0.0%	n/a	0.0%	n/a	12.9%	
Total Dam:		97.1% (97.8%)		97.3% (100%)		97.3% (100%)		96.5% (100%)
Total Development:		.(92.9%)		.(85.5%)		.(94.4%)		.(95.8%)

	PRD - 2014		PRD - 2010*		PRD - 2009*		PRD - 2008*	
	Steelhead		Steelhead		Steelhead		Steelhead	
	FPE	survival rate	FPE	survival rate	FPE	survival rate	FPE	survival rate
Powerhouse:	25.1%	93.8%	39.3%	94.9%	44.5%	92.9%	57.2%	
Bypass:	46.1%	99.6%	60.6%	97.9%	55.4%	97.5%	34.8%	
Spillway:	21.5%	97.0%	0.1%	100%	0.1%	100%	8.0%	
Total Dam:		97.1% (98.5%)		96.7% (99.7%)		n/a% (98.3%)		91.8% (95.2%)
Total Development:		.(96.1%)		.(90.4%)		.(88.1%)		.(86.4%)
PR Project:		**89.3%**		**77.3%**		**83.1%**		**82.8%**

		WAN - 2014*		WAN - 2010		
		Steelhead		Steelhead		
		FPE	survival rate	FPE	survival rate	
Powerhouse:		40.3%	94.1%	21.1%	91.4%	
fish-mode "on"				10.6%	91.4%	
fish-mode "off"				10.6%	*88.4%	* = 3% decrease in tur
				10.6%	*86.4%	* = 5% decrease in tur
				10.6%	*81.4%	* =10% decrease in tu
Bypass:	20 kcfs	9.5%	100%	78.9%	98.9%	
	15 kcfs					
Spillway:		43.5%	99.4%	0.0%	n/a	
Total Dam:			97.1% (97.8%)		97.3% (100%)	
					97.1%	{0.23% decrease in da
					96.9%	{ 0.44% decrease in da
					96.3%	{ 0.97% decrease in da
Total Development:			.(92.9%)		.(85.5%)	

	PRD - 2014			PRD - 2010*	
	Steelhead			Steelhead	
	FPE	survival rate		FPE	survival rate
Powerhouse:	25.1%	93.8%		39.3%	94.9%
fish-mode "on"	12.1%	93.8%			
fish-mode "off"	12.1%	*90.8%	* = 3% decrease in turbine passage survival		
	12.1%	*88.8%	* = 5% decrease in turbine passage survival		
	12.1%	*83.8%	* =10% decrease in turbine passage survival		
Bypass:	46.1%	99.6%		60.6%	97.9%
Spillway:	21.5%	97.0%		0.1%	100%
Total Dam:		97.1% (98.5%)			96.7% (99.7%)
		95.9%	{1.20% decrease in dam survival}		
		95.7%	{ 1.45% decrease in dam survival}		
		95.1%	{ 2.05% decrease in dam survival}		
Total Development:		.(96.1%)			.(90.4%)
PR Project:		**89.3%**			**77.3%**
		86.2%			
		85.8%			
		84.7%			

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Curtis Dotson

From:	Allen Evans <allen@realtimeresearch.com>
Sent:	Saturday, January 24, 2015 8:03 AM
To:	Curtis Dotson
Subject:	RE: Hanford PIT Tagging Summary and Tag Files
Attachments:	GCPUD_HAN_13W_2014_Cumulative Avian Predation.xlsx

Hi Curt - Attached please find an estimate of avian predation rates by 14 different piscivorous waterbird colonies on subyearling Chinook released into the Hanford Reach in June of 2014. These calculations were made possible by funding from GPUD/PRCC as part of the JSATS predation study approved in June. We had the R code prepped and ready to go, so it was not big deal to run the numbers. If you feel like these data are of use to your efforts, we could write up a brief describe of the methods. I recall Leah saying that mortality of subyearling Chinook in McNary Reservoir was high but I'm not sure if these data shed light on the subject or not.

Finally, results indicate that avian predation rates differ significantly by salmonid species/population and avian colony. For instance, predation rates on subyearling Chinook we significantly higher by American white pelicans on Badger Island and double-crested cormorant on Foundation Island than they were on juvenile steelhead and yearling Chinook released from Rock Island Dam (RIS), yet over-all impacts (all 14 colonies combined) were higher on steelhead (36%) and yearling Chinook (12%), due largely as a result of higher predation impacts by gull and tern colonies on steelhead and yearling Chinook. Data, including a complete write up of methods and results, on RIS released steelhead and yearling Chinook in 2014 will be included in our Annual Report, which will be submitting in the coming days.

Let me know if you have any question about this ancillary predation rate calculation.

Cheers for now,

Allen

From: Curtis Dotson [mailto:Cdotson@gcpud.org]
Sent: Tuesday, June 10, 2014 8:54 AM
To: Allen Evans
Subject: FW: Hanford PIT Tagging Summary and Tag Files

Good Morning Allen,

Here is some additional summary information on those PIT-tagged sub-yearlings I mentioned at the PRCC last week – as they relate to another group of tagged fish that might show up on one of the avian colonies.

Curt.

From: Leah Sullivan [mailto:lsullivan@blueleafenviro.com]
Sent: Monday, June 09, 2014 9:40 PM
To: Curtis Dotson
Cc: Mark Timko; Jeffrey K. Fryer Ph. D.; Ryan Richmond
Subject: FW: Hanford PIT Tagging Summary and Tag Files

In Curt,

Please find attached the information delivered by Biomark (Ryan Richmond) today that summarizes the fish handling in the Hanford Reach (see excel spreadsheet - tagging, release, pre-release mortality rates, fish length characteristics, etc.)

Cumulative estimated predation rates (95% credible interval) on wild PIT-tagged subyearling Chinook released into the Hanford Reach (middle Columbia River) by 14 different piscivorous waterbird colonies in the Columbia River Basin in 2014. Predation rates were adjusted to account for tag loss due to on-colony PIT tag detection and deposition probabilities (see Hostetter et al. In press). Predation rates were calculated based on the number of fish available (n) released into the Hanford Reach and were thus not adjusted for survival to the vicinity of the downstream colony.

Reach	Location	Colony[1]	RKM	Subyearling Fall Chinook (n=9,940)		
McNary	Twinning Island	CATE	Off-river	<0.1%		
	Goose Island (NW Rocks)	CATE	Off-river	<0.1%		
	Island 20	Gulls	545	0.5% (0.2-1.0)		
	Foundation Island	DCCO	518	3.3% (1.9-6.2)		
	Badger Island	AWPE[2]	512	1.5% (1.2-1.9)	2.9% (2.1-3.9)	0.53 (0.47-0.60) Deposition rate applied based on research in ID
	Crescent Island	CATE	510	0.4% (0.3-0.7)		
		Gulls	510	0.3% (0.1-0.8)		
	Blalock Islands (Anvil Is.)	CATE	441	0.2% (0.1-0.3)		
John Day		Gulls	441	<0.1%		
	Blalock Islands (Straight Six Is.)	Gulls	439	<0.1%		
The Dalles	Miller Rocks Island	Gulls	331	1.0% (0.5-1.8)		
	East Sand Island	CATE	8	0.3% (0.2-0.6)		
Estuary		BRAC	8	<0.1%		
		DCCO	8	0.3% (0.2-0.6)		
Total				8.2% (6.3-11.1)	9.5% (7.6-12.6)	

[1] CATE = Caspian tern; DCCO = double-crested cormorant; BRAC = Brandt's cormorant; GULLS = ring-billed and California gulls; AWPE = American white pelican

[2] Predation rates by American white pelicans were not adjusted for deposition rate due to lack of empirical data and should be considered minimum estimates.

From:	Tom Skiles
To:	Alyssa Buck; Debbie Williams; Denny Rohr; Jim_L_Craig@fws.gov; Tom Dresser; carmen.andonaegui@dfw.wa.gov; Curtis Dotson; jeff.korth@dfw.wa.gov; justin.yeager@noaa.gov; kirk.truscott@colvilletribes.com; melissarohr76@gmail.com; Orlene Hahn; patrick.verhey@dfw.wa.gov; rosb@yakamafish-nsn.gov; scott.carlon@noaa.gov
Subject:	Re: Fwd: Wanapum Future Unit Bypass
Date:	Monday, May 18, 2015 2:14:54 PM
Attachments:	ATT00001 ATT00002

I just had a helpful conversation with Curt about this and he suggested that I take a look at the 1-hr time step data and account for the change in flow operations, which occur at 10am every third day, not at midnight. Making that adjustment may change these histograms quite a bit.

As well, he also explained the operational relationship between forebay elevation and spill.

Standby…

Tom D. Skiles

Fish Passage Specialist

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>>> Denny Rohr <drohr5@aol.com> 5/18/2015 2:01 PM >>>

PRCC:

Please see information and analysis below from Tom S regarding the WFB testing. This subject is an agenda item and will be discussed at our May 27th PRCC meeting, and including Tom's information below. Please contact Tom directly with questions and/or comments, and let me know if there is anything I can do to help as well.

Thanks for sending, Tom.

--Denny

Dennis E. Rohr
DRohr & Associates, Inc.
PO Box 65
Fox Island, WA. 98333

253.279.3330 - cell
253.549.4370 - office
253.549.4371 - fax

-----Original Message-----
From: Tom Skiles <skit@critfc.org>
To: Denny Rohr <drohr5@aol.com>
Cc: Brent Hall <brenthall@ctuir.org>; Carl Merkle <carlmerkle@ctuir.org>; Mike Matylewich <MATM@critfc.org>
Sent: Mon, May 18, 2015 1:09 pm
Subject: Wanapum Future Unit Bypass

Hi Denny,
Can you share this with the PRCC?

Hi Folks-

I decided to check-in and see how Grant was doing with their Wanapum Future Unit Bypass spill test (see the two figures below). I took a look at COE data and summarized it in two figures (actually, I sliced it and diced it in a bunch of different ways). The figures below are very similar. The upper figure has histogram bars for turbine generation flow (light blue) and the one below does not. The red bars represent the three-day blocks that the WFUB should be at 15kcfs and the darker blue bars are the three-day blocks at 20kcfs or above. As you can see, there is a lot of variation, which perhaps illustrates the challenge that Grant has hitting the agreed upon flow targets. There are some caveats with these figures (e.g. these are daily averages), but I hope they serve to inform the committee, to a lesser or greater degree.

Please provide comments, questions, and criticisms.

Tom D. Skiles

Fish Passage Specialist

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Bonneville Power Administration, USACE – Portland District, and Grant County PUD/Priest Rapids Coordinating Committee

Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River

2014 Draft Annual Report

Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River

2014 Draft Annual Report

This 2014 Draft Annual Report has been prepared for the Bonneville Power Administration, the U.S. Army Corps of Engineers, and the Grant County PUD/Priest Rapids Coordinating Committee.

This report is not for citation without permission from the authors.

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Draft submitted: February 18, 2015

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EXECUTIVE SUMMARY

The primary objectives of this study in 2014 were to (1) evaluate management initiatives implemented to reduce predation on juvenile salmonids (*Oncorhynchus* spp.) by Caspian terns (*Hydroprogne caspia*) nesting on East Sand Island in the Columbia River estuary, including the monitoring of alternative Caspian tern nesting islands built by the Corps outside the Columbia River basin; (2) evaluate management implemented to reduce predation on juvenile salmonids by Caspian terns nesting on Goose Island - Potholes Reservoir in the Columbia Plateau region, including monitoring Caspian tern dispersal patterns associated with activities to dissuade nesting on the island; (3) collect, compile, and analyze data needed to adaptively manage ongoing efforts to reduce the impact of Caspian terns on survival of salmonid smolts in the Columbia Plateau region; (4) collect, compile, and analyze data needed to (a) assist in the completion of a management plan for double-crested cormorants (*Phalacrocorax auritus*) in the Columbia River estuary and (b) adaptively manage initiatives to reduce the impact of cormorants on survival of salmonid smolts in the Columbia River estuary; and (5) provide technical assistance to resource managers on the topic of avian predation on ESA-listed juvenile salmonids, as warranted.

The management plan entitled, *Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary* was first implemented in 2008 and continued in 2014. As part of this plan, the U.S. Army Corps of Engineers – Portland District (Corps) maintained 1.55 acres of suitable nesting habitat for Caspian terns on East Sand Island in 2014, slightly less than the area of nesting habitat provided during 2012-2013 (1.58 acres), and a 69% reduction in area of tern nesting habitat on East Sand Island compared to what was provided during 2001-2007, prior to implementation of the management plan. In 2014, Caspian terns nested on the East Sand Island colony at an average density of 1.06 nests/m^2, a decrease from the average nesting density recorded in 2013 (1.17 nests/m^2), but still a higher nesting density compared to pre-management (average of 0.55 nests/m^2). Passive nest deterrence measures (stakes, ropes, and flagging) installed by the Corps to dissuade Caspian terns from nesting on the upper beach near the main tern colony and elsewhere on East Sand Island were successful in preventing Caspian terns from forming satellite colonies anywhere on East Sand Island in 2014.

The Caspian tern colony on East Sand Island, the largest for the species in the world, consisted of about 6,270 breeding pairs in 2014. This is a decrease from the estimate of 7,400 pairs in 2013 and the smallest Caspian tern colony size recorded at East Sand Island since the initiation of reductions in tern nesting habitat on the island in 2008, as part of the Caspian Tern Management Plan. This represents a decline of about 41% in the size of the Caspian tern colony on East Sand Island from its peak in 2008 (ca. 10,670 breeding pairs). As was the case in 2013, Caspian terns at this colony were relatively resilient to disturbances by bald eagles (*Haliaeetus leucocephalus*) and associated gull (*Larus* spp.) depredation of tern eggs and chicks, limiting factors that caused the Caspian

tern colony to fail or nearly fail during 2010-2012. The Caspian tern colony on East Sand Island produced roughly 1,700 fledglings in 2014 (average of about 0.28 young raised/breeding pair), an increase compared to 2010-2012 when productivity averaged 0 – 0.06 young raised/breeding pair, but still lower than the average during the previous decade (2000-2009).

The average proportion of juvenile salmonids in the diet of Caspian terns nesting on East Sand Island during the 2014 nesting season was 33%, similar to the average observed over the previous eight nesting seasons. The estimated total smolt consumption by Caspian terns nesting at East Sand Island in 2014 was 4.5 million (95% c.i. = 3.9 - 5.1 million), not significantly different from total annual smolt consumption during 2011, 2012, and 2013, but significantly less than pre-management. Predation rates on specific populations of salmonids (ESUs/DPSs) by Caspian terns in 2014 were similar to those observed during 2011-2013, but were generally lower than those observed during the period 2007-2010. Reductions in tern predation rates following the implementation of management coincided with comparable reductions in tern colony size, suggesting that Caspian tern management initiatives to reduce tern nesting habitat on East Sand Island are resulting in lower predation rates on particular ESUs/DPSs of salmonids in the Columbia River estuary. Similar to previous years, Caspian tern predation rates were significantly higher on populations of steelhead (*O. mykiss*) smolts (8.6 – 11.4%, depending on DPS) compared with populations of salmon (0.9 – 1.6%, depending on ESU).

Since 2008, the Corps has constructed nine islands as alternative colony sites for Caspian terns displaced from East Sand Island, six in interior Oregon and three in the Upper Klamath Basin region of northeastern California. Two of these islands were not available for tern nesting in 2014, and one is no longer being monitored for Caspian tern nesting activity. The other six Corps-constructed islands were monitored for Caspian tern nesting activity in 2014, and nesting attempts by Caspian terns were recorded at five of these islands. A combined total of 786 breeding pairs of Caspian terns attempted to nest at these five Corps-constructed islands in 2014, a 33% decrease from the number of breeding pairs nesting on these islands in 2013. Estimated average productivity among the five Corps-constructed islands, however, was somewhat higher in 2014 (0.27 young raised/breeding pair) compared to 2013 (0.18 young raised/breeding pair). The increase in average nesting success by Caspian terns at the Corps-constructed islands from 2013 to 2014 was in large part due to increased predator control efforts at these sites. Regardless, nest predation by mammalian and avian predators, displacement by other colonial waterbird species (i.e., California gulls [*L. californicus*] and American white pelicans [*Pelecanus erythrorhynchos*]), drought, adverse weather conditions, and apparent low availability of preferred forage fish (due to drought) continued to limit Caspian tern colony formation, colony size, and nesting success at the Corps-constructed islands. Nevertheless, a substantial number of Caspian terns that were banded at the colony on East Sand Island in the Columbia River estuary used the Corps-constructed islands as alternative colony sites; a total of 84 Caspian terns banded in the

Columbia River estuary were resighted at one or more of the Corps-constructed islands in interior Oregon and northeastern California during the 2014 nesting season. Based on estimated movement rates (3.1%) based on resightings of Caspian terns banded as adults, about 461 Caspian terns (including both banded and unbanded individuals) moved from East Sand Island to the Corps-constructed islands in 2014.

To further reduce the impacts of predation by Caspian terns nesting at East Sand Island on survival of salmonid smolts in the Columbia River estuary, more Caspian terns will need to be relocated to colonies outside the basin; the objective of the management plan is to reduce the size of the East Sand Island Caspian tern colony to 3,125 - 4,375 breeding pairs, less than 45% of its pre-management size (ca. 10,000 breeding pairs), while attracting the displaced Caspian terns to alternative colony sites outside the basin. This will likely require a further reduction in area of suitable Caspian tern nesting habitat on East Sand Island by at least one third, or down to about 1 acre of nesting habitat.

In 2014, efforts to monitor of the double-crested cormorant colony on East Sand Island in the Columbia River estuary were reduced from previous years, awaiting the completion and release of the *Double-crested Cormorant Management Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary*, with management actions scheduled for implementation as early as the spring of 2015. Objectives for monitoring the double-crested cormorant colony on East Sand Island in 2014 were to (1) estimate colony size and (2) estimate stock-specific predation rates on juvenile salmonids. The double-crested cormorant colony on East Sand Island consisted of about 13,600 breeding pairs in 2014, about 9% fewer than nested on East Sand Island in the previous year (ca. 14,900 breeding pairs). This one colony includes at least 40% of the breeding population of double-crested cormorants in western North America, and is the largest known breeding colony of the species anywhere. In addition to double-crested cormorants, ca. 1,630 pairs of Brandt's cormorants (*P. penicillatus*) nested in the cormorant colony on East Sand Island in 2014. Brandt's cormorants first nested in this mixed-species colony in 2006, and numbers increased each year through 2012, when 1,680 breeding pairs were counted.

Despite a smaller colony in 2014, recoveries of smolt PIT tags on the East Sand Island cormorant colony in 2014 indicated that ESU/DPS-specific predation rates were up substantially compared with 2013 and were some of the highest recorded since the colony was first scanned for PIT tags in 1999. Predation rates on salmon ESUs were especially high relative to previous years, with an estimated 8.5% (95% c.i. = 6.1 - 13.2%) and 6.1% (95% c.i. = 3.9 - 10.1%) of Snake River spring/summer Chinook (*O. tshawytscha*) and Upper Columbia River spring Chinook, respectively, consumed by cormorants in 2014. Predation on steelhead DPSs ranged from 6.4% (95% c.i. = 3.7 - 10.7%) on Middle Columbia River steelhead to 10.4% (95% c.i. = 7.3 - 16.3%) on Upper Columbia River steelhead. As demonstrated by smolt PIT tag data collected in 2014 and previous years, inter-annual variation in the impact of cormorant predation on survival of salmonid smolts in the Columbia River estuary was poorly explained by differences in colony size alone. Factors that have been linked to high inter-annual variation in cormorant predation (smolt consumption and predation rates) include river discharge into the estuary and ocean conditions (i.e., the North Pacific Gyre Oscillation) as they influence the abundance and availability of alternative prey (marine and estuarine forage fishes).

Native piscivorous colonial waterbirds that nest in the Columbia Plateau region include Caspian terns, double-crested cormorants, American white pelicans, California gulls, and ring-billed gulls (*L. delawarensis*). Of these, Caspian terns have been identified as the single most significant avian predator on salmonid smolts in the Columbia Plateau region on a per capita (per bird) basis. The impacts of Caspian tern predation in the Columbia Plateau region on survival of ESA-listed steelhead populations from the Upper Columbia River and Snake River have been especially high. In January 2014, the U.S Army Corps of Engineers – Walla Walla District completed the *Inland Avian Predation Management Plan* (IAPMP). The goal of the IAPMP is to reduce Caspian tern predation rates on ESA-listed Columbia Basin salmonids to less than 2% (per colony and per ESA-listed population) by redistributing Caspian terns from the two largest nesting sites in the Columbia Plateau region (i.e., colonies on Goose Island in Potholes Reservoir and on Crescent Island in the mid-Columbia River) to multiple dispersed colony sites outside the Columbia River Basin. In 2014, the Corps and the Bureau of Reclamation (BOR) implemented Phase I of the IAPMP by reducing nesting habitat on Goose Island and actively discouraging Caspian terns from nesting there.

In 2014, we monitored Caspian tern nesting activity throughout the Columbia Plateau region to help evaluate the effectiveness of the nest dissuasion actions implemented at Goose Island in dispersing Caspian terns to alternative colony sites outside the basin. These nest dissuasion actions were successful in preventing all but three breeding pairs of Caspian terns from nesting on Goose Island proper in 2014 (340 breeding pairs nested there the previous year). The three breeding pairs that nested on Goose Island each laid a single egg that was collected under permit soon after it was laid. Formation of a Caspian tern breeding colony on Goose Island was prevented in 2014 without causing any apparent disruption of breeding California and ring-billed gulls on the island. Surveys throughout the Columbia Plateau region in 2014 indicated that Caspian terns attempted to nest at four additional sites where they had previously nested and two new sites not previously used by nesting Caspian terns. The four previously used Caspian tern colony sites that were also active in 2014 were: Crescent Island on the mid-Columbia River (474 breeding pairs); Twinning Island in Banks Lake (67 breeding pairs); the Blalock Islands on the mid-Columbia River (45 breeding pairs); and Harper Island in Sprague Lake (8 breeding pairs). The new Caspian tern breeding sites were on a small rocky islet adjacent to Goose Island in Potholes Reservoir (dubbed "Northwest Rocks"; 159 breeding pairs) and amongst a small colony of gulls on a small island in Lenore Lake (2 breeding pairs). Of these seven sites, only the colonies at Crescent Island, the Blalock Islands, and Northwest Rocks succeeded in raising any young.

Recoveries of smolt PIT tags on the colony at Northwest Rocks indicated that Caspian terns nesting there consumed 2.9% (95% c.i. = 1.9 - 5.1%) and 0.3% (95% c.i. = 0.1 - 0.7%) of Upper Columbia River steelhead and yearling Chinook salmon, respectively. Estimated predation rates by Caspian terns nesting at Northwest Rocks in 2014 were the lowest recorded for Caspian terns nesting at Potholes Reservoir to date, and significantly lower than pre-management estimates during 2007-2013. These results indicate that efforts to dissuade Caspian terns from nesting on Goose Island in Potholes Reservoir were successful at reducing smolt consumption by Caspian terns in the Columbia Plateau region in 2014. The reduction in Caspian tern predation rate on steelhead smolts, however, was not below the 2% threshold target established by the IAPMP.

In conjunction with the efforts to dissuade Caspian terns from nesting on Goose Island in 2014, we evaluated the individual responses of 28 Caspian terns that were captured on Goose Island prior to egg-laying and fitted with solar-powered satellite telemetry tags. We observed three types of initial response by tagged Caspian terns to elimination of tern nesting habitat on Goose Island: (1) stay in the area and compete for reduced available nesting habitat (i.e. Northwest Rocks), (2) move to one of several nearby colonies (70 – 125 km away) and attempt to nest there, returning to the Goose Island area if nesting fails, and (3) nomadic wandering throughout the region, without a sustained association with any colony. Tern foraging activity was reduced in areas of the mid-Columbia River where terns have previously had substantial impacts on Upper Columbia River steelhead (i.e. the Wanapum and Priest Rapids pools). Displaced terns did not leave the larger Columbia Plateau region at an appreciable rate during the primary smolt outmigration period, however. Consequently, some predation may have been shifted to other locations and/or other Columbia Basin salmonid populations. Additional IAPMP actions to be implemented in 2015, including an expansion of nest dissuasion from Goose Island to the nearby adjacent islets, initiation of nest dissuasion at Crescent Island, and enhancement of nesting habitat for Caspian terns in San Francisco Bay, appear poised to address several of the factors limiting the displacement of terns from the Columbia Plateau. Marginal nesting habitat at Banks Lake, Sprague Lake, or in the Blalock Islands in the Columbia River (John Day Pool) may be a continued draw for displaced Caspian terns, however. The inability of tagged terns to nest successfully anywhere away from the rocky islet adjacent to Goose Island in 2014 suggests that the long-term goal of reducing tern predation on Columbia Basin salmonids by encouraging fidelity to nest sites outside the Columbia Basin will likely require a sustained, multi-year effort.

The largest Caspian tern breeding colony in the Columbia Plateau region during 2014 was on Crescent Island in the mid-Columbia River. A total of about 474 breeding pairs of Caspian terns attempted to nest on Crescent Island in 2014, a 21% increase in colony size compared to 2013. Resighting of banded Caspian terns on the Crescent Island tern colony suggested that much of the increase in colony size at Crescent Island was related to management actions at Goose Island to reduce colony size there, causing some

Caspian terns to immigrate to the Crescent Island colony, about 100 km away. Despite increases in colony size at both Crescent Island and other Caspian tern colonies in the Columbia Plateau region in 2014, the overall size of the Caspian tern breeding population in the region did not increase, and apparently declined slightly in 2014 (758 breeding pairs) compared to 2013 (773 breeding pairs).

Predation rates on steelhead populations by Caspian terns nesting on Crescent Island were higher in 2014 compared to previous years; predation rates on Snake River steelhead (4.7%; 95% c.i. = 3.7 - 6.9%) were the second highest recorded since 2007, and predation rates on Upper Columbia River steelhead (3.4%; 95% c.i. = 2.5 - 4.9%) were the highest recorded since 2007. Impacts on survival of salmonid smolts, both steelhead and salmon, from Caspian terns nesting on Twinning Island and the Blalock Islands in 2014 were lower than for Caspian terns nesting on Crescent Island, due in part to the much larger size of the Crescent Island tern colony (474 pairs), compared with the Caspian tern colonies on Twinning Island (66 pairs) or the Blalock Islands (45 pairs). Over-all (all Caspian tern colonies combined) predation rate estimates indicate that actions to dissuade Caspian terns from nesting in Potholes Reservoir in 2014 resulted in lower impacts on upper Columbia River ESUs/DPSs compared to previous years, suggesting that management actions in 2014 benefited fish survival, particular survival of Upper Columbia River steelhead.

Appendix A: Goose Island Best Management Practices
2014 Nesting Season

The goal of management on Goose Island, Potholes Reservoir is to prevent more than 40 pairs of Caspian terns from nesting on Goose Island.

In order to achieve this goal, the objective in 2014 is to dissuade all Caspian terns from nesting on Goose Island. Caspian tern nesting is defined as terns laying one or more eggs in a nest scrape.

The strategy that the federal management agencies (Corps of Engineers, Bureau of Reclamation, and U.S. Fish and Wildlife Service) have advocated for achieving the above objective is to try to prevent all gulls from nesting on Goose Island. This strategy is based on the supposition that if gulls start to nest on Goose Island (lay eggs), then any Caspian terns that subsequently attempt to nest near active gull nests can not be hazed without causing gull nests to fail (nests of gulls that are flushed during tern hazing would be at high risk of having their eggs depredated by other gulls). The U.S. Fish and Wildlife Service has stated that, while it is prepared to issue a permit to take a limited number of Caspian tern eggs on Goose Island (< 200 eggs) as a fallback in the event that Caspian terns successfully lay eggs, it can not issue a permit for incidental take of other migratory bird species, including incidental take of gull eggs during tern hazing activities. Therefore, by preventing any gulls from nesting on Goose Island, the prospect of active gull nests (those with eggs) shielding Caspian tern nests from hazing would be precluded. Similarly, small numbers of Canada geese have bred on Goose Island in past years, and several goose nests were located in late March 2014. Therefore, best management practices (BMPs) have been developed for Canada geese as well.

The difficulty in dissuading all gulls from nesting on Goose Island using passive dissuasion (stakes, ropes, and flagging) and human hazing techniques alone has been communicated to the federal management agencies. The large area of passive dissuasion on Goose Island that has been installed at the direction of the management agencies (2.25 acres pre-season; up to an additional 0.25 acres in-season) is in part an effort to make most of Goose Island less attractive to nesting gulls, as well as nesting terns. Recent observations on Goose Island have indicated that ring-billed gulls are less responsive to passive dissuasion compared to Caspian terns. In addition, gulls tend to acclimate more readily than terns to repeated human hazing.

The Bureau of Reclamation (owner of Goose Island) has considered additional management approaches to precluding gull nesting on Goose Island, such as the use of dogs, pyrotechnics, propane cannons, trained falcons, etc. However, none of these management techniques were evaluated and described in the Corps' Environmental Assessment (EA), and therefore cannot be used during this season. Nocturnal hazing using bright lights and lasers to enhance the efficacy of passive dissuasion and daytime human hazing has been authorized for use this season. Nocturnal and crepuscular human hazing using lights and lasers seems to hold some promise for delaying gulls in initiating nests on Goose Island. Weather-permitting, personnel will stay overnight in the portable building on Goose Island so that they can haze any gulls that attempt to spend the night on Goose Island, and use bright lights and the laser to dissuade gulls that attempt to return to the island at first light.

The passive dissuasion (stakes, ropes, and flagging) covers essentially all of the suitable and marginally suitable Caspian tern nesting habitat on Goose Island, and the area where passive dissuasion has been deployed should be the primary focus of gull hazing. The "doughnut hole" of no dissuasion on top of the island (where Caspian terns will be captured for satellite-tagging) should be the focus of intense gull hazing, especially at night, to prevent gulls from laying eggs in this area before Caspian terns are captured and tagged. The observation blind can be used to laser any gulls that attempt to nest in the doughnut hole. Even if Caspian terns are present in the doughnut hole, the laser can potentially be used to scare off individual gulls without scaring off the terns.

Even if gulls are successful in establishing nests and laying eggs around the edge of the island outside the passive dissuasion area, it is unlikely that significant numbers of Caspian terns would nest close to these gulls. Gulls that establish nests inside the passive dissuasion, however, may attract Caspian terns to nest nearby, and thereby decoy terns into the passive dissuasion.

Because several Canada goose nests with eggs were discovered on Goose Island during late March 2014, we have developed best management practices (BMPs) for reducing researcher disturbance that could lead to take of goose eggs. First, using the same techniques described for terns and gulls, Canada geese will be dissuaded from establishing new nests on Goose Island. For any existing or newly established goose nests with eggs that may be discovered, practices to reduce the chances of nest loss are detailed below.

Dissuasion Protocol

Early in the pre-breeding period, before widespread pre-egg-laying behaviors are observed, human hazing of gulls should consist of walk-throughs of the island to flush any and all gulls that are present. Twice each day, a 2-person crew should conduct a walk-through of the entire area of Goose Island. These walk-throughs should occur early in the day (before 10:00 am) and late in the day (after [illegible]:00 pm), weather permitting. During each walk-through, the locations of gull aggregations should be mapped on a diagram of the island. Once per week, map the locations of gulls by species (ring-billed gulls or California gulls). Any areas where gulls are holding territories or engaged in pre-laying behaviors (courtship, territorial display, copulation, nest-building) should also be marked on the map. If possible, the species of gull (California or ring-billed) that is engaged in pre-laying behaviors should be recorded. All gulls on the island should be flushed at least once during each walk-through event, unless gulls are known or suspected of attending eggs.

Prior to each of the early-day walk-throughs, the crew should boat around Goose Island and count all gulls and terns on the island, as well as the numbers of gulls and terns roosting on emergent rocks near the Goose Island shoreline. Counts should be completed relatively quickly (≲ 20 min). It is acceptable to count gulls in 100's and there is no need to distinguish between gull species. Gull counts should be entered into the waterbird survey application and reported in the weekly report to the Corps and Reclamation. Include an estimate of the proportion of each gull species and how gull numbers were estimated (e.g., counted in 100's). Tern counts should be entered into the tern application and reported in the weekly report to the Corps and Reclamation. If terns are likely present in areas difficult to survey from the boat, follow-up tern counts should be conducted from the blind adjacent to the former colony, or other suitable vantage. For etended observations of terns from the blind, include counts upon arrival and before departure, and include the maimum number of terns observed in the notes section of the tern app. Update or replace boat-based counts of gulls in the waterbird survey and tern applications with blind-based counts when blind-based counts are more accurate or complete. In addition to counts of piscivorous waterbirds, use the waterbird survey application to record the number of Canada geese that are observed during waterbird surveys and during hazing activities. Record data on the number of individual geese, nesting status (if known), and number of eggs for any active goose nests located. As for gulls and terns, include goose counts, nesting status, and any observed pre-breeding behaviors in the weekly report to the Corps and Reclamation.

nce large numbers of gulls have initiated pre-laying behaviors on Goose Island, island walk-throughs should be increased in frequency in an effort to increase the deterrence for gulls and terns to lay eggs on the island. At least two morning walk-throughs starting in the pre-dawn hour and conducted over a -hour period, and two afternoon walk-throughs conducted over a -hour period and ending after dusk should be conducted, when all gulls andor terns are flushed each time, with the eception of those gulls known or suspected to be attending eggs. uring this period leading up to egg-laying by gulls, colony monitors should stay over-night on the island (weather-permitting) so that all gulls can be cleared off the island over-night by hazing after dark, and hazing can be initiated as soon as gulls attempt to return to the island in the pre-dawn hours.

If gulls are suspected of having laid eggs in a nest, either outside or inside the passive dissuasion area, the attending adult gull should be approached slowly and cautiously in order to induce the gull to stand-up, but not flush from its nest. This may require carefully approaching the gull nest to within a few meters. nce the gull has stood up and the observer determines that eggs are present, the observer should gradually back off from the nest in order to avoid flushing the adult gull and eposing the egg(s) to potential predation by other gulls. The number of gull nests with eggs and the number of eggs per nest should be recorded. The first gull eggs detected on Goose Island, as well as the first gull eggs to be laid in areas of Goose Island where gull eggs have not previously been detected, should be reported to Pete Loschl and/or Dan Roby as soon as practical (same day at minimum) so that they can forward the information to the Corps and Reclamation. If loss of gull eggs due to gull depredation is observed, this should also be reported the same day to Pete Loschl or Dan Roby. Check potential gull nests for eggs only if the potential nest is more than �0 m from the nearest gull nest confirmed to contain eggs.

If a Caspian tern nest with eggs is suspected anywhere on Goose Island, the verification procedure would depend on the context of the suspected tern nest. If no active gull nests are verified or suspected within 15 m of the suspected tern nest, then the tern nest should be approached close enough to cause the tern to flush from the nest scrape. If there are known or suspected gull nests within 25 m of the suspected tern nest, then the approach of the suspected tern nest should be slow and cautious so as to preclude gulls from flushing from their nests and exposing their eggs to gull predation. If the tern on the suspected nest is flushed and reveals one or more tern eggs, those eggs should be collected (under permit) and transported whole in egg containers back to the field house. Collected tern eggs can be stored temporarily in a refrigerator, for eventual transport back to OSU for further analyses.

If a suspected Caspian tern nest is located within 15 m of a known or suspected gull nest containing eggs, the tern nest should not be approached to verify the presence of tern eggs UNLESS previous experience with the nesting gulls in question indicates that they are unlikely to flush from their nests as a result of an observer approaching the suspected tern's nest. If a recently laid tern egg can be collected without causing nesting gulls to flush and expose their own eggs to gull predation, then it should be collected; if the tern egg can't be collected without flushing gulls from nearby nests with eggs, than the tern egg should not be collected. Any Caspian tern eggs that are laid on Goose Island, whether they are collected or not, should be reported to Pete Loschl and/or Dan Roby as soon as practical so that they can forward the information to the Corps and Reclamation, and for subsequent reporting to the USFWS. Reporting to the Corps and Reclamation shall occur the same day any tern eggs are detected or collected for reporting to the USFWS Migratory Bird office in Portland.

If a Canada goose nest with eggs is suspected anywhere on Goose Island, the verification procedure would depend on the context of the suspected goose nest, as for suspected tern nests. If no active gull nests are verified or suspected in the vicinity of the suspected goose nest, then the goose nest should be inspected to confirm the nest contents. If eggs are confirmed, they should be counted quickly and the goose down lining the nest should be pulled over the eggs to shield them from the view of predators. This should occur very quickly and researchers should then move away from the nest.

Continued gull nest dissuasion in any area around an active or suspected goose nest should be carried out using techniques to minimize the possibility of goose nest loss.

These include (1) a slow, indirect approach to the area where a goose nest is known to be present, (2) averting eyes to avoid direct eye contact with the attending goose, (⍰) when possible, traveling along the water line below the goose nest to avoid pressuring the attending goose into the preferred escape route in the direction of the water, and (4) moving relatively quickly through the area where a goose nest is located (the general 25-m vicinity). When the possibility of gull nest initiation appears low, (5) the frequency of gull dissuasion will be temporarily reduced in areas with newly discovered goose nests with eggs and⍰or goose nests with recently-laid eggs (as suggested by small, possibly incomplete clutches ⍰e.g., < 4 eggs⍰. If feasible, gull dissuasion near the incipient goose nest will be reduced for 4-⍰ days until geese further invest in their nesting effort and there is less risk of nest abandonment. If there is a potential risk of egg predation during any short term displacement of a goose from a nest (e.g., by common ravens), (⍰) the goose down lining the nest will be used to cover the eggs to obscure them from view. ⍰ther best management practices to minimize goose nest loss will be employed as identified.

If there are known or suspected gull nests with eggs within 25 m of the suspected goose nest, then the goose nests should not be approached and monitoring of goose nesting activity should be done from a distance to avoid flushing nesting gulls and the geese at this location, or goose nest monitoring should be terminated if subsequent gull dissuasion is distant enough so as to be unlikely to displace the attending geese.

APPENDIX B

CASPIAN TERN RESPONSE TO MANAGEMENT AT GOOSE ISLAND, POTHOLES RESERVOIR, AS INDICATED USING SATELLITE TELEMETRY

Introduction

In the Columbia Plateau region, avian predators consume substantial numbers of juvenile salmonids (*Oncorhynchus* spp.) belonging to multiple populations, several of which are listed as threatened or endangered under the U.S. Endangered Species Act (ESA; Antolos et al. 2005, Weise et al. 200[illegible], Maranto et al. 2010, Lyons et al. 2011a, Evans et al. 2012). In particular, Caspian terns (*Hydroprogne caspia*) nesting on Goose Island in Potholes Reservoir have been documented to consume in excess of 15% of the available steelhead (*O. mykiss*) population below Rock Island Dam in some years (Evans et al. 2012). Lyons et al. (2011b) estimated that the annual population growth rate (λ) of the Upper Columbia River steelhead distinct population segment could be increased by up to 4.2% (for the hatchery-raised portion of the population) and [illegible].2% (for the wild portion of the population) if predation by Caspian terns nesting at the Goose Island colony was completely eliminated and if other mortality factors did not compensate for the reduction in tern predation. These results have led resource managers to develop a management plan to reduce tern predation on ESA-listed juvenile salmonids by Caspian terns across the Columbia Plateau, including by terns that have nested at Potholes Reservoir (USACE 2014).

Caspian terns are colonial fish-eating waterbirds that were first documented nesting in the Columbia Plateau region in 1[illegible]2[illegible] (Kitchin 1[illegible]0). Since 2000, terns have nested on at least 11 islands across the Columbia Plateau (Adkins et al. 2014, BRNW 2014). One of the largest Caspian tern colonies on the Columbia Plateau is located at Goose Island in Potholes Reservoir, WA. The Goose Island colony ranged from [illegible] to 4[illegible] breeding pairs during 2004-201[illegible], exceeding 200 breeding pairs in all but 2004, the year of initial colonization (BRNW 2014).

Caspian terns nesting at Potholes Reservoir were first documented to consume Columbia River juvenile salmonids in 2000, by the discovery of salmonid Passive Integrated Transponder (PIT) tags at the nesting colony on Solstice Island (Antolos et al. 2004). Remarkably, the Columbia River is [illegible]0 km from Potholes Reservoir, requiring a lengthy commute by nesting terns. Subsequent studies have documented predation rates on PIT-tagged samples of Chinook salmon (*O. tshawytscha*) and steelhead (Maranto et al. 2010, Evans et al. 2012) from Upper Columbia River populations. In 201[illegible], Caspian terns nesting at Goose Island were tracked during the steelhead outmigration period using telemetry tags that regularly recorded Global Positioning System (GPS) locations (BRNW 2014). Just over half of the tagged terns foraged in the Columbia River, with concentrated foraging activity occurring in the reservoirs impounded by Wanapum and Priest Rapids dams and around islands in the Hanford reach. In addition, a small proportion of actively nesting tagged terns were tracked to foraging locations [illegible]0 km away on the Snake River – the longest foraging trips documented for the species.

Survival standards for juvenile salmonids established under the 2004 Biological pinion for the Priest Rapids Project (Wanupum am and Priest Rapids am and their associated reservoirs; operated by the Grant County Public Utility istrict GPU No. 2) require at least survival for juvenile salmonids through each hydropower development (one dam and reservoir; NMFS 2004). Studies have indicated that survival standards for steelhead were not met in the Priest Rapids development during 200 -2010 and in the Wanapum development in 2010 (Timko et al. 2011, Thompson et al. 2012). Estimates of predation rates by Goose Island Caspian terns on steelhead smolts tagged and released by GPU during these years ranged from 10. to 21. of available steelhead smolts below Rock Island am (Evans et al. 201), indicating that predation by Caspian terns was a substantial source of smolt mortality.

In response to the 200 2010 Biological pinion on the operation of the Federal Columbia River Power System (N AA 200 , 2010), the U.S. Army Corps of Engineers Walla Walla istrict and the U.S. Bureau of Reclamation developed an Inland Avian Predation Management Plan (IAPMP; USACE 2014) to reduce avian predation on juvenile anadromous salmonids, particularly that by Caspian terns on the Columbia Plateau. This plan outlined steps to be taken to dissuade Caspian terns from nesting on two islands in the region Goose Island at Potholes Reservoir and Crescent Island in the McNary Pool of the mainstem Columbia River. In 2014 the primary management objective was to reduce the size of the Goose Island colony to less than 50 breeding pairs. A combination of techniques were used to accomplish this colony reduction passive habitat manipulation (placement of stakes, ropes, and flagging across more than half of Goose Island and all of the former Caspian tern colony), active hazing (human presence, shining of a green laser over roosting birds), and limited egg removal (three eggs were collected under permit within 24 hours of laying). With the e ception of the three nascent nests where eggs were collected, Caspian terns were prevented from nesting on Goose Island proper. Caspian terns were not dissuaded from nesting on a small rocky islet immediately adjacent (ca. 100m offshore) to Goose Island, however, and eventually 15 breeding pairs of terns nested there.

Wildlife telemetry tags capable of transmitting to the ARG S satellite network have been used to track the activity of a variety of species, including large waterbirds (e.g., Courtot et al. 2012), for over 20 years. Technology miniaturization in recent years has resulted in satellite telemetry tags small enough to be fitted onto medium-sized birds, including Caspian terns. Tags using the ARG S satellite network deliver less location precision (ca. 1 km) than GPS-based technology (ca. 10s of m), but benefit from lower power consumption and consequently offer greater fle ibility in tag lifetime and weight. ARG S-based satellite tags with a small solar panel incorporated to recharge the on-board battery can achieve e tended lifetimes (1 year).

In this study, we captured and tagged a sample of adult Caspian terns at the Goose Island colony site prior to the beginning of the 2014 breeding season and tracked them through the subsequent breeding period. ur objectives were to (1) describe the different types of responses by terns to the loss of nesting habitat at Goose Island, (2) quantify how much of the activity of these terns still occurred on the Columbia Plateau region and specifically in foraging areas traditionally used by terns nesting at Goose Island, and ( ) identify where terns that left

Goose Island might seek to nest. Collectively, these observations allow for an evaluation of the efficacy of Caspian tern management plan at Goose Island by providing data on dispersal patterns and by providing data on whether or not terns continue to forage on juvenile salmonids in the Columbia Plateau region.

Met□ods

□a□□in□

Caspian terns were captured using a Netblaster compressed-air powered net launcher (Wildlife Control Supplies, East Granby, CT) at the former colony site on Goose Island in Potholes Reservoir (Figure B1). Materials covering the colony to dissuade tern nesting (stakes, ropes, and flagging erected in early March) were temporarily moved aside from a portion of the former colony appro□imately 15 m □ 15 m in size on □1 March to allow deployment of the net launcher. Terns were captured in small groups during 2 □ 11 April. □n 11 April, immediately following the final capture session, the dissuasion materials were redeployed across the former colony and all capture materials removed. No terns were observed landing on or near the former colony area following redeployment of dissuasion materials and no terns nested there during the 2014 breeding season. Capture and tagging of terns was completed 12 days before any Caspian terns were observed to lay eggs anywhere in Potholes Reservoir (2□ April).

We attached satellite tags to a subsample of captured Caspian terns using one of two harness configurations. Initially, 10 tags were deployed using a backpack-style harness used previously on royal terns (*□halasse□s ma□im□s*) and black skimmers (*Rynchops ni□er*; □ Ferguson, The Wetlands Institute, Stone Harbor, N□). Terns fitted with backpack harnesses e□perienced a 24-4□ hour acclimation period, and one tagged bird was found depredated along the shoreline of Potholes Reservoir within 4□ hours of release. Consequently, the remainder of deployments used a leg-loop harness attachment previously used on south polar skuas (*□atharacta maccormic□i*) and northern fulmars (*□□lmar□s □lacialis*; Mallory and Gilbert 200□). Terns fitted with a leg-loop harness rapidly adjusted to carrying the tag and resumed normal behavior shortly, if not immediately, following release. The tag recovered from the depredated tern was redeployed on 11 April, resulting in a total of 2□ tags deployed on terns□□ with back-pack harnesses and 1□ with leg-loop harnesses.

Satellite tags were manufactured by Microwave Telemetry Inc. (Columbia, M□) and programmed to operate on a □2 hour duty cycle, with □ hours on and 2□ hours off, transmitting at a □0 second repetition rate during the on period of each cycle. Each tag incorporated a small solar panel that recharged a battery allowing transmission during daylight or nighttime hours. Tags weighed 12.4 □ 12.□ g, not including harness materials, and were ≤ 2.2□ of body mass for all individuals tagged (body mass of tagged terns ranged from 5□0 to □20 g).

We collected 5-□ breast feathers from tagged terns for □NA-based gender identification (Avian Biotech International, Tallahassee, F□).

Data □ilterin□ and □nalyses

Raw position fi□es of tagged terns were reported daily by the Argos System (C□S America, Inc., □argo, M□). We used the □ouglas Argos-Filter Algorithm (□ouglas et al. 2012) to remove unlikely raw locations, using criteria similar to other seabird satellite telemetry studies. For e□ample, consecutive locations that would have required flight speeds □ □0 km□h were discarded. Across all tags, a median of □ filtered locations were retained during each □ h on cycle (range□1 □ 14 locations).

□ora□in□ □cti□ity

To describe the response of tagged Caspian terns to the reduction in nesting habitat at Goose Island, we characterized their activity within three geographic e□tents of potential interest□

- Foraging areas of terns nesting at Goose Island in the past, prior to tern management activities
- The Columbia and Snake rivers defined by the Federal Columbia River Power System (FCRPS) above The Dalles Dam, near The Dalles, OR
- The Columbia Plateau region (Figure 1B)

To represent foraging areas of terns nesting at Goose Island in the past, we used results from a tagging study conducted at Goose Island in 2013 (BRNW 2014). In that study, terns nesting at Goose Island were captured during the peak steelhead smolt outmigration period in May (FPC 2014) and fitted with tags that collected location data using the Global Positioning System (GPS) satellite network. We used a 95% contour interval for a kernel density estimate based on all GPS locations within 60 km of the colony but excluding locations within 500 m of the colony. The resulting extent included foraging areas on the Columbia River (Wanapum and Priest Rapids dam reservoirs, Hanford Reach), Potholes Reservoir, Moses Lake, and Scooteney Reservoir.

To describe use of the FCRPS we used geographic extents for the Columbia and Snake rivers (available from the U.S. Geological Survey National Hydrography Dataset at nhd.usgs.gov) from The Dalles Dam (Columbia River rkm 309) upstream to Lower Granite Dam (Snake River rkm 177). An additional buffer width of 5 km per side were added to the river extent to account for tag location uncertainty.

Finally, to describe use of the broad region, we defined the Columbia Plateau to include the Columbia Plateau ecoregion boundary (as defined by the U.S. Environmental Protection Agency's Level III ecoregion classifications at www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm), truncated at the Washington/Idaho border to the east, the Washington/Oregon border to the south, and The Dalles Dam to the west (Figure 1B). This extent captures all the areas of the upper Columbia Basin where anadromous salmonid smolts have been found to be susceptible to predation by Caspian terns, and includes all of the colony sites used in recent years (Goose Island in Potholes Reservoir, Crescent and Badger islands in the McNary Pool of the Columbia River, the Blalock Islands in the John Day Pool, as well as colonies on islands in Banks Lake and Sprague Lake (see Map 1 of the main report). As with the FCRPS extent, an additional 5 km buffer was added to the extent to allow for tag location uncertainty.

For each of these geographic extents we quantified the presence of each tagged tern during the primary smolt outmigration period (April 1� – May 31). Specifically, we classified a tagged tern to be present during a given on-cycle if any of the locations recorded were within the given geographic extent. For each tagged individual, we calculated the proportion of on-cycles in which the tern was present in each extent. Potential differences in these metrics between males and females and between those with backpack and leg-loop harnesses were examined using Mann-Whitney rank-sum tests.

Colony Associations

To assess the potential breeding response to habitat loss at Goose Island, we characterized the association of birds with known colony sites across the Pacific Northwest. We considered possible use of 24 currently or recently active colony sites including those in the Columbia Plateau region, western Washington, southern British Columbia, Oregon, and northern California. It was not possible to exhaustively identify nesting status at the various colony sites through site visits and visual monitoring; however, anecdotal observations were collected in a few cases. Instead of visual observations, we used nighttime location data to infer associations of tagged terns with specific colony sites. Nighttime location data provided an incomplete record of activity, however, as location data were collected only during 2-5 nights per week due to the 32 hour duty cycle. We defined a tagged individual to be associated with a specific colony on a particular day of the season if it had been positively located at that colony on at least 3 of the previous 9 nights and had not been located at any other colonies during those 9 nights. This definition of colony association was consistent with limited visual observations at colonies which were regularly monitored (primarily the rocky islet immediately adjacent to Goose Island and at Crescent Island).

Results

Of the 29 Caspian terns captured and tagged in early April, 11 were previously banded with leg-bands (external bands with emblazoned codes). Leg bands indicated that, ten tern had been captured and banded as adults at Goose Island during 2010 – 2013, with the other captured and banded as an adult at Crescent Island in 2005. All 11 had been observed nesting at Goose Island in one or more years during 2010 – 2013. Based on genetic analysis of feathers, of the 28 terns tracked, 14 were males and 14 were females. Four tags quit transmitting data during the April-July period; a tern carrying one of these tags was found dead in Everett, WA, but the cause of tag failure could not be confirmed in the other three cases. The last days of transmission for these tags were 30 May, 5 June, 15 June, and 30 June. Three of the four failed tags had been attached using a backpack configuration, including the tern found dead.

Half (n □ 14) of the tagged birds were visually observed displaying nesting behavior (nest scraping, copulating, incubating eggs, or attending chicks) during the course of the season, including six terns that were observed incubating eggs or attending chicks. The majority of nesting behavior was observed at the rocky islet adjacent to Goose Island, although three birds were seen displaying nesting behavior at Crescent Island. Nesting behavior was not visually confirmed at other colony sites□limited access, poor visibility, and infrequent visits made such observations unlikely.

On average, 5□% of the filtered locations of individual satellite-tagged terns were within the previously documented foraging areas of Caspian terns nesting at Goose Island (range□6 □ 100%□Figure B2). An average of 21% of locations were within the reaches of the Columbia and Snake rivers defined by the FCRPS above The Dalles Dam (range□0 □ □□%□Figure B3). On a regional scale, on average, 90% of locations were within the Columbia Plateau region (range□6 □ 100%□Figure B4), with half (n □ 14) of the tagged terns only detected on the Plateau, and 24 terns located on the Plateau in more than 75% of all locations. Based on rank-sum tests, no statistical differences (alpha □ 0.05) in these measures were detected between male and female tagged terns, or between terns carrying tags affixed with a backpack or leg-loop harness.

After a brief period of dispersal from Goose Island, a majority of tagged terns returned and were associated with that colony site for days, weeks, or in a few cases for the entire breeding season (Figure B5). In early to mid-May, during the peak of steelhead out-migration period (see Figure 17 of the main report), the majority of tagged terns (1□-22 individuals) were regularly associated with the Goose Island colony. This number declined throughout the month, and only three tagged terns were consistently associated with the Goose Island at the end of May. Some tagged terns were often associated with other colony sites on the Columbia Plateau. A peak of six tagged terns were associated with the Banks Lake colony around 2□ May and a peak of five tagged terns with the Sprague Lake colony around 4 June. Smaller numbers of tagged terns (1-2 individuals at a time) were associated with the Crescent Island and Blalock Islands colonies. Most tagged terns that associated with the Banks Lake colony had ended their association with that site by 4 June□the last tern associated with the Sprague Lake colony ended its association around 1□ June. Boat-based surveys, along with periodic aerial surveys, indicated that up to 67 breeding pairs of terns attempted to nest at the Banks Lake colony and up to □ breeding pairs attempted to nest at the Sprague Lake colony. Terns were observed on nests at the Banks Lake colony as late as 1□ June but on 22 June the nesting area had been abandoned. One tagged tern remained associated with the Banks Lake colony until 24 June, however. Observations off the Sprague Lake colony indicated that terns were apparently nesting at the site as late as June 24th, but during a visit on June 29th it was observed that the apparent nesting area had been abandoned. Tagged terns were associated with Crescent Island and the Blalock Islands as late as 11 June and 1 June, respectively. As tagged terns ended their associations with other sites on the Columbia Plateau, they frequently resumed an association with the Goose Island colony. The number of tagged terns associated with Goose Island grew from just three at the beginning of June to thirteen by 20 June □ just over half of the tags still functional at that date (n □ 25).

This large number of tagged terns associated with Goose Island was consistent for approximately a month, with 12 tagged terns still associated with the colony site as late as 24 July, when numbers began to decline. Colony associations of male and female tagged terns both followed the general pattern described above.

Across the breeding season, tagged individuals were also intermittently associated with colony sites in coastal Washington, including at the Port of Bellingham, the Everett waterfront, the Seattle waterfront, and in Grays Harbor. These associations typically lasted for 7-10 days and with only one individual associated with any given coastal site at a time.

The median date of final departure from the Columbia Plateau during the 2014 breeding season, for those tags that provided location data through the entire breeding season, was 7 July. The earliest final departure occurred on 25 May and the latest on 31 August.

Discussion

The Caspian terns we tracked in this study displayed three general responses to nesting habitat dissuasion at the Goose Island colony where they were captured: (1) stay and compete for reduced nesting habitat, (2) move and associate with another colony, returning if that colony fails, or (3) nomadically wander without a sustained association with any colony.

The small amount of nesting habitat left available at the rocky islet adjacent to Goose Island allowed some tagged terns to nest in the vicinity of Goose Island despite the dissuasion that prevented nesting at the former colony site. Almost half of the tagged terns were visually observed displaying breeding behavior at the rocky islet adjacent to Goose Island and two were ultimately observed attending near fledging-aged chicks. Other tagged terns sought nesting opportunities elsewhere, as suggested by prolonged associations with other colony sites and visually confirmed at the Crescent Island colony. These associations with other colonies, presumably nesting attempts for at least some individuals, were temporary in all cases, either due to colony failure, as in the case of tagged terns associated with Banks or Sprague lakes, or individual nest failure, as in the case of at least one tagged tern at Crescent Island. None of the tagged terns were associated with other colonies long enough to have successfully reared chicks. Finally, about half of the tagged terns left Goose Island during April or May and did not have any sustained associations with any colony after that departure. These terns visited colonies both on the Columbia Plateau and elsewhere, but lengthy (a week or more) associations were not observed. It is possible that these terns could have initiated brief nesting attempts, but if so their attempts were only short investments. Without exception, tagged individuals that displayed a dispersal response to the habitat dissuasion at Goose Island did not successfully raise young in 2014, and presumably in some cases did not even initiate a nesting attempt (i.e., lay eggs). Caspian terns are a long-lived species (some birds live > 25 years; Cuthbert and Wires 1999), so one year of foregone reproduction is not catastrophic at the population level, and is presumably consistent with the species' evolved use of ephemeral nesting habitat.

Based on the distribution of tagged Caspian terns during the primary smolt outmigration period of late-April to May, the initial implementation of the Inland Avian Predation Management Plan was successful in shifting the foraging activity of some terns away from areas where they traditionally preyed upon juvenile salmonids. In particular, tagged terns shifted almost half of their activity away from areas used by terns nesting at Goose Island in 2013, and specifically reduced foraging activity in the reaches of the mid-Columbia River impounded by Priest Rapids and Wanapum dams. The Upper Columbia River population of steelhead trout has been documented to be particularly susceptible to predation by Goose Island Caspian terns in these areas (Evans et al. 2013). The tern activity we tracked suggested that predation would have been lower in 2014 compared with 2013—a finding supported by steelhead PIT tag predation rate data that indicated ca. [illegible]0% reduction in steelhead predation rates by terns nesting in Potholes Reservoir in 2014 compared with 2013 (see Appendix C, Table C2, of the main report). Presumably, if tern nesting is prevented anywhere in the proximity of Goose Island in future years, an even greater portion of tern activity will be shifted away from traditional foraging areas in the mid-Columbia River.

Reductions in smolt predation rates by tern nesting in Potholes Reservoir observed in 2014 were lower than those implied by a reduction in colony size alone (see Figure 17 of this report). Numerous factors have been linked to juvenile salmonid susceptibility to Caspian tern predation, including fish abundance, run-timing, and abiotic river conditions (see Section 1.2.3 of the main report and Hostetter et al. 2012). Another possible factor influencing both tern foraging activity and predation rates on smolts in 2014 was the drawdown of the Wanapum Pool to facilitate repair of faults found in Wanapum Dam. Lower water levels and increased river flows could have result in shorter transit times of smolts and ultimately may have made steelhead less susceptible to tern predation in 2014 relative to years past. Tagged terns were still tracked to the Wanapum pool in 2014, but less efficient foraging there could have contributed to a reduction in tern presence. This factor is difficult to assess using data from 2014 alone—additional data collection in 2015 (when normal water management practices are expected) may improve our understanding of the importance of water levels and river flows in the Wanapum Pool on tern foraging behavior and predation rates.

At a larger scale, the 2014 dissuasion of nesting habitat at Goose Island did little to shift tern activity away from the Columbia Plateau during the smolt outmigration period. A notable portion of the activity of tagged terns (21% on average) was in the reaches of the Columbia and Snake rivers defined by the Federal Columbia River Power System. That shift in activity within the Plateau region could shift predation pressure onto other Columbia Basin populations of salmon and steelhead, or partially compensate for improvements in smolt survival in the Wanapum and Priest Rapids pools. The planned dissuasion of nesting habitat at Crescent Island (Phase 2 of the IAPMP) is expected to prevent a long-term shift of terns from Potholes Reservoir to this portion of the Columbia River, however.

We cannot completely rule out the possibility that the behavior of tagged terns was affected by the burden of carrying the satellite transmitter. Terns tagged using the backpack harness configuration experienced an initial acclimation period, and one bird was depredated with 4[illegible] hours of tagging and release. Following that initial acclimation period, and typically immediately upon release for birds tagged using a leg-loop harness configuration, our visual observations of the behavior of tagged terns (mostly at the rocky islet adjacent to Goose Island, but also at Crescent Island and other monitored colonies in the region) indicated that terns quickly resumed normal behavior. Given limited opportunities, observing breeding behavior for half of the tracked terns suggested that breeding was in general not substantially inhibited. We also saw no differences in the distribution, or colony associations, of terns tagged using either harness configuration. Finally, tagged terns displayed high mobility during the breeding season and fall migration. A total of 23 of the tracked individuals reached their overwintering locations in Mexico apparently without incident.

In conclusion, Caspian terns tracked as part of this study suggested that the IAPMP achieved some success in the initial year of implementation. Tern foraging activity was reduced in areas of the mid-Columbia River where terns have previously had substantial impacts on Upper Columbia River steelhead. Displaced terns did not leave the larger Columbia Plateau region at an appreciable rate during the primary smolt outmigration period, however. Consequently, some predation may have been shifted to other locations and/or other Columbia Basin salmonid populations. Additional IAPMP actions to be implemented in 2015, including an expansion of nest dissuasion from Goose Island to the nearby adjacent islets, initiation of nest dissuasion at Crescent Island, and enhancement of nesting habitat for Caspian terns in San Francisco Bay, appear poised to address several of the factors limiting the displacement of terns from the Columbia Plateau. Marginal nesting habitat at Banks Lake, Sprague Lake, or in the Blalock Islands in the Columbia River (John Day Pool) may be a continued draw for displaced Caspian terns, however. The inability of tagged terns to nest successfully anywhere away from the rocky islet adjacent to Goose Island in 2014 suggests that the long-term goal of reducing tern predation on Columbia Basin salmonids by encouraging fidelity to nest sites outside the Columbia Basin will likely require a sustained, multi-year effort.

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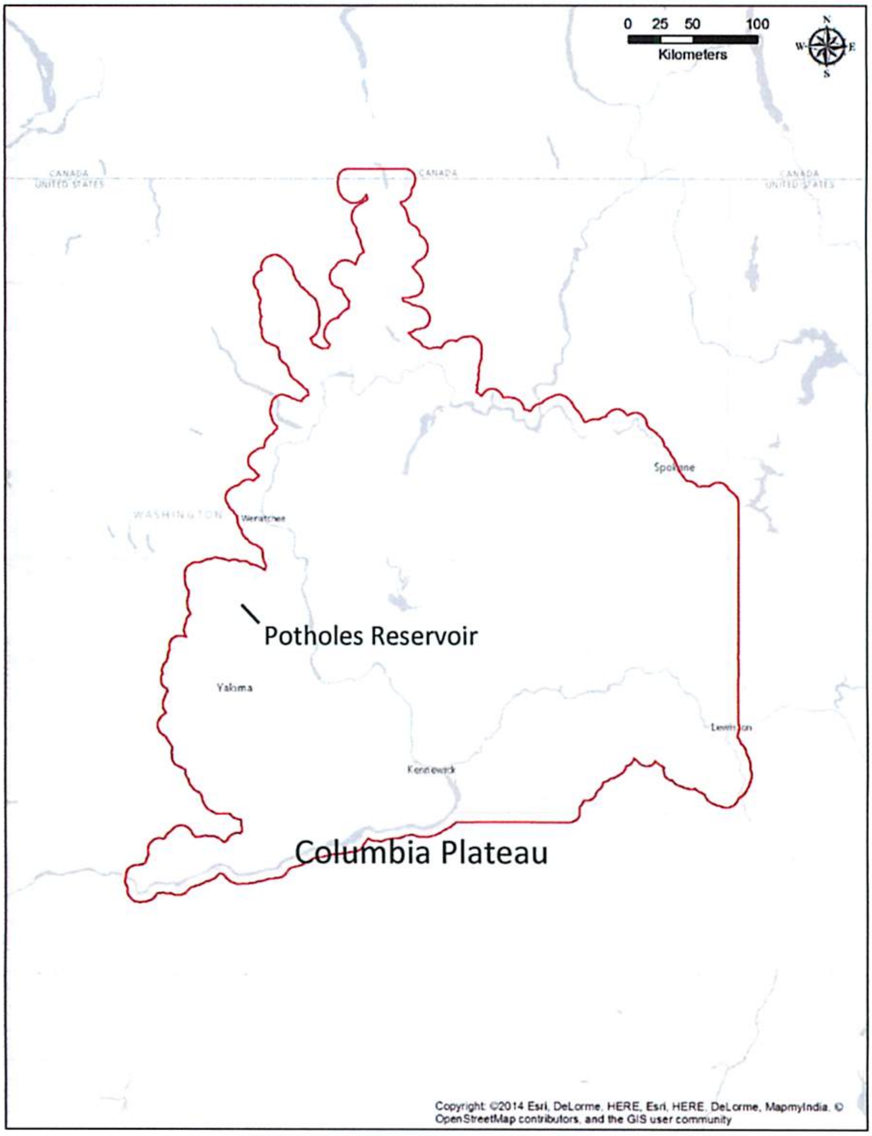

Figure B1. Columbia Plateau region of eastern Washington State (red polygon). Caspian terns were captured, tagged, and released at Goose Island in Potholes Reservoir during 2 – 11 April, 2014.

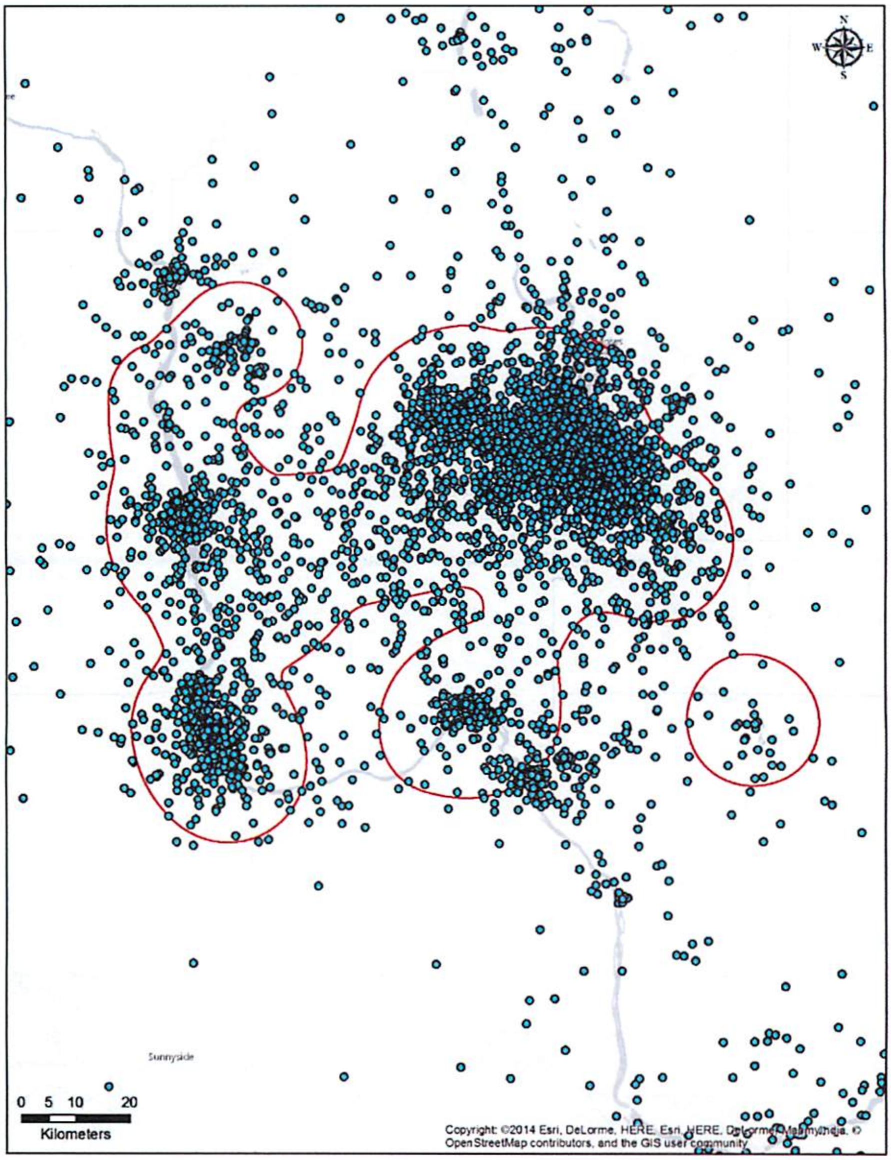

Figure B2. Locations of satellite-tagged Caspian terns during 1� April � 31 May, 2014 (points), in relation to the previously documented foraging areas of Caspian terns nesting at Goose Island, Potholes Reservoir (red polygons). Data to define the foraging areas of nesting terns were collected in 2013 by using GPS telemetry tags fitted to a sample of terns nesting at Goose Island. The foraging area used is a 95% contour interval for a kernel density estimate based on all GPS locations within 60 km of the colony but excluding locations within 500 m of the colony. A mean of 5�% of locations of satellite-tagged terns (range 6 � 100%) were within the previously documented foraging areas.

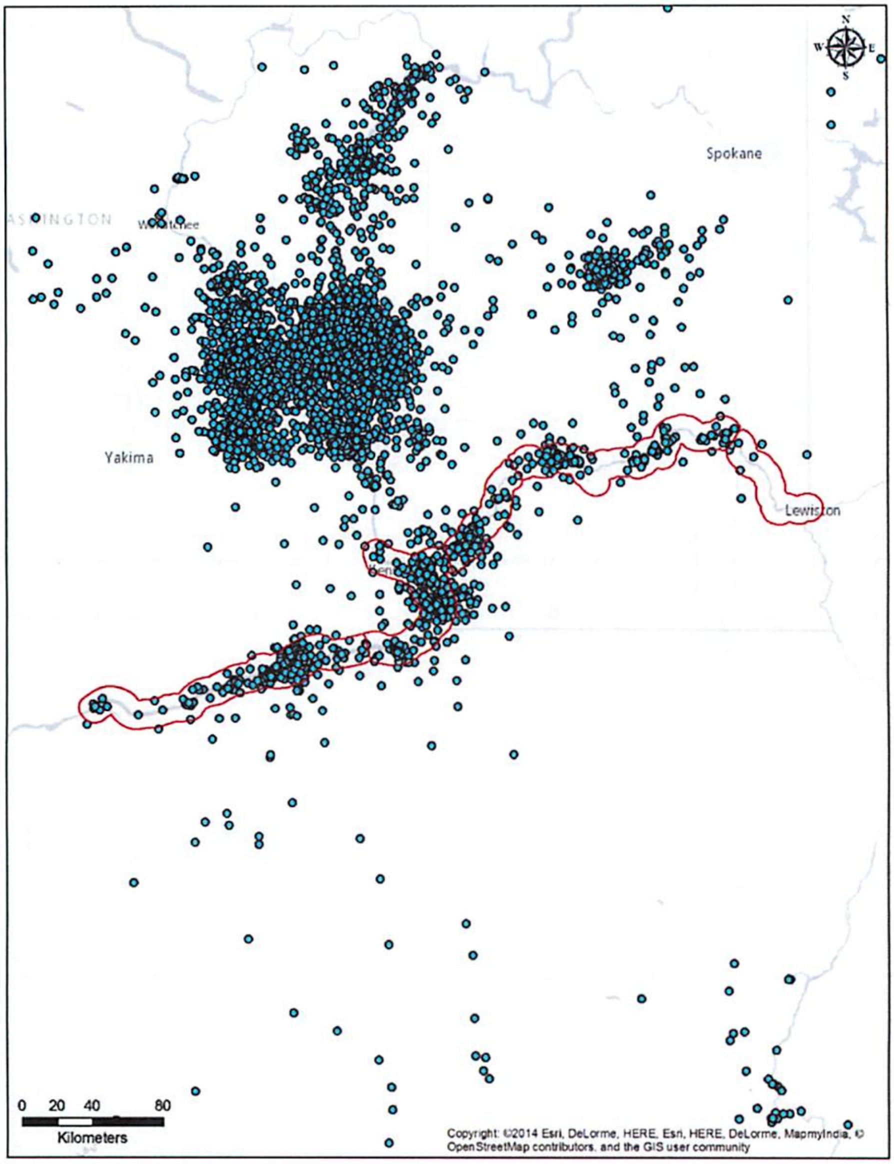

Figure B3. Locations of satellite-tagged Caspian terns during 1□ April □ 31 May, 2014 (points), in relation to reaches of the Columbia and Snake rivers defined by the Federal Columbia River Power System (FCRPS), above The Dalles Dam (red polygon). A mean of 21% of locations of satellite-tagged terns (range 0 □ □□%) were within the region defined by the FCRPS.

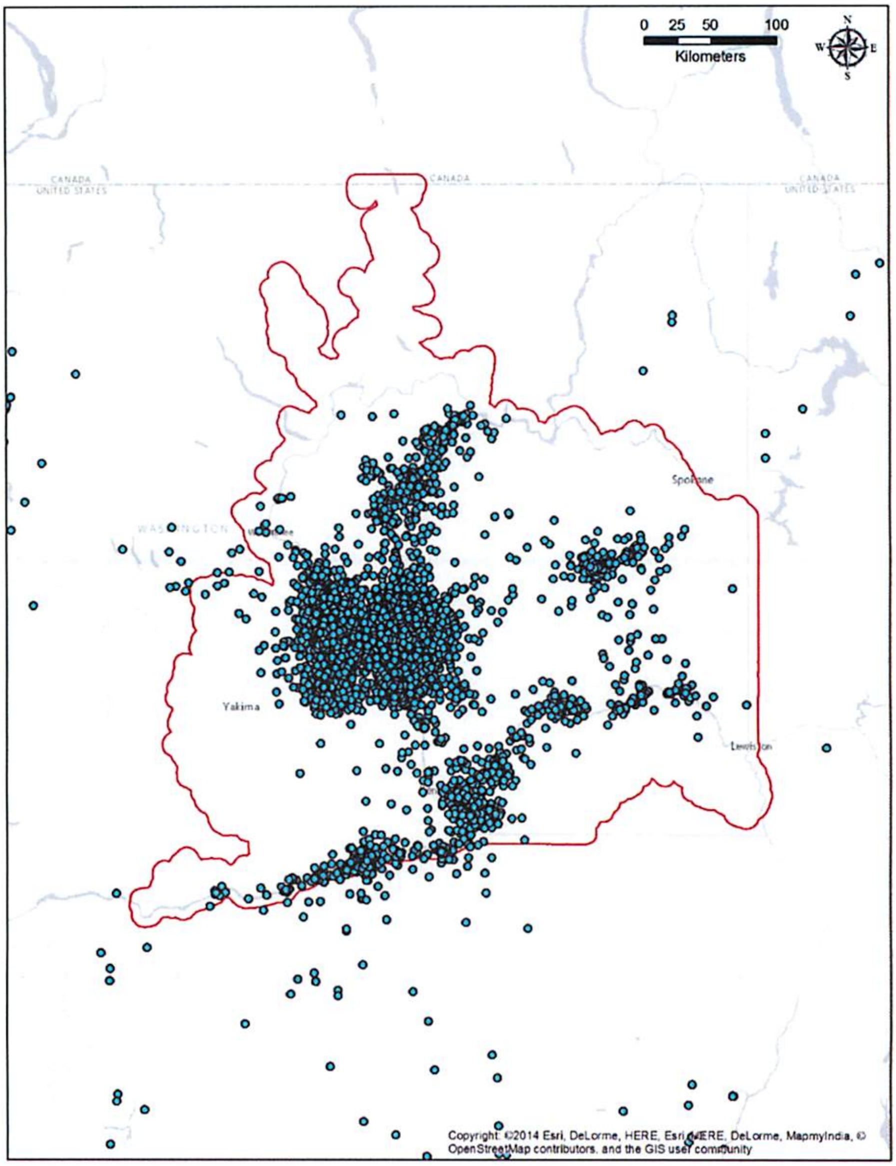

Figure B4. Locations of satellite-tagged Caspian terns during 1□ April □ 31 May, 2014 (points) in relation to the Columbia Plateau region (red polygon). A mean of 90% of locations of satellite-tagged terns (range 6 □ 100%) were within the Columbia Plateau region, with half of all tagged terns (n □ 14) only detected on the Plateau and 24 tagged terns located on the Plateau in more than 75% of all locations.

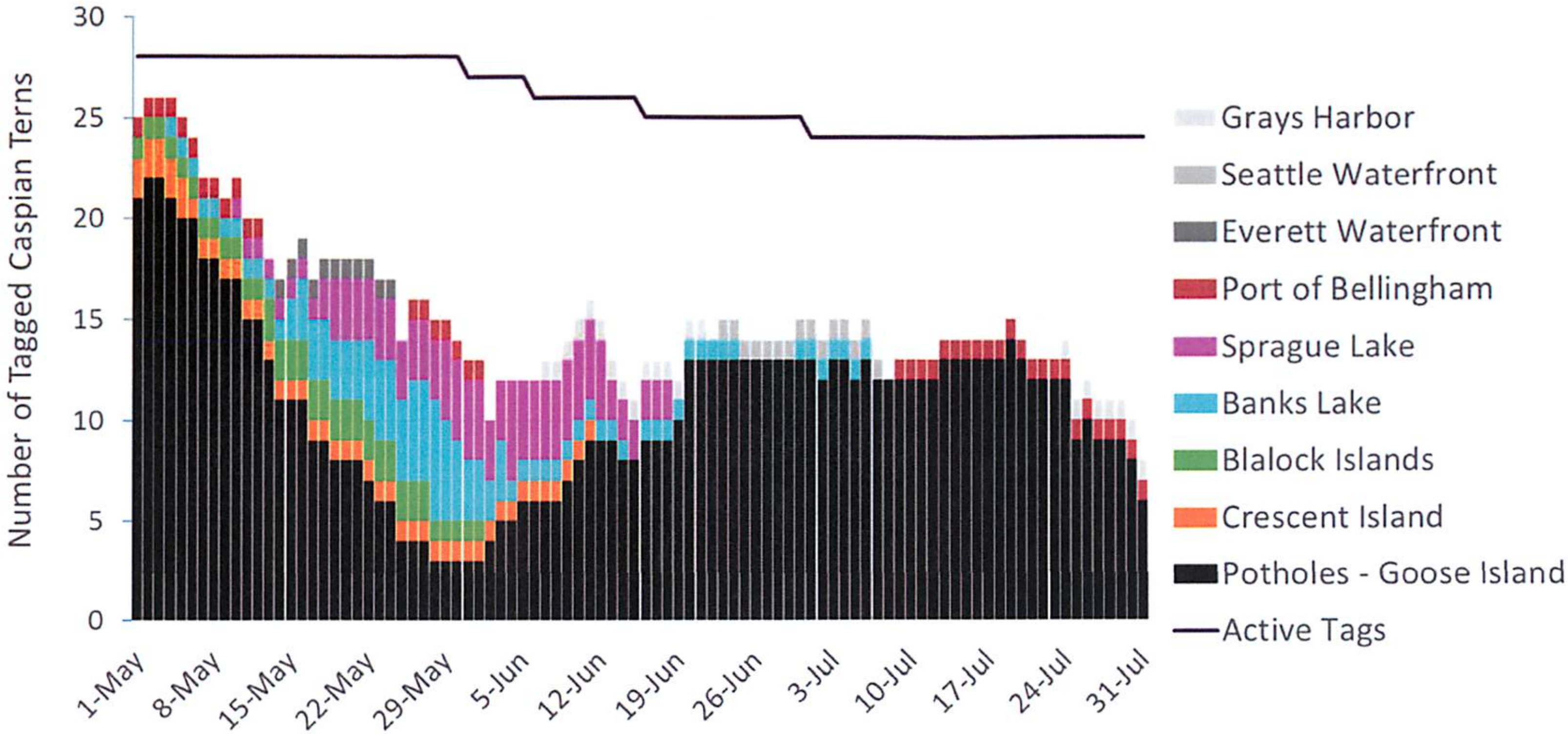

Figure B5. Colony associations of satellite-tagged Caspian terns during 1 May ? 31 ?uly, 2014. A tagged individual was considered to be associated with a specific colony on a particular day of the season if it had been positively located at that colony on at least 3 of the previous 9 nights and had not been located at any other colonies during those 9 nights.

[illegible]

CUMMALTIVE PREDATION IMPACTS ON PIT-TAGGED JUVENILE STEELHEAD AND YEARLING CHINOOK RELEASE AT ROCK ISLAND DAM, 2014

Introduction

A study to evaluate mortality of smolts tagged using the Juvenile Salmonid Acoustic Telemetry System (JSATS) in the Columbia River Basin has been funded to better understand where (spatially) and when (temporally) smolt mortality occurs and what fraction of that mortality is related to piscivorous colonial waterbird predation. Research associated with study resulted in the recovery of not only JSATS-tagged smolts on bird colonies but also PIT-tagged only smolts, including steelhead and yearling Chinook released as part of our tagging study at Rock Island Dam in 2014 (see Section 1.1.4). Presented here are predation rates or probabilities on Rock Island Dam released steelhead and yearling Chinook by 14 different bird colonies in 2014. Colonies range from those within foraging distance of the middle Columbia River all the way to the Columbia River estuary. Results provide valuable insight regarding the over-all or cumulative impact of colonial waterbird predation on smolt survival during outmigration, including predation by Caspian tern, double-crested cormorant, California and ring-billed gull, and American white pelican colonies.

Methods

Methods to calculate predation probabilities are the same as those described in Section 1.1.4, with a few exceptions that are noted below. Colonies scanned for PIT tags include Caspian terns nesting on Twinning Island, Goose Island-Northwest Rocks, Crescent Island, Blalock Islands, and East Sand Island. Double-crested cormorants nesting on Foundation Island and East Sand Island. Brandt's cormorants nesting on East Sand Island. California and ring-billed gulls nesting on Island 20, Crescent Island, Anvil Island (Blalock islands), Straight Six Island (Blalock islands), and Miller Rocks Island and American white pelicans nesting on Badger Island (Table D1).

Fish availability to all 14 colonies were based on the number of PIT-tagged steelhead (n = 7,757) and yearling Chinook (n = 5,446) sampled, and released into the tailrace of Rock Island Dam (RIS) from 12 April to 13 June as part of Avian Predation Project (see Section 1.2.3). As defined herein, availability is not adjusted for downstream survival of fish to the vicinity of each bird colony, as was the case for predation rates presented elsewhere in this report (see Section 1.1.4, 1.2.3, and 2.1.3). For instance, predation rates by double-crested cormorants nesting on East Sand Island in the Columbia River estuary are based on the number of fish available in the tailrace of RIS (Rkm 729) and not the number available in the tailrace of Bonneville Dam (Rkm 234). This approach standardizes fish availability for all colonies, resulting in a cumulative measure of predation impacts on □uvenile steelhead and yearling Chinook during outmigration from Rock Island Dam to the Columbia River estuary. Since Rock Island Dam is considered the start of the migration corridor for ESA-listed Upper Columbia River steelhead and spring Chinook, impacts are considered during the entire smolt life history stage for these two salmonid populations.

Detection efficiency data used to calculate predation probabilities are based on methods and results described in Sections 1.1.4, 1.2.3, and 2.1.2 (see Table 2). Detection efficiency estimates (range of daily values□sample si□e) for gull, cormorant, and pelicans colonies □ those not provided in Table 6 □ were as follows□ Island 20 gulls (59-93%□n □ 50), Foundation Island cormorants (20-20%□n □ 100), Badger Island white pelicans (66-70%□n □ 50), Crescent Island gulls (50-99%□n□100), Anvil Island gulls (□3-9□%□n □ 100), Straight Six Island gulls (77-9□%□n □ 100), and Miller Rock Island gulls (□1-□7%□n □ 100). □alues reflect daily ranges in detection efficiency from 1 April to 31 □uly, 2014.

Deposition data used to calculate predation probabilities are based on methods and results described in Section 1.1.4 (see Table 7). Data on PIT tag deposition probabilities for California gulls □ data not presented in Table 7 □ were those reported in Hostetter et al. *□n press* with a mean deposition probability of 15% (95% c.i. □ 11-21%□n □ 1,□12). No deposition estimate exits for ring-billed gulls but since gull colonies scanned for PIT tags in 2014 were numerically dominated by California gulls and not ring-billed gulls and since the si□e, foraging behavior, and nesting chorology of ring-billed gulls is similar to that of California gulls (Winkler 1996), the California gull deposition estimate was applied. No deposition estimate currently exist for American white pelicans on Badger Island, and since the si□e, foraging behavior, and nesting chronology of white pelicans differ substantially from that of terns, gulls, and cormorants, no attempt was made to ad□ust American white pelican predation rates for deposition probabilities. As such, predation rates presented below for white pelicans represent minimum estimates (those ad□usted for detection efficiency, but not for deposition probabilities).

Results □□□ □□□uss□□□

Predation rates were highly variable by salmonid species (steelhead, Chinook), bird species (tern, cormorant, gull, pelican), and colony site (Rkm), ranging from □ 0.1% to 6.□% (95% c.i. □ 4.6-10.4) of available fish in the tailrace of RIS. Predation impacts were consistently greater on □uvenile steelhead compared with yearling Chinook, with steelhead disproportionally consumed in nearly all cases (Table D1). This finding is consistent with relative differences in steelhead versus salmon predation susceptibility observed in other ESUs in 2014 (e.g., Snake River steelhead versus Snake River spring/summer Chinook□Table 4, 5, and 7). A discussion of factors that influence the greater susceptibility of steelhead to avian predation can be found Section 1.2.3.

Predation impacts by the large Caspian tern and double-crested cormorant colony on East Sand Island were some the highest observed in 2014, particularly impacts to steelhead (6.6%□95%

c.i. ▯ 5.0-9.7) by Caspian terns and impacts to yearling Chinook (4.▯%▯95% c.i. ▯ 3.3-7.7) by double-crested cormorants (Table D1). Again, impacts reported herein apply to the available sample of fish passing RIS and suggest that relative to other bird colonies, many of which are closer in proximity to RIS, predation in the estuary is ma▯or source of smolt mortality. If availability is ad▯usted for survival to the estuary ▯ by limiting the analysis to the number of fish last detected passing Bonneville Dam ▯ predation impacts on Upper Columbia River steelhead and Chinook roughly double (11.4% and ▯.5% by terns and cormorants on upper Columbia River steelhead and spring Chinook, respectively, see Table 4) compared with impacts not ad▯ust for downstream survival (i.e., those presented in Table D1). Similar to results presented in Section 2.1.2, predation impacts by Brandt's cormorants were significantly lower than those reported for terns and double-crested cormorants on East Sand Inland and were some of lowest observed at any colony in 2014 (Table 4 and Table D1).

Predation impacts by some gull colonies were similar to or greater than those of tern and cormorant colonies (Table D1). For instance, predation by Crescent Island gulls on steelhead (6.▯%▯95% c.i. ▯ 4.6-10.4) was the highest individual estimate of the 14 bird colonies evaluated (D1). Hostetter et al. (In press) reported that impacts from gulls, a generalist predator, were higher than previously reported in the published literature because previous estimates did not include a measure of on-colony PIT tag deposition. Data from BRNW (2014) indicates that PIT tag deposition probabilities are low in gulls because gulls macerate PIT tags during digestion, resulting in a small fraction of ingested tags being egested on-colony. High predation impacts by gull colonies were likely associated with the colonies large si▯e (ca. 4,100 to 14,500 adults counted, depending on the colony▯see Section 3.2) and behavior flexibility to exploit temporally available prey (Ruggerone 19▯6▯Osterback et al. 2013). Not all of the gull colonies evaluated, however, had high predation impacts on ▯uvenile steelhead and yearling Chinook released at RIS, with predation rates by gulls nesting on Island 20 and the Blalock islands (Anvil and Straight Six) generally lower than those of other bird colonies evaluated (Table D1).

Similar to data reported by Evans et al (2012), of the various bird species evaluated, impacts were the lowest by American white pelicans nesting on Badger Island. Evans et al. (2012) hypothesi▯ed that several factors may account for low predation impacts by American white pelicans on particular smolt DPSs/ESUs, including (1) a reliance on larger fish or on fish that congregate in shallow-water habitats, (2) differences in foraging behavior that reduce the habitat overlap between Badger Island pelicans and out-migrating salmonids from the upper Columbia River, or (3) a combination of these. It's important to note, however, that white pelican predation estimates presented here and those of Evans et al. (2012) do not incorporate tag loss due to off-colony deposition and thus represent minimum impacts. In a study of trout predation by nesting American white pelicans in Idaho, Larson et al. (2013) estimated that deposition and detection efficiency of PIT-tagged trout consumed ▯ 200 ▯m from a pelican colony was approximately 30% (range ▯ 10-60%). Applying this correction factor to the raw, unad▯usted number of yearling Chinook and steelhead smolts PIT tags recovered on Badger Island, however, would not change predation rates in a meaningful way, as predation rates would still be ▯ 0.1% for both species. In fact, even if deposition values for white pelicans were lower than those of California gulls (15%), predation impacts by pelicans would still be the lowest reported herein because so few steelhead (n = 1) and Chinook (n = 0) PIT tags were recovered on the white pelican colony in 2014. This does not mean white pelicans nesting on Badger Island do not consume other salmonid DPSs/ESUs or age-classes of fish (in fact, large numbers of PIT tags implanted in subyearling Chinook and adult sockeye were recovered on Badger Island in 2014) but simply that impacts to upper Colombia River juvenile steelhead and yearling Chinook were low in 2014.

Taken together (all colonies combined), 36.0% (95% c.i. = 31.2-44.1) and 11.6% (95% c.i. = 9.0-16.0) of the steelhead and yearling Chinook, respectively, released into the tailrace of Rock Island Dam were consumed by one of the 14 bird colonies evaluated in 2014 (Table D1). For steelhead, about half of the predation losses (16% of released fish) were from birds nesting on colonies upstream of McNary Dam (Rkm 470; Table D1). For yearling Chinook, losses were generally smaller and more evenly distributed throughout the migration corridor, with the exception of predation by double-crested cormorants in the Columbia River estuary (4.[illegible]% of released fish; Table D1). This estimate does not account for other sources of mortality (piscine predation, dams, disease, or other sources) that occurred during out-migration from Rock Island Dam to the Columbia River estuary, indicating that predation by these 14 colonies was a substantial mortality factor for these fish during the smolt life history stage. For instance, relative to non-avian documented mortality factors, mortality associated with avian predation reported herein is comparable to or higher than that reported for piscine predation (generally [illegible] 5% per reservoir; Ward et al. 1995, Thompson et al. 2012) and passage mortality associated with individual dams on the Columbia and lower Snake rivers (generally [illegible] 4% per dam; Ferguson et al. 2006; Timko et al. 2011; Skalski 2009).

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Table D1. Cumulative estimated predation probabilities (95% credible interval) of steelhead and yearling Chinook released into the tailrace of Rock Island Dam by 14 different piscivorous waterbird colonies in the Columbia River Basin in 2014. Predation probabilities were adjusted to account for tag loss due to on-colony PIT tag detection and deposition probabilities (see Methods). Predation rates were calculated based on the number of fish available (n) in the tailrace of at Rock Island Dam (river kilometer (RKM 729) and were thus not adjusted for survival to the vicinity of the downstream colony. Bird species include Caspian tern (CATE), double-crested cormorants (DCCO), Brandt's cormorants (BRAC), ring-billed and California gulls (Gulls), and American white pelican (AWPE).

Location	Colony	RKM	Steelhead (n = 7,757)	Yearling Chinook (n = 5,446)
Twinning Island	CATE	Off-river	1.2% (0.3-6.4)	0.4% (<0.1-3.6)
Goose Island (NW Rocks)	CATE	Off-river	2.9% (1.9-5.1)	0.3% (0.1-0.7)
Island 20	Gulls	545	1.6% (0.9-2.9)	0.3% (<0.1-0.9)
Foundation Island	DCCO	51[illegible]	0.2% (<0.1-0.[illegible])	<0.1%
Badger Island	AWPE[1]	512	<0.1%	0.1% (<0.1-0.2)
Crescent Island	CATE	510	3.4% (2.5-4.9)	0.2% (0.1-0.5)
	Gulls	510	6.[illegible]% (4.6-10.4)	0.5% (0.2-1.4)
Blalock Islands (Anvil Is.)	CATE	441	0.7% (0.5-1.3)	<0.1%
	Gulls	441	1.6% (0.9-2.[illegible])	0.4% (0.1-1.0)
Blalock Islands (Straight Six Is.)	Gulls	439	0.4% (0.1-1.0)	0.4% (0.1-1.0)
Miller Rocks Island	Gulls	331	4.6% (3.0-7.2)	2.0% (1.1-3.7)
East Sand Island	CATE	[illegible]	6.6% (5.0-9.7)	1.3% (0.[illegible]-2.1)
	BRAC	[illegible]	0.2% (0.1-0.4)	0.1% (<0.1-0.4)
	DCCO	[illegible]	4.6% (3.2-7.1)	4.[illegible]% (3.3-7.7)
Total			36.0% (31.2-44.1)	11.6% (9.0-16.0)

[1] Predation rates by American white pelicans were not adjusted for deposition probabilities and should be considered minimum estimates.

MEMORANDUM February 23, 2015

TO: Interested Parties
FROM: Peter Graf, Fisheries Scientist
SUBJECT: Status update on the HRFCPPA Periods and Flow Constraints

Discussion:

Below, Table 1 details the completed, current, and projected dates of each flow constraint Periods as described in the Hanford Reach Fall Chinook Protection Program Agreement (HRFCPPA). The HRFCPPA Periods are determined by the accumulation of temperature units (ATUs) from the Initiation of Spawning date. The projected dates are predicted based on historical temperature trends. The projected dates may change throughout the 2014-2015 season. An updated table will be distributed as the season progresses.

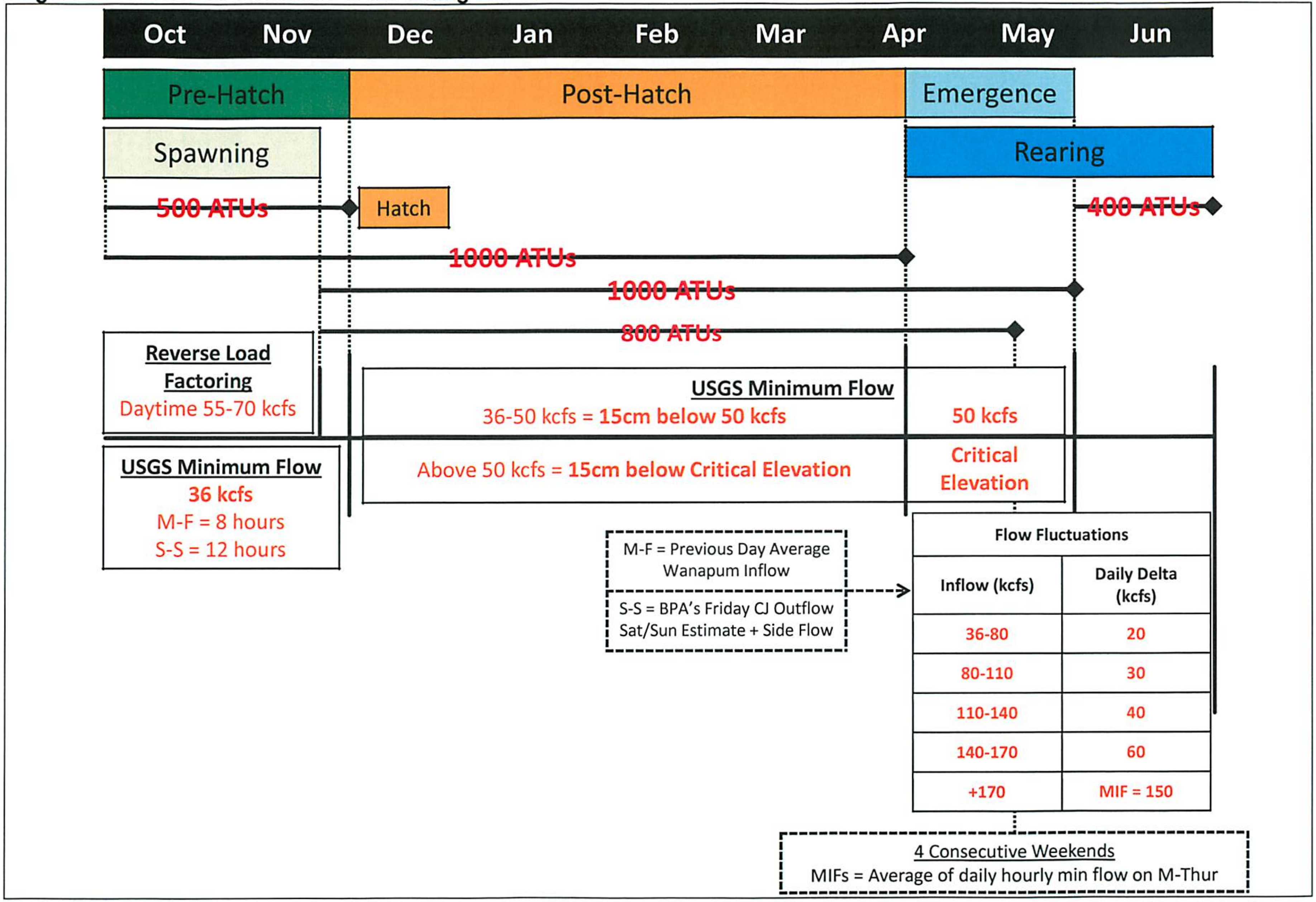
Following the table is a generalized schematic describing the timing of each Period, how the Periods progress during the flow protection season, and the primary flow constraints during each Period. This schematic is an approximation of the timing of each Period and should only be used as a guide for the constraints during each Period.

If there are any questions or concerns regarding the Periods or constraints please feel free to contact me.

Table 1. Current status and projected dates of the HRFCPPA Periods.

HRFCPPA Period		Begin (000 hrs)	End (2400 hrs)	Status of Constraint
Spawning Period		10/22/2014	11/23/2014	Completed
Pre-Hatch Period	<50k	10/22/2014	11/28/2014	Completed
	>50k	10/22/2014	11/28/2014	Completed
Post-Hatch Period	<50k	11/29/2014	2/28/2015	Constraints currently in effect
	>50k	12/11/2014	3/25/2015	Constraints currently in effect
Emergence Period	<50k	**2/26/2015**	**5/9/2015**	**Not yet in effect**
	>50k	3/24/2015	5/9/2015	Not yet in effect
Rearing Period		**2/26/2015**	**6/12/2015**	**Not yet in effect**

Figure 1. Generalized schematic of the timing and constraints of the HRFCPPA Periods.



Trash Rack at Wanapum Left-Bank Fishway Exit

The trash rack is in place at all times during normal fishway operation/fish passage season. The basic design is that the upper portion of the trash rack is solid to prevent debris from entering the fishladder exit pool. With the Wanapum Reservoir at the current elevation (558'-562'), the solid plating is not doing the job and we are experiencing high accumulations of tumble weeds, sticks, flotsam, etc. within the exit pool.

Grating/open area (in which fish pass through) at the bottom of the trash rack is 6' (top to bottom under normal operations). In this photograph, we can see that most of the opening is under the water surface (~5' 2").

To preclude debris loading into the fish ladder exit pool, Grant PUD will be installing an additional plate of steel, which would overlap the current solid plate on the outside of the trash rack.

This plating is temporary and will be installed and removed without a ladder outage. It would also be removed prior to the next interim refill stage and/or back to normal pool (571.5').

This new temporary plating would decrease the current opening from 6' to 3'.

NOTE: The reservoir level in photo is 561', which leaves a 10" gap for debris to enter. At 558' that gap opens to ~3' 10".

Fishladder Exit Pool- Wanapum Left-Bank Fishway Exit (Debris Loading)

Example of the type of debris that is making it through the trash rack at the Wanapum Fishways and accumulating in the fish ladder exit pools. Concern is that this type of debris could make it down to the crowders in front of the fish counting stations, which could result in necessary extended outages over the next 3 months, prior to getting the reservoir back up to normal operation (571.5’).

PRCC - Habitat Funds

Report of Unencumbered Fund Balances

As of December 31, 2014

No Net Impact (NNI) Fund 601:

Cash & Investments Fund Balance per Monthly Report: $ 5,993,853

	Status	Project ID	Less remaining balance with Open Project ID's:	Project Balance	
1.	Open	60100008H	Fish Screen Monitor Program	625,505	
2.	Open	60100009H	Juv NPM Population Control	40,204	
3.	Open	60100011H	Geochemical Analysis of Scales & Fin Rays	990	
4.	Open	60100012H	Goose Is. Terns Eval & Behavio	1,642,579	
5.	Open	60100014H	Electrofishing Boat	(4,896)	
7.	Open	60100016H	Mid-Columbia Intake Screen & Diversion Asses	98,892	
8.	Open	60100017H	JSATS Subyearling Survival Study Lower Hanfc	10,723	
9.	Open	60100018H	WAN Drawdown Migrat Study	488	
10.	Open	60100019H	Lw Wenatchee Instream Flow Ph II	456,241	
11.	Open	60100020H	Methow Valley Irrigation District Instream Flow	1,290,250	
				4,160,977 →	4,160,977
			Fund 601 Unencumbered Balance		**$ 1,832,876**

Habitat Supplemental Fund 602:

Cash & Investments Fund Balance per Monthly Report: $ 4,935,701

	Status	Project ID	Less remaining balance with Open Project ID's:	Project Balance	
1.	Open	60200003H	Trinidad Creek	$ 32,149	
2.	Open	60200006H	ORRI Spawning Hab Improvement	6,306	
3.	Open	60200007H	Methow Sugar Dike Acquisition 1	15,402	
4.	Open	60200008H	Nason Ck LWP B+ Enhance	160,000	
5.	Open	60200009H	Wen Nutrient Enhance Treatment	-	
6.	Open	60200010H	Entiat Stormy Rch Phs III Acq	117,632	
7.	Open	60200012H	ORRI Construction Phase II	65,728	
9.	Open	60200014H	Shuttleworth Crk Diversion and Well Implement	20,563	
11.	Open	60200016H	Roaring Ck Restor/Div Removal	151,577	
12.	Open	60200017H	Robinson Acquisition	5,051	
13.	Open	60200020H	Entiat Riv Cottonwood Phs 2	5,000	
14.	Open	60200021H	Barkley Irr Co. Diverson	267,950	
16.	Open	60200023H	Fish Jump Passage McIntyre	22,559	
17.	Open	60200024H	ORRI-Spawning Platforms in Penticton Channel	145,936	
18.	Open	60200025H	Primary Appraiser Land Acq & Conservation Ea	39,200	
19.	Open	60200026H	Lwr Nason Channel RM 2.4 Land	6,725	
20.	Open	60200027H	Silver Side Channel Pittag Array	49,536	
21.	Open	60200028H	Newby Narrows	350,000	
22.	Open	60200029H	ORRI Spawning Platform	367,368	
				1,828,682 →	1,828,682
			Fund 602 Unencumbered Balance		**$ 3,107,019**

Habitat Fund 603:

Cash & Investments Fund Balance per Monthly Report: $ 1,001,581

	Status	Project ID	Less remaining balance with Open Project ID's:	Project Balance	
1.	Open	60300016H	Libby Ck Riparian Acquisition	63,906	
2.	Open	60300022H	White River Gage Station	7,712	
3.	Open	60300024H	Barkley Irrigation Ditch Diversion Project	5,673	
4.	Open	60300025H	Methow River 1890's Side Channel Acquisition	15,000	
5.	Open	60300026H	Okan River Discharge Monitor	37,232	
6.	Open	60300027H	Icicle IRR Pump Exch Analysis	9,011	
7.	Open	60300028H	Icicle Creek Boulder Pit Tag Array	39,254	
				177,789 →	177,789
			Fund 603 Unencumbered Balance		**$ 823,792**

Total Unencumbered Balance for all PRCC Funds **$ 5,763,687**

PRCC - Habitat Funds

No Net Impact (NNI) - Fund 601

As of December 31, 2014

Activity Detail and Project Balance

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100008H	Open	601-08	Fish Screen Monitor Program			1,377,873.21

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100008H	7/9/2012	RCT00000000053545	WASHINGTON ST DEPT OF FISH & WILDLIFE		FISH SCREEN PROGRAM	$1,279.33
60100008H	8/28/2012	RCT00000000056803	WASHINGTON ST DEPT OF FISH & WILDLIFE		FISH SCREEN PROGRAM 2012	$13,009.44
60100008H	10/22/2012	RCT00000000060120	WASHINGTON ST DEPT OF FISH & WILDLIFE		FISH SCREEN MONITORING PROGRAI	$21,226.09
60100008H	11/28/2012	RCT00000000065971	WASHINGTON ST DEPT OF FISH & WILDLIFE		FISH SCREEN MONITORING PROGRAI	$5,756.11
60100008H	12/19/2012	RCT00000000063920	WASHINGTON ST DEPT OF FISH & WILDLIFE		301-8H	$24,811.09
60100008H	12/19/2012	RCT00000000063916	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$26,254.18
60100008H	12/31/2012	RCT00000000065812	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8 2012	$17,711.55
60100008H	12/31/2012	RCT00000000065892	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$1,485.73
60100008H	12/31/2012	RCT00000000065893	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$2,017.63
60100008H	12/31/2012	RCT00000000065807	WASHINGTON ST DEPT OF FISH & WILDLIFE		FISH SCREEN MONITORING PROGRAI	$3,217.73
60100008H	2/7/2013	RCT00000000067195	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H FISH SCREEN MONITORING	$22,288.85
60100008H	3/21/2013	RCT00000000070233	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$18,690.24
60100008H	4/4/2013	RCT00000000071048	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$56,047.79
60100008H	5/1/2013	RCT00000000072948	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H FISH SCREEN MONITORING	$20,834.05
60100008H	5/15/2013	RCT00000000073824	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$7,985.66
60100008H	7/2/2013	RCT00000000076894	WASHINGTON ST DEPT OF FISH & WILD		601-8H	$38,105.82
60100008H	7/9/2013	RCT00000000077071	WASHINGTON ST DEPT OF FISH & WILD		601-8H FISH SCREEN MONITORING	$45.49
60100008H	7/9/2013	RCT00000000077070	WASHINGTON ST DEPT OF FISH & WILD		601-8H FISH SCREEN MONITORING	$303.84
60100008H	7/9/2013	RCT00000000077069	WASHINGTON ST DEPT OF FISH & WILD		601-8H FISH SCREEN MONITORING	$218.03
60100008H	7/9/2013	RCT00000000077068	WASHINGTON ST DEPT OF FISH & WILD		601-8H FISH SCREEN MONITORING	$333.56
60100008H	7/9/2013	RCT00000000077050	WASHINGTON ST DEPT OF FISH & WILD		601-8H	$35,777.12
60100008H	7/9/2013	RCT00000000077040	WASHINGTON ST DEPT OF FISH & WILD		601-8H	$71.20
60100008H	7/9/2013	RCT00000000077039	WASHINGTON ST DEPT OF FISH & WILD		601-8H	$176.34
60100008H	7/9/2013	RCT00000000077036	WASHINGTON ST DEPT OF FISH & WILD		601-8H	$226.24
60100008H	7/9/2013	RCT00000000077038	WASHINGTON ST DEPT OF FISH & WILD		601-8H	$80.92
60100008H	9/4/2013	RCT00000000080739	WASHINGTON ST DEPT OF FISH & WILD		601-8H FISH SCREEN MONITORING	$10,818.54
60100008H	9/4/2013	RCT00000000080741	WASHINGTON ST DEPT OF FISH & WILD		601-8H FISH SCREEN MONITORING	$241.13
60100008H	10/1/2013	RCT00000000082565	WASHINGTON ST DEPT OF FISH & WILD		601-8H FISH SCREEN MONITORING	$4,244.69
60100008H	10/8/2013	RCT00000000083198	WASHINGTON ST DEPT OF FISH & WILD		601-8H	$12,190.94
60100008H	11/13/2013	RCT00000000085383	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$21,172.48
60100008H	12/11/2013	RCT00000000087463	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$24,559.60
60100008H	12/31/2013	RCT00000000088817	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$26,441.27
60100008H	2/5/2014	RCT00000000091066	WASHINGTON ST DEPT OF FISH & WILD		601-8H FISH SCI	$27,263.43
60100008H	3/6/2014	RCT00000000092806	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$29,832.39
60100008H	4/8/2014	RCT00000000094921	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$40,478.31
60100008H	5/6/2014	RCT00000000096977	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$38,176.47
60100008H	6/10/2014	RCT00000000099670	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$25,340.55
60100008H	7/7/2014	RCT00000000101592	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$18,322.79
60100008H	9/8/2014	RCT00000000105823	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$27,432.90
60100008H	9/30/2014	RCT00000000107518	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$16,380.84
60100008H	10/13/2014	RCT00000000108036	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$20,439.20
60100008H	11/10/2014	RCT00000000110216	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$17,765.79
60100008H	12/19/2014	RCT00000000112975	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$23,460.73
60100008H	12/31/2014	RCT00000000113936	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-8H	$49,852.25
					Total Project Expenditures	$752,368.33
					Remaining Project Balance	**625,504.88**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100009H	Open	601-09	Juv NPM Population Control			267,306.23

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100009H	9/20/2012	RCT00000000058134	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H	$75,278.70
60100009H	10/4/2012	RCT00000000059082	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H	$822.45
60100009H	10/22/2012	RCT00000000060118	WASHINGTON ST DEPT OF FISH & WILDLIFE		JUVENILE NORTHERN PIKEMINNOW	$37,246.15
60100009H	12/20/2012	RCT00000000064040	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H	$23,151.27
60100009H	12/20/2012	RCT00000000064036	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H	$27,976.40
60100009H	12/31/2012	RCT00000000065895	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H	$19,284.97
60100009H	2/6/2013	RCT00000000067116	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H	$152.75
60100009H	2/14/2013	RCT00000000067820	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H	$18,197.65

PRCC - Habitat Funds

No Net Impact (NNI) - Fund 601

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Activity Detail and Project Balance

60100009H	3/21/2013	RCT00000000070262	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H JUVENILE NORTHERN PIKEM	$12,600.59
60100009H	4/15/2013	RCT00000000071727	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-9H	$2,191.99
60100009H	7/9/2013	RCT00000000077080	WASHINGTON ST DEPT OF FISH & WILD		601-9H JUVENILE NORTHERN PIKEM	$1,089.78
60100009H	7/9/2013	RCT00000000077059	WASHINGTON ST DEPT OF FISH & WILD		601-9H	$3,515.66
60100009H	7/9/2013	RCT00000000077060	WASHINGTON ST DEPT OF FISH & WILD		601-9H	$12,221.06
60100009H	7/9/2013	RCT00000000077061	WASHINGTON ST DEPT OF FISH & WILD		601-9H	$1,611.79
60100009H	7/9/2013	RCT00000000077062	WASHINGTON ST DEPT OF FISH & WILD		601-9H	$1,318.72
60100009H	7/9/2013	RCT00000000077072	WASHINGTON ST DEPT OF FISH & WILD		601-9H JUVENILE NORTHERN PIKEM	$1,314.24
60100009H	7/9/2013	RCT00000000077074	WASHINGTON ST DEPT OF FISH & WILD		601-9H JUVENILE NORTHERN PIKEM	$1,723.75
60100009H	7/9/2013	RCT00000000077079	WASHINGTON ST DEPT OF FISH & WILD		601-9H JUVENILE NORTHERN PIKEM	$1,792.37
60100009H	8/27/2013	ML000000000004844				($14,388.18)
					Total Project Expenditures	$227,102.11
					Remaining Project Balance	**40,204.12**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100011H	Open	601-11	Geochemical Analysis S F Rays		To determine the accuracy of geochemical analysis for identifying the origin of	513,342.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100011H	9/10/2012	RCT00000000057345	BATTELLE-NORTHWEST CORP		601-11	$16,538.22
60100011H	9/27/2012	RCT00000000058570	BATTELLE-NORTHWEST CORP		601-11H	$9,194.62
60100011H	10/25/2012	RCT00000000060477	BATTELLE-NORTHWEST CORP		601-11H	$28,084.84
60100011H	11/7/2012	RCT00000000061321	BATTELLE-NORTHWEST CORP		601-11H	$53,213.21
60100011H	1/13/2013	RCT00000000066790	BATTELLE-NORTHWEST CORP		601-11H GEOCHEMICAL ANALYSIS	$69,074.89
60100011H	2/19/2013	RCT00000000068161	BATTELLE-NORTHWEST CORP		601-11H	$58,767.38
60100011H	3/18/2013	RCT00000000069970	BATTELLE-NORTHWEST CORP		601-11H	$44,293.89
60100011H	5/2/2013	RCT00000000073003	BATTELLE-NORTHWEST CORP		601-11H ANALYSIS OF SCALES & F	$31,840.41
60100011H	5/15/2013	RCT00000000073818	BATTELLE-NORTHWEST CORP		601-11H	$42,901.80
60100011H	8/27/2013	RCT00000000080449	BATTELLE-NORTHWEST CORP		601-11H GEOCHEMICAL ANALYSIS O	$67,679.06
60100011H	8/27/2013	RCT00000000080450	BATTELLE-NORTHWEST CORP		601-11H GEOCHEMICAL ANALYSIS O	$27,756.51
60100011H	11/12/2013	RCT00000000085238	BATTELLE-NORTHWEST CORP		601-11H	$29,941.83
60100011H	2/26/2014	RCT00000000092388	BATTELLE-NORTHWEST CORP		601-11H	$8,832.27
60100011H	2/26/2014	RCT00000000092345	BATTELLE-NORTHWEST CORP		601-11H GEOCHEMICAL ANALYSIS O	$16,031.76
60100011H	2/26/2014	RCT00000000092344	BATTELLE-NORTHWEST CORP		601-11H GEOCHEMICAL ANALYSIS O	$8,201.08
					Total Project Expenditures	$512,351.77
					Remaining Project Balance	**990.23**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100012H	Open	601-12	Evaluation and Behavior Analysis of Caspian Terns on Goose Island		Study to evaluate the foraging behavior and colony connectivity of Caspian terns	2,586,977.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100012H	5/30/2013	RCT00000000074721	OUS OREGON STATE UNIVERSITY		601-12H	$16,055.14
60100012H	6/20/2013	RCT00000000076023	OUS OREGON STATE UNIVERSITY		601-12H CASPIAN TERN M & E GOO	$106,436.69
60100012H	7/24/2013	RCT00000000078363	OSU OREGON STATE UNIVERSITY		601-12H	$63,827.32
60100012H	8/14/2013	RCT00000000079591	OSU OREGON STATE UNIVERSITY		601-12H	$65,667.14
60100012H	8/26/2013	RCT00000000080258	OSU OREGON STATE UNIVERSITY		601-12H CASPIAN TERN M & E GOO	$7,623.88
60100012H	10/1/2013	RCT00000000082584	OSU OREGON STATE UNIVERSITY		601-12H	$24,641.52
60100012H	11/12/2013	RCT00000000085284	OSU OREGON STATE UNIVERSITY		601-12H CASPIAN TERN M & E GOO	$38,409.96
60100012H	12/31/2013	RCT00000000088819	OSU OREGON STATE UNIVERSITY		601-12H	$26,173.84
60100012H	3/17/2014	RCT00000000093591	OSU OREGON STATE UNIVERSITY		601-12H	$8,510.17
60100012H	3/17/2014	RCT00000000093589	OSU OREGON STATE UNIVERSITY		601-12H	$32,142.36
60100012H	3/19/2014	RCT00000000093707	OSU OREGON STATE UNIVERSITY		601-12H CASPIAN TERN M & E GOO	$17,864.13
60100012H	5/28/2014	RCT00000000098928	OSU OREGON STATE UNIVERSITY		601-12H	$145,721.58
60100012H	6/17/2014	RCT00000000100291	OSU OREGON STATE UNIVERSITY		601-12H	$71,643.42
60100012H	7/1/2014	RCT00000000101374	OSU OREGON STATE UNIVERSITY		601-12H	$50,308.63
60100012H	8/13/2014	RCT00000000104237	OSU OREGON STATE UNIVERSITY		601-12H	$87,062.47
60100012H	8/25/2014	RCT00000000104875	OSU OREGON STATE UNIVERSITY		601-12H	$12,371.11
60100012H	11/12/2014	RCT00000000110276	OSU OREGON STATE UNIVERSITY		601-12H	$47,863.97

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No Net Impact (NNI) - Fund 601

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Activity Detail and Project Balance

60100012H	11/18/2014	RCT00000000110668	OSU OREGON STATE UNIVERSITY		601-12H	$33,156.55
60100012H	12/31/2014	RCT00000000114570	OSU OREGON STATE UNIVERSITY		601-12H	$36,645.78
60100012H	12/19/2014	RCT00000000112980	OSU OREGON STATE UNIVERSITY		601-12H	$52,271.96
					Total Project Expenditures	$944,397.62
					Remaining Project Balance	**1,642,579.38**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100014H	Open	601-14	Electrofishing Boat			125,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100014H	6/12/2014	RCT00000000099933	MIDWEST LAKE MANAGEMENT, INC		601-14H	$120,351.00
60100014H	7/1/2014	RCT00000000101313	WA ST DEPT OF LICENSING-GRANT COUNTY		601-14H	$9,545.48
					Total Project Expenditures	$129,896.48
					Remaining Project Balance	**(4,896.48)**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100016H	Open	601-16	Mid-Columbia Intake Screen & Diversion Assessment			102,838.58

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100016H	9/8/2014	RCT00000000105827	TROUT UNLIMITED - WASH. WATER PROJECT		601-16H	$588.67
60100016H	10/13/2014	RCT00000000108033	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-16H	$201.48
60100016H	11/10/2014	RCT00000000110212	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-16H	$621.08
60100016H	12/19/2014	RCT00000000112979	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-16H	$835.81
60100016H	12/31/2014	RCT00000000113955	WASHINGTON ST DEPT OF FISH & WILDLIFE		601-16H	$1,699.31
					Total Project Expenditures	$3,946.35
					Remaining Project Balance	**98,892.23**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100017H	Open	601-17	JSATS Subyearling Survival Study Lower Hanford Reach			79,906.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100017H	3/20/2014	RCT00000000093811	BATTELLE-NORTHWEST CORP		JSATS SURVIVAL STUDY LOWER HAI	$39,953.00
60100017H	6/24/2014	RCT00000000100885	BATTELLE-NORTHWEST CORP		601-17H	$29,229.79
					Total Project Expenditures	$69,182.79
					Remaining Project Balance	**10,723.21**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100018H	Open	601-18	WAN Drawdown Migrat Study			225,000.00

Project Expenditure Activity:

PRCC - Habitat Funds

No Net Impact (NNI) - Fund 601

As of December 31, 2014

Activity Detail and Project Balance

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100018H	5/28/2014	RCT00000000098756	BLUE LEAF ENVIRONMENTAL, INC			$19,096.41
60100018H	5/28/2014	RCT00000000098755	BLUE LEAF ENVIRONMENTAL, INC			$23,174.40
60100018H	6/3/2014	RCT00000000099120	SKALSKI STATISTICAL SERVICES			$1,864.20
60100018H	7/1/2014	RCT00000000101334	BLUE LEAF ENVIRONMENTAL, INC			$18,260.03
60100018H	7/22/2014	RCT00000000102724	BLUE LEAF ENVIRONMENTAL, INC			$27,288.28
60100018H	7/1/2014	RCT00000000101332	BLUE LEAF ENVIRONMENTAL, INC			$38,830.01
60100018H	7/29/2014	RCT00000000103168	BLUE LEAF ENVIRONMENTAL, INC			$94,970.87
60100018H	8/5/2014	RCT00000000103699	BLUE LEAF ENVIRONMENTAL, INC			$1,027.93
					Total Project Expenditures	$224,512.13
					Remaining Project Balance	**487.87**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100019H	Open	601-19	Lw Wenatchee Instream Flow Ph II			456,241.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
					Total Project Expenditures	$0.00
					Remaining Project Balance	**456,241.00**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60100020H	Open	601-20	Methow Valley Irrigation District Instream Flow Improvement Project			1,400,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60100020H	10/21/2014	RCT00000000108814	TROUT UNLIMITED - WASH. WATER PROJECT		601-20H	$55,016.29
60100020H	11/25/2014	RCT00000000111156	TROUT UNLIMITED - WASH. WATER PROJECT		601-20H	$39,772.93
60100020H	12/19/2014	RCT00000000112976	TROUT UNLIMITED - WASH. WATER PROJECT		601-20H	$2,467.40
60100020H	12/31/2014	RCT00000000114951	TROUT UNLIMITED - WASH. WATER PROJECT		601-20H	$12,492.93
					Total Project Expenditures	$109,749.55
					Remaining Project Balance	**1,290,250.45**

PRCC - Habitat Funds

Habitat Supplemental - Fund 602

As of December 31, 2014

Activity Detail and Project Balance

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200003H	Open	602-03	Trinidad Creek Land Purchase	WDFW	63 acres of shrub steppe land purchase	117,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200003H	7/29/2010	RCT00000000011359	WASHINGTON ST DEPT OF FISH & WILDLIFE		TRINIDAD CREEK	$6,019.88
60200003H	10/5/2010	RCT00000000015264	WASHINGTON ST DEPT OF FISH & WILDLIFE		TRINIDAD CREEK ACQUISITION-CRS	$124.19
60200003H	10/5/2010	RCT00000000015263	WASHINGTON ST DEPT OF FISH & WILDLIFE		TRINIDAD CREEK ACQUISITION	$1,733.12
60200003H	11/4/2010	RCT00000000017797	WASHINGTON ST DEPT OF FISH & WILDLIFE		TRINIDAD CREEK/CRESCENT VIEW E	$837.85
60200003H	11/12/2010	RCT00000000018637	WASHINGTON ST DEPT OF FISH & WILDLIFE		HABITAT 603-14	$11.26
60200003H	11/12/2010	RCT00000000018632	WASHINGTON ST DEPT OF FISH & WILDLIFE		ENVIRONMENTAL AUDIT	$1,375.81
60200003H	7/28/2011	RCT00000000033309	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-14H TRINIDAD CREEK	$1,363.70
60200003H	8/31/2011	RCT00000000035332	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-14 JUN-11	$10,096.15
60200003H	11/17/2011	RCT00000000039958	WASHINGTON ST DEPT OF FISH & WILDLIFE		CRESCENT VIEW ESTATES	$1,363.79
60200003H	11/17/2011	RCT00000000039959	WASHINGTON ST DEPT OF FISH & WILDLIFE		CRESCENT VIEW ESTATES	$4,938.99
60200003H	12/31/2011	RCT00000000042888	WASHINGTON ST DEPT OF FISH & WILDLIFE		NOV-11 TRINIDAD CREEK ACQUISIT	$611.10
60200003H	12/31/2011	RCT00000000042918	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-14	$677.18
60200003H	2/15/2012	RCT00000000044747	WASHINGTON ST DEPT OF FISH & WILDLIFE		ACQUISITION T CREEK/ C VIEW ES	$622.25
60200003H	3/8/2012	RCT00000000045996	WASHINGTON ST DEPT OF FISH & WILDLIFE			$53,613.50
60200003H	4/5/2012	RCT00000000047730	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-14	$1,321.98
60200003H	5/2/2012	RCT00000000049429	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-14 TRINIDAD CREEK ACQUISIT	$140.69
					Total Project Expenditures	$84,851.44
					Remaining Project Balance	**32,148.56**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200006H	Open	602-06	ORRI Spawning Hab Improvement	ONA	Okanogan River in BC	65,141.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200006H	9/6/2012	RCT00000000057237	OKANAGAN NATION AQUATIC ENTERPRISES, LTD.		HFA 602-6	$2,881.82
60200006H	10/3/2012	RCT00000000058957	OKANAGAN NATION ALLIANCE		HFA 602-6	$2,576.02
60200006H	12/31/2012	RCT00000000064915	OKANAGAN NATION ALLIANCE		602-6H	$91.93
60200006H	3/26/2013	RCT00000000070529	OKANAGAN NATION ALLIANCE		FEB-13 OKANAGAN RIVER VERTICAI	$481.82
60200006H	12/18/2013	RCT00000000087910	OKANAGAN NATION ALLIANCE		602-6 OKANAGAN RIVER VERTICAL	$2,710.29
60200006H	12/23/2013	RCT00000000088207	OKANAGAN NATION ALLIANCE		602-6H	$42,518.87
60200006H	3/7/2014	RCT00000000092941	OKANAGAN NATION ALLIANCE		602-6H	$82.11
60200006H	5/15/2014	RCT00000000097769	OKANAGAN NATION AQUATIC ENTERPRISES, LTD.		602-6H	$4,976.02
60200006H	7/11/2014	RCT00000000101991	OKANAGAN NATION ALLIANCE		602-6H	$252.05
60200006H	11/25/2014	RCT00000000111158	OKANAGAN NATION ALLIANCE		602-6H	$1,287.19
60200006H	12/19/2014	RCT00000000112965	OKANAGAN NATION ALLIANCE		602-6H	$445.37
60200006H	12/31/2014	RCT00000000114403	OKANAGAN NATION ALLIANCE		602-6H	$531.20
					Total Project Expenditures	$58,834.69
					Remaining Project Balance	**6,306.31**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200007H	Open	602-07	Methow Sugar Dike Acquisition 1	Methow Salmon	Purchase 10.4 acre parcel lower segment M	190,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200007H	8/31/2011	RCT00000000035447	BAINES TITLE & ESCROW		HFA-6027H METHOW DIKE ACQUISIT	$168,366.48
60200007H	5/24/2012	RCT00000000050829	METHOW SALMON RECOVERY FNDN		602-7 ACQUISITION	$3,016.73
60200007H	10/2/2012	RCT00000000058851	METHOW SALMON RECOVERY FNDN		602-7H	$2,747.11
60200007H	8/7/2013	RCT00000000079172	METHOW SALMON RECOVERY FNDN		602-7H METHOW SUGAR DIKE ACQUI	$148.50

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60200007H	5/20/2014	RCT00000000098095	METHOW SALMON RECOVERY FNDN	602-7		$319.00
					Total Project Expenditures	174,597.82
					Remaining Project Balance	**15,402.18**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200008H	Open	602-8	Nason Ck LWP B+ Enhance	Chelan PUD NR	Design and permitting of an in-stream vorte	160,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
					Total Project Expenditures	-
					Remaining Project Balance	**160,000.00**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200009H	Open	602-09	Wen Nutrient Enhance Treatment			130,570.79

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200009H	9/27/2012	RCT00000000058569	CASCADE COLUMBIA FISHERIES ENHC GRP		602-9H NUTRIENT ENHANCEMENT	$19,953.56
60200009H	11/1/2012	RCT00000000060926	CASCADE COLUMBIA FISHERIES ENHC GRP		602-9H WENATCHEE NUTRIENT ENH/	$14,443.55
60200009H	12/27/2012	RCT00000000064512	CASCADE COLUMBIA FISHERIES ENHC GRP		602-9H	$10,526.87
60200009H	12/30/2012	RCT00000000064706	CASCADE COLUMBIA FISHERIES ENHC GRP		602-9H	$9,570.92
60200009H	3/4/2013	RCT00000000068856	CASCADE COLUMBIA FISHERIES ENHC GRP		602-9 WENATCHEE NUTRIENT ENHAI	$8,048.58
60200009H	4/4/2013	RCT00000000071028	CASCADE COLUMBIA FISHERIES ENHC GRP		602-9 WENATCHEE NUTRIENT ENHAI	$7,623.87
60200009H	6/6/2013	RCT00000000075154	CASCADE COLUMBIA FISHERIES ENHC (		602-9	$9,316.85
60200009H	6/27/2013	RCT00000000076523	CASCADE COLUMBIA FISHERIES ENHC (		602-9	$13,231.82
60200009H	7/24/2013	RCT00000000078296	CASCADE COLUMBIA FISHERIES ENHC (		602-9H WENATCHEE NUTRIENT ENH/	$5,144.75
60200009H	9/25/2013	RCT00000000082163	CASCADE COLUMBIA FISHERIES ENHC (		WENATCHEE NUTRIENT ASSESSMEN	$8,800.75
60200009H	11/4/2013	RCT00000000084775	CASCADE COLUMBIA FISHERIES ENHC GRP		602.9H WENATCHEE NUTRIENT ENH/	$13,163.51
60200009H	10/13/2014	RCT00000000108018	CASCADE COLUMBIA FISHERIES ENHC GRP		602-9H	$174.97
60200009H	12/31/2014	RCT00000000114953	CASCADE COLUMBIA FISHERIES ENHC GRP		602-9H	$10,570.79
					Total Project Expenditures	$130,570.79
					Remaining Project Balance	**-**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200010H	Open	602-10	Eniat Stormy Rch Phs III Acq			711,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200010H	3/14/2013	RCT00000000069772	CHELAN-DOUGLAS LAND TRUST		ENTIAT STORMY REACH PHASE 3	$3,083.27
60200010H	6/19/2013	RCT00000000075844	CHELAN-DOUGLAS LAND TRUST		602-10H ENTIAT STORMY REACH PH	$3,633.52
60200010H	12/23/2013	RCT00000000088193	CHELAN-DOUGLAS LAND TRUST		602-10H ENTIAT STORMY REACH PH	$11,402.78
60200010H	4/28/2014	RCT00000000096514	CHELAN-DOUGLAS LAND TRUST		602-10H	$1,142.63
60200010H	4/28/2014	RCT00000000096506	CHELAN-DOUGLAS LAND TRUST		602-10H	$3,772.53
60200010H	7/8/2014	RCT00000000101807	CHELAN-DOUGLAS LAND TRUST		602-10H	$10,000.00
60200010H	7/15/2014	RCT00000000102229	CHELAN-DOUGLAS LAND TRUST		602-10H	$10,372.59
60200010H	7/8/2014	RCT00000000101808	CHELAN-DOUGLAS LAND TRUST		602-10H	$535,211.32
60200010H	12/31/2014	RCT00000000114294	CHELAN-DOUGLAS LAND TRUST		602-10H	$14,749.46

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Activity Detail and Project Balance

Total Project Expenditures	593,368.10
Remaining Project Balance	**117,631.90**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200012H	Open	602-12	ORRI Construction Phase II			599,588.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200012H	9/6/2012	RCT00000000057240	OKANAGAN NATION AQUATIC ENTERPRISES, LTD.		HFA 602-12H	$975.43
60200012H	9/18/2013	RCT00000000081732	OKANAGAN NATION ALLIANCE		602-12H OKANAGAN RIVER RESTOR/	$5,546.52
60200012H	9/25/2013	RCT00000000082349	OKANAGAN NATION ALLIANCE		602-12H OKANAGAN RIVER RESTOR/	$89,953.92
60200012H	9/25/2013	RCT00000000082352	OKANAGAN NATION ALLIANCE		602-12H OKANAGAN RIVER RESTOR/	$15,700.57
60200012H	10/8/2013	RCT00000000083144	OKANAGAN NATION ALLIANCE		602-12H	$108,619.11
60200012H	10/15/2013	RCT00000000083574	OKANAGAN NATION ALLIANCE		602-12H	$104,665.35
60200012H	11/12/2013	RCT00000000085285	OKANAGAN NATION ALLIANCE		602-12H OKANAGAN RIVER RESTOR/	$2,614.78
60200012H	11/20/2013	RCT00000000085968	OKANAGAN NATION ALLIANCE		601-124	$141,814.27
60200012H	12/31/2013	RCT00000000089775	OKANAGAN NATION ALLIANCE		602-12H OKANAGAN RIVER RESTOR/	$4,650.90
60200012H	12/31/2013	RCT00000000089691	OKANAGAN NATION ALLIANCE		602-12H	$26,273.03
60200012H	3/7/2014	RCT00000000092942	OKANAGAN NATION ALLIANCE		602-12H	$13,258.07
60200012H	5/15/2014	RCT00000000097768	OKANAGAN NATION AQUATIC ENTERPRISES, LTD.		602-12H	$7,980.10
60200012H	6/17/2014	RCT00000000100278	OKANAGAN NATION ALLIANCE		602-12H	$882.57
60200012H	7/11/2014	RCT00000000101992	OKANAGAN NATION ALLIANCE		602-12H	$3,227.66
60200012H	8/12/2014	RCT00000000104189	OKANAGAN NATION ALLIANCE		602-12H	$4,428.19
60200012H	9/23/2014	RCT00000000106941	OKANAGAN NATION ALLIANCE		602-12H	$3,009.49
60200012H	12/31/2014	RCT00000000114400	OKANAGAN NATION ALLIANCE		602-12H	$259.91

Total Project Expenditures	$533,859.87
Remaining Project Balance	**65,728.13**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200014H	Open	602-14	Shuttleworth Ck Diversion/Well			477,230.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200014H	11/7/2012	RCT00000000061325	OKANAGAN NATION AQUATIC ENTERPRISES, LTD.		602-14H	$4,272.27
60200014H	11/26/2012	RCT00000000062444	OKANAGAN NATION ALLIANCE		602-14H SHUTTLEWORTH CREEK DIV	$39,412.89
60200014H	12/10/2012	RCT00000000063308	OKANAGAN NATION ALLIANCE		SHUTTLEWORTH CREEK DIVERSION	$3,846.99
60200014H	12/27/2012	RCT00000000064481	OKANAGAN NATION ALLIANCE		SHUTTLEWORTH CREEK DIVERSION	$116,699.77
60200014H	12/30/2012	RCT00000000064709	OKANAGAN NATION ALLIANCE		SHUTTLEWORTH CREEK DIVERSION	$59,159.92
60200014H	1/23/2013	RCT00000000066264	OKANAGAN NATION ALLIANCE		602-14H SHUTTLEWORTH CREEK DIV	$225.92
60200014H	2/27/2013	RCT00000000068657	OKANAGAN NATION ALLIANCE		602-14H	$13,824.93
60200014H	3/20/2013	RCT00000000070194	OKANAGAN NATION ALLIANCE		302-14H SHUTTLEWORTH CREEK DIV	$6,733.07
60200014H	4/4/2013	RCT00000000071050	OKANAGAN NATION ALLIANCE		302-14H SHUTTLEWORTH CREEK DIV	$18,770.05
60200014H	5/16/2013	RCT00000000073947	OKANAGAN NATION ALLIANCE		678-010 MAR-13 SHUTTLEWORTH CK	$30,912.15
60200014H	6/18/2013	RCT00000000075738	OKANAGAN NATION ALLIANCE		SHUTTLEWORTH CREEK DIVERSION	$2,966.69
60200014H	7/12/2013	RCT00000000077484	OKANAGAN NATION ALLIANCE		602-14H SHUTTLEWORTH CREEK DIV	$4,664.18
60200014H	9/18/2013	RCT00000000081731	OKANAGAN NATION ALLIANCE		678-013 JUL-13 SHUTTLEWORTH CR	$5,862.34
60200014H	10/2/2013	RCT00000000082697	OKANAGAN NATION ALLIANCE		602-14H	$1,761.06
60200014H	12/18/2013	RCT00000000087909	OKANAGAN NATION ALLIANCE		678-015 OCT-13 SHUTTLEWORK CRD	$8,158.03
60200014H	12/23/2013	RCT00000000088076	OKANAGAN NATION ALLIANCE		602-14H SHUTTLEWORTH CREEK DIV	$0.90
60200014H	12/31/2013	RCT00000000089689	OKANAGAN NATION ALLIANCE		602-14H	$3,369.18
60200014H	6/24/2014	RCT00000000100734	OKANAGAN NATION AQUATIC ENTERPRISES, LTD.		602-14H	$69,490.27
60200014H	6/17/2014	RCT00000000100277	OKANAGAN NATION ALLIANCE		602-14H	$41,787.06
60200014H	8/12/2014	RCT00000000104188	OKANAGAN NATION ALLIANCE		602-14H	$24,508.75
60200014H	9/23/2014	RCT00000000107071	OKANAGAN NATION ALLIANCE		602-14H	$240.49

Total Project Expenditures	$456,666.91
Remaining Project Balance	**20,563.09**

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PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200016H	Open	602-16	Roaring Ck Restor/Div Removal			160,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200016H	9/18/2013	RCT00000000081693	TROUT UNLIMITED - WASH. WATER PRO		602-16H	$846.00
60200016H	12/18/2013	RCT00000000087908	TROUT UNLIMITED - WASH. WATER PROJECT		602-16 ROARING CREEK FLOW REST	$3,287.26
60200016H	2/19/2014	RCT00000000091911	TROUT UNLIMITED - WASH. WATER PRO		602-16H	$708.73
60200016H	4/28/2014	RCT00000000096525	TROUT UNLIMITED - WASH. WATER PRO		602-16H	$2,400.00
60200016H	5/20/2014	RCT00000000098123	TROUT UNLIMITED - WASH. WATER PRO		602-16H	$1,181.30
					Total Project Expenditures	8,423.29
					Remaining Project Balance	**151,576.71**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200017H	Open	602-17	Robinson Acquisition		For the purchase of 18 acres including abou	270,065.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200017H	6/25/2013	RCT00000000076270	INLAND PROFESSIONAL TITLE, LLC		ROBINSON LAND ACQUISITION	$257,466.96
60200017H	8/7/2013	RCT00000000079220	METHOW SALMON RECOVERY FNDN		602-17H ROBINSON LAND ACQUISIT	$4,036.50
60200017H	1/22/2014	RCT00000000090167	METHOW SALMON RECOVERY FNDN		602-17H	$241.50
60200017H	9/2/2014	RCT00000000105486	METHOW SALMON RECOVERY FNDN		602-17H	$3,269.44
					Total Project Expenditures	$265,014.40
					Remaining Project Balance	**5,050.60**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200020H	Open	602-20	Entiat Riv Cottonwood Phs 2			10,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200020H	2/26/2014	RCT00000000092308	CHELAN-DOUGLAS LAND TRUST		602-20H	$5,000.00
					Total Project Expenditures	5,000.00
					Remaining Project Balance	**5,000.00**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200021H	Open	602-21	Barkley Irr Co. Diverson			299,380.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200021H	10/22/2014	RCT00000000108842	TROUT UNLIMITED - WASH. WATER PRO		602-21H	$16,100.00
60200021H	11/25/2014	RCT00000000111155	TROUT UNLIMITED - WASH. WATER PRO		602-21H	$15,330.00

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Activity Detail and Project Balance

Total Project Expenditures	31,430.00
Remaining Project Balance	**267,950.00**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200023H	Open	602-23	Fish Jump Passage McIntyre			32,940.60

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200023H	9/23/2014	RCT000000000107070	OKANAGAN NATION ALLIANCE		602-23H	$4,117.48
60200023H	11/4/2014	RCT000000000109803	OKANAGAN NATION ALLIANCE		602-23H	$1,117.82
60200023H	12/15/2014	RCT000000000112539	OKANAGAN NATION ALLIANCE		602-23H	$5,146.37

Total Project Expenditures	$10,381.67
Remaining Project Balance	**22,558.93**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200024H	Open	602-24	ORRI-Spawning Platforms in Penticton Channel			391,200.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200024H	7/15/2014	RCT000000000102251	OKANAGAN NATION ALLIANCE		602-24H	$33,572.50
60200024H	9/23/2014	RCT000000000107067	OKANAGAN NATION ALLIANCE		602-24H	$36,732.97
60200024H	9/23/2014	RCT000000000107069	OKANAGAN NATION ALLIANCE		602-24H	$57,034.78
60200024H	10/13/2014	RCT000000000108032	OKANAGAN NATION ALLIANCE		602-24H	$36,285.05
60200024H	10/13/2014	RCT000000000108030	OKANAGAN NATION ALLIANCE		602-24H	$70,435.86
60200024H	11/25/2014	RCT000000000111157	OKANAGAN NATION ALLIANCE		602-24H	$4,297.22
60200024H	12/19/2014	RCT000000000112966	OKANAGAN NATION ALLIANCE		602-24H	$6,906.07

Total Project Expenditures	245,264.45
Remaining Project Balance	**145,935.55**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200025H	Open	602-25	Primary Appraiser Land Acq & Conservation Ease			50,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200025H	9/23/2014	RCT000000000106943	CASCADE CHELAN APPRAISAL, INC		602-25H	$10,800.00

Total Project Expenditures	$10,800.00
Remaining Project Balance	**39,200.00**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200026H	Open	602-26	Lwr Nason Channel RM 2.4 Land			10,000.00

Project Expenditure Activity:

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Activity Detail and Project Balance

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200026H	12/16/2014	RCT000000000112962	CHELAN-DOUGLAS LAND TRUST		602-26H	$3,274.75
					Total Project Expenditures	3,274.75
					Remaining Project Balance	**6,725.25**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200027H	Open	602-27	Silver Side Channel Pittag Array			123,638.30

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60200027H	12/19/2014	RCT000000000112963	CASCADE COLUMBIA FISHERIES ENHC (		602-27H	$22,859.94
60200027H	12/31/2014	RCT000000000114954	CASCADE COLUMBIA FISHERIES ENHC (		602-27H	$51,242.51
					Total Project Expenditures	74,102.45
					Remaining Project Balance	**49,535.85**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200028H	Open	602-28	Newby Narrows			350,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
					Total Project Expenditures	-
					Remaining Project Balance	**350,000.00**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60200029H	Open	602-29	ORRI Spawning Platform			367,368.34

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
					Total Project Expenditures	-
					Remaining Project Balance	**367,368.34**

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Activity Detail and Project Balance

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60300016H	Open	603-16	Libby Ck Riparian Acquisition	WDFW	18.5 acres on Libby Creek, Methow basin	206,600.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60300016H	10/7/2010	RCT00000000015539	WASHINGTON ST DEPT OF FISH & WILDLIFE		PR HABITAT CONSERVATION-LIBBY	$714.92
60300016H	11/4/2010	RCT00000000017798	WASHINGTON ST DEPT OF FISH & WILDLIFE		PR HABITAT CONSV.LIBBY CREEK	$489.56
60300016H	11/4/2010	RCT00000000017800	WASHINGTON ST DEPT OF FISH & WILDLIFE		PR HABITAT CONSERVATION-LIBBY	$643.96
60300016H	11/12/2010	RCT00000000018635	WASHINGTON ST DEPT OF FISH & WILDLIFE		LIBBY CREEK HABITAT	$5,731.52
60300016H	12/31/2010	RCT00000000021924	WASHINGTON ST DEPT OF FISH & WILDLIFE		LIBBY CREEK HABITAT	$258.23
60300016H	12/31/2010	RCT00000000021454	WASHINGTON ST DEPT OF FISH & WILDLIFE		LIBBY CREEK HABITAT	$2,053.16
60300016H	2/23/2011	RCT00000000024036	WASHINGTON ST DEPT OF FISH & WILDLIFE		LIBBY CREEK	$130,387.58
60300016H	3/2/2011	RCT00000000024403	WASHINGTON ST DEPT OF FISH & WILDLIFE		PR HABITAT CONSERVATION-LIBBY	$439.03
60300016H	7/22/2011	RCT00000000033027	WASHINGTON ST DEPT OF FISH & WILDLIFE		LOWER LIBBY CREEK	$189.08
60300016H	8/31/2011	RCT00000000035330	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-16 LIBBY CREEK JUN-11	$521.61
60300016H	12/19/2012	RCT00000000063918	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-164	$334.18
60300016H	2/5/2014	RCT00000000091068	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-16H	$408.51
60300016H	7/7/2014	RCT00000000101594	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-16H	$23.81
60300016H	11/10/2014	RCT00000000110215	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-16H	$498.47
					456,241.00 :al Project Expenditures	$142,693.62
					Remaining Project Balance	**63,906.38**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60300022H	Open	603-22	White River Gage Station			22,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60300022H	10/25/2012	RCT00000000060464	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$103.09
60300022H	11/19/2012	RCT00000000062010	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$115.98
60300022H	1/24/2013	RCT00000000066317	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$343.86
60300022H	3/5/2013	RCT00000000068904	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$181.18
60300022H	5/1/2013	RCT00000000072960	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$811.71
60300022H	6/26/2013	RCT00000000076515	WASHINGTON ST DEPT OF ECOLOGY		603-22H WHITE RIVER GAGE STAT	$354.48
60300022H	7/29/2013	RCT00000000078501	WASHINGTON ST DEPT OF ECOLOGY		603-22 WHITE RIVER GAGE STATIO	$360.76
60300022H	8/14/2013	RCT00000000079600	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$249.34
60300022H	11/4/2013	RCT00000000084776	WASHINGTON ST DEPT OF ECOLOGY		603-22 WHITE RIVER GAGE STATIO	$571.21
60300022H	12/31/2013	RCT00000000088821	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$671.76
60300022H	1/22/2014	RCT00000000090183	WASHINGTON ST DEPT OF ECOLOGY		603.22H WHITE	$13.82
60300022H	2/26/2014	RCT00000000092387	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$3,233.43
60300022H	3/17/2014	RCT00000000093607	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$1,081.97
60300022H	4/28/2014	RCT00000000096536	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$1,655.10
60300022H	5/20/2014	RCT00000000098092	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$1,336.73
60300022H	6/23/2014	RCT00000000100593	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$748.43
60300022H	7/28/2014	RCT00000000103097	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$647.59
60300022H	9/9/2014	RCT00000000105973	WASHINGTON ST DEPT OF ECOLOGY		603-22H	$1,807.75
					Total Project Expenditures	$14,288.19
					Remaining Project Balance	**7,711.81**

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60300024H	Open	603-24	Barkley Irrigation Diversion			220,866.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60300024H	10/24/2012	RCT00000000060356	TROUT UNLIMITED - WASH. WATER PROJECT		BARKLEY IRRIGATION DITCH DIVEI	$168,288.39
60300024H	12/6/2012	RCT00000000063151	TROUT UNLIMITED - WASH. WATER PROJECT		BARKLEY IRRIGATION DITCH DIVEI	$2,018.22

PRCC - Habitat Funds

Habitat Supplemental - Fund 603

As of December 31, 2014

Activity Detail and Project Balance

60300024H	12/21/2012	RCT00000000064115	TROUT UNLIMITED - WASH. WATER PROJECT	603-24 BARKLEY IRRIG DITCH DIV	$1,294.58
60300024H	10/24/2013	RCT00000000084177	TROUT UNLIMITED - WASH. WATER PROJECT	603-24H	$28,036.95
60300024H	12/18/2013	RCT00000000087930	TROUT UNLIMITED - WASH. WATER PROJECT	603-24H	$3,999.91
60300024H	9/23/2014	RCT00000000107064	TROUT UNLIMITED - WASH. WATER PROJECT	603-24H	$3,920.59
60300024H	10/13/2014	RCT00000000108012	TROUT UNLIMITED - WASH. WATER PROJECT	603-24H	$3,015.35
60300024H	12/31/2014	RCT00000000114958	TROUT UNLIMITED - WASH. WATER PROJECT	603-24H	$4,618.72

Total Project Expenditures $215,192.71

Remaining Project Balance 5,673.29

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60300025H	Open	603-25	Methow River 1890's Side Channel Acquisition			90,000.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60300025H	9/2/2014	RCT00000000105491	CONFEDERATED TRIBES & BANDS OF THE YAKAMA N		603-25H	$75,000.00

Total Project Expenditures $75,000.00

Remaining Project Balance 15,000.00

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60300026H	Open	603-26	Okan River Discharge Monitor		0	90,952.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60300026H	5/9/2014	RCT00000000097360	COLVILLE CONFEDERATED TRIBES		603-26H	$13,430.00
60300026H	6/17/2014	RCT00000000100280	COLVILLE CONFEDERATED TRIBES		603-26H	$13,430.00
60300026H	11/25/2014	RCT00000000111160	COLVILLE CONFEDERATED TRIBES		603-26H	$13,430.00
60300026H	12/31/2014	RCT00000000114490	COLVILLE CONFEDERATED TRIBES		603-26H	$13,430.00

Total Project Expenditures $53,720.00

Remaining Project Balance 37,232.00

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60300027H	Open	603-27	Icicle IRR Pump Exch Analysis		To determine the feasibility, of constructing additional pumping	174,847.00

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60300027H	12/18/2013	RCT00000000087932	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H	$9,960.00
60300027H	12/31/2013	RCT00000000089688	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H	$38,682.11
60300027H	2/19/2014	RCT00000000091872	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H ICICLE-PESHASTIN IRRIG	$4,285.00
60300027H	3/17/2014	RCT00000000093598	TROUT UNLIMITED - WASH. WATER PROJECT		ICICLE-PESHASTIN ANALYSIS FOR	$12,720.00
60300027H	4/28/2014	RCT00000000096537	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H	$30,006.90
60300027H	5/20/2014	RCT00000000098121	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H	$21,630.00
60300027H	6/17/2014	RCT00000000100298	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H	$17,733.75
60300027H	7/29/2014	RCT00000000103144	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H	$13,443.75
60300027H	8/15/2014	RCT00000000104443	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H	$16,343.00
60300027H	12/31/2014	RCT00000000114945	TROUT UNLIMITED - WASH. WATER PROJECT		603-27H	$1,031.50

Total Project Expenditures $165,836.01

Remaining Project Balance 9,010.99

PRCC - Habitat Funds

Habitat Supplemental - Fund 603

As of December 31, 2014

Activity Detail and Project Balance

PID	Status	HCFA	Name/Description	Contractor	Description	Project Budget Amount
60300028H	Open	603-28	Icicle Creek Boulder Pit Tag Array		0	167,097.87

Project Expenditure Activity:

Project ID	Acctg Date	Voucher / PA Document No.	Vendor Name	Invoice Ref	Item Description	Expenditure Amount
60300028H	7/15/2014	RCT00000000102230	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-28H	$213.01
60300028H	9/9/2014	RCT00000000105984	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-28H	$11,331.77
60300028H	9/30/2014	RCT00000000107519	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-28H	$13,829.40
60300028H	10/22/2014	RCT00000000108843	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-28H	$15,401.45
60300028H	11/10/2014	RCT00000000110214	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-28H	$75,238.65
60300028H	12/31/2014	RCT00000000114402	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-28H	$1,893.22
60300028H	12/19/2014	RCT00000000112964	WASHINGTON ST DEPT OF FISH & WILDLIFE		603-28H	$9,935.95
					Total Project Expenditures	$127,843.45
					Remaining Project Balance	**39,254.42**

BioAnalysts, Inc.
4725 N. Cloverdale Rd.
Suite 102
Boise, Idaho 83713
Phone: 208.321.0363
Fax: 208.321.0364

Memorandum

To: Denny Rohr

From: Tracy Hillman

Date: 20 February 2015

Re: FCWG Meeting Progress Report

The Fall Chinook Working Group (FCWG) met at Grant PUD in Ephrata, WA, on Tuesday, 17 February from 10:00 am to 12:00 pm.

Wanapum Dam Issues

- Grant PUD gave an update on the status of Wanapum Dam. All fishway modifications have been removed and Grant PUD is operating Wanapum Reservoir within a four-foot range between 558 and 562 feet elevations. To date, 21 of the 35 tendons have been installed. Grant PUD believes they will be able to achieve a normal operation level of 571.5 feet by mid-April 2015.
- The left-bank ladder at Wanapum Dam is fully operational and providing fish passage. The right-bank is dewatered for annual maintenance.

Final Report and Implementation Feasibility Study/Implementation Feasibility Plan

- Grant PUD received comments on the draft Final Report from WDFW, NOAA Fisheries, ADFG, USFWS, CRITFC, and consultants. Grant is preparing a response table to address all comments received. Grant noted that there were about ten common themes contained within the comments. The goal is to incorporate comments, edit the final report, and submit it to Ecology by no later than 17 April. Grant will work with individual commenters to make sure they addressed each entity's comments adequately

Hanford Reach Working Group Updates

- Fall Chinook post-hatch constraints are currently in effect. Fall Chinook emergence is predicted to occur around 28 February. Flows are high because of drafting from Grand Coulee Dam. There have been no exceedances during the spawning or incubation periods. All temperature and flow data are displayed in the Fixed Site Monitoring – Monthly Summary files on the Grant PUD Water Quality Website. Grant PUD will continue to send monthly updates to the FCWG/HRWG.
- WDFW reported that the forecast for 2015 is about 900,200 adult fall Chinook to the Columbia River. The Upriver Bright forecast is about 500,300 adult Chinook. The Hanford Reach forecast is about 225,000 adults with half the run consisting of hatchery fish. The projected run in 2015 is the third largest on record (2013 and 2014 were higher).

Meeting Schedule

Once the Final Report and IFS/IFP are complete, there will be no need for the FCWG/HRWG to meet monthly. Therefore, the Working Groups decided to meet at least twice per year, once in March and again in October. These dates correspond to important check-ins and reporting periods. The Working Groups will meet at other times if necessary.

Next Steps

The FCWG will next meet on Tuesday morning, 31 March 2015 at Grant PUD in Ephrata, WA.

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Boise, Idaho 83713
Phone: 208.321.0363
Fax: 208.321.0364

Memorandum

To: Denny Rohr

From: Tracy Hillman

Date: 20 February 2015

Re: PRFF Meeting Progress Report

The Priest Rapids Fish Forum (PRFF) met at Grant PUD Natural Resources Office in Wenatchee, WA, on Wednesday, 4 February 2015, from 9:00 am to 12:00 pm.

Wanapum Dam Issues

- Grant PUD gave an update on the status of Wanapum Dam. As repairs to the dam continue, Grant PUD is operating Wanapum Reservoir within a four-foot range between 558 and 562 feet elevations.
- To date, 21 of the 35 tendons have been installed. Grant PUD believes they will be able to achieve a normal operation level of 571.5 feet by April 2015.
- The left-bank ladder at Wanapum Dam is fully operational and providing fish passage. The right-bank is dewatered for annual maintenance.

White Sturgeon Updates

- Juvenile sturgeon rearing at Marion Drain are doing well. Growth of juvenile sturgeon in 2014-2015 is similar to growth of juveniles in previous years.
- Grant PUD is working with Chelan PUD to evaluate the feasibility and application of using the Ecopath with Ecosim model as a way to estimate sturgeon carrying capacity within the project area. This information may be used to determine how many juvenile sturgeon will be released into the project area annually.
- WDFW provided a revised draft SOA for the release of juvenile white sturgeon in the Priest Rapids Project Area in 2016. The PRFF will review the revised SOA and submit their approval of the SOA by Friday, 20 February.
- Grant PUD is currently preparing the white sturgeon annual report. The draft report should be available for review in February.

Pacific Lamprey Updates

- The PRFF Pacific Lamprey Subgroup met on 29 January to discuss how the PRFF should address NNI for Pacific lamprey. The Subgroup discussed a seven-step process for establishing an NNI Agreement. As part of the seven-step process, they began discussing possible draft recommendations for an NNI Agreement. They will continue to meet in order to attempt to reach agreement on a proposed NNI Agreement and its duration, identify specific elements of the proposed NNI Agreement, identify roles and responsibilities, identify outcomes or end products, and identify annual contributions.
- PRFF received the 2014 Pacific Lamprey Management Plan Comprehensive Draft Annual Report for review on 29 January. Comments are due to Grant PUD on Monday, 2 March.

- Blue Leaf Environmental provided a PowerPoint presentation on adult lamprey passage at Priest Rapids and Wanapum dams. Blue Leaf concluded that: (1) Grant PUD's monitoring program contributes substantially to the passage database, both locally and regionally; (2) 2014 was an anomalous year with emergency measures taken due to the Wanapum spillway fracture; (3) the modified weir structure at Wanapum Dam was effective for passing lamprey (27/28 tagged fish detected within 48 hours); (4) minimum fish passage efficiency and median fishway travel times of tagged lamprey were improved at Priest Rapids in 2014 compared to previous years, but diminished at Wanapum left ladder likely because of altered fishway operations; (5) additional PIT interrogation stations at the OLAFT in the left ladder at Priest Rapids Dam should help identify potential passage bottlenecks there; (6) lamprey trap-and-transport was effective (n = 2,269 lamprey transported; 22.8% of run); (7) fallback lamprey usually re-ascend the fishways (less than 1% of all fish detected); (8) lamprey passage efficiency will be recalculated through redetection of fish at large; and (9) study plan objectives are being achieved.
- This winter, Grant PUD will install PIT arrays upstream and downstream from the OLAFT in the left-bank ladder at Priest Rapids Dam. These arrays will help identify possible lamprey passage issues near the OLAFT.
- The PRFF will tour the adult fish ladders on Friday, 20 February.

Next Steps

The next meeting of the PRFF will be on Wednesday, 4 March 2015 at Grant PUD in Wenatchee, WA.