Fall Chinook Work Group

Tuesday, 2 December 2014

Grant PUD (USBOR Building)

Ephrata, WA

Technical members

Paul Wagner, NMFS	Joe Skalicky/Don Anglin, USFWS
Jeff Fryer, CRITFC	Paul Ward/Bob Rose, YN
Holly Harwood, BPA	Brett Swift, American Rivers
Keith Truscott, CPUD	Tom Kahler, DPUD
Bill Tweit, WDFW	Paul Hoffarth, WDFW
Patrick McGuire, WDOE	John Clark, ADFG
Peter Graf, GCPUD	Todd Pearsons, GCPUD
Steve Hemstrom, CPUD	

Attendees: (*Denotes Technical member)

Peter Graf, GCPUD*	Russell Langshaw, Ecosyst. Insights (Phone)
Paul Hoffarth, WDFW* (Phone)	Jeff Fryer, CRITFC*
Tom Skiles, CRITFC (Phone)	Ryan Harnish, Battelle
Todd Pearsons, GCPUD	Geoff McMichael, Mainstem Fish Res (Phone)
John Clark, ADFG*	Curt Dotson, GCPUD
Tracy Hillman, Facilitator	

Action Items:

1. **FCWG will review the draft Final Report and Implementation Feasibility Study/Implementation Feasibility Plan and provide comments to Peter Graf by Friday, 13 February 2015.**

Draft Meeting Minutes

I. Welcome and Introductions – Tracy Hillman welcomed attendees to the meeting. Attendees introduced themselves.

II. Agenda Review – The agenda was reviewed and approved.

III. Approval of Meeting Minutes

- The November Meeting Minutes were reviewed and approved.

IV. Review of Action Items - Action items identified during the October meeting were discussed.

- Grant PUD will complete the draft Final Report and Implementation Feasibility Study/Implementation Feasibility Plan and distribute it to the FCWG by Wednesday, 12 November 2014. **Complete. Comments are due on Friday, 13 February.**
- The FCWG will review the 2013-14 Hanford Reach Fall Chinook Protection Program Draft Report and send their comments to Peter Graf by Friday, 28 November. **Complete. Comments were received and incorporated into the final report.**
- The FCWG will review the Draft 2013-2014 Priest Rapids Hatchery M&E Report and send their comments to Todd Pearsons by Friday, 21 November 2014. **Complete. No comments were received.**

V. Update on Wanapum Dam Issues

Tracy Hillman noted that he has been sending updates from Tom Dresser to the FCWG. Peter Graf noted that the interim proposal to raise the pool elevation to 558-562 feet was approved by the Board of Consultants and FERC. As a result, Grant PUD initiated the refilling of Wanapum pool on 25 November. At about 1:43 pm on Monday, 1 December, Wanapum pool reached an elevation of 561.82 feet. This is slightly below the 562 foot elevation to ensure that Grant PUD does not overshoot the 562 foot mark. Engineers at Grant PUD are taking surveillance readings to monitor the dam to ensure there are no issues. After this surveillance is complete, and if no issues are found, the pool will be operated in the 558-562 foot range.

Peter said that the spiral chute and supporting infrastructure for the spiral chute were removed in mid-November. The remaining structures will be removed in December. Peter noted that the reservoir shoreline continues to remain closed. Grant PUD will provide notification when the shoreline is opened. Finally, Peter said that after all 35 tendons have been installed, the pool will be raised to its normal elevation. This will likely occur by late April or early May.

Todd Pearsons noted that he will propose an “emergency fish passage” session at the American Fisheries Society meeting in Portland in August 2016. A presentation on the “Wanapum Experience” would be presented during the meeting.

VI. Final Report and Implementation Feasibility Study/Implementation Feasibility Plan

Tracy Hillman reported that the draft Final Report was sent to the FCWG on 12 November. Members have 90 days to review the document and to provide comments to Peter Graf and Russell Langshaw by 13 February. Tracy encouraged members to provide comments before the 13 February due date.

Tracy asked the FCWG if they had any comments or questions on the draft Final Report. No members had any comments or questions at this time. Tracy noted that the authors may consider a different title and suggested a few minor organizational changes. He also asked for some clarification on the models used to analyze stranding and entrapment data. Peter Graf noted that Grant PUD is working on providing a web link to the technical reports summarized in the draft Final Report.

Peter described the timeline for completing the final report:

- February—Comments on the draft final report are due.
- March—Report revisions and responses to comments.
- April—Final report and IFS/IFP due to Ecology and FERC.

VII. Presentation by CRITFC on Tagging Hanford Reach Fall Chinook Salmon

Jeff Fryer, CRITFC, gave a presentation on tagging juvenile Hanford Reach fall Chinook during 2014 (see Attachment 1). He began by describing the project and its genesis. He also described briefly the methods used to collect juvenile fall Chinook salmon, CWT tagging operations, and funding. He indicated that three crews working from 29 May to 9 June were able to tag 192,739 juvenile Chinook (falling just short of their goal to tag 200,000 juveniles). He noted that many of the juvenile Chinook were too small to tag; 60.5% were large enough to tag (48-80 mm). Jeff said that mortality from sort to pre-tag was about 5%, post-tag mortality was 2.6%, and 24-hour mortality was 3.1%. He then showed tagging results by date and noted that 24-hour mortalities decreased after Battelle provided the tagging crews with a large recovery trough. Jeff reported that high flows, decreased crew productivity because of Treaty Day celebrations, and the loss of 3,093 juvenile Chinook for PIT tagging that did not receive CWTs were the primary reasons they did not meet their tagging goal of 200,000 fish.

Jeff then described the PIT-tagging work conducted in 2014. He noted that PIT tags were provided by Grant PUD and that experienced crews tagged juvenile Chinook larger than 60 mm. These fish were also ad-clipped and tagged with CWTs (there was no double tagging on the same day). They PIT tagged 10,088 juvenile Chinook. About 1.5% died resulting in a release of 9,941 PIT-tagged Chinook. Jeff then shared with the group survival rates and travel times for the different tag groups. In general, survival from release site to McNary Dam was between 31% and 40% and it took the fish about 24 to 30 days to travel to McNary Dam. Larger fish had higher survival rates and faster travel times than did smaller fish.

Jeff noted possible changes for tagging work in 2015, including moving the water pump intake, changing the starting date, and possibly not working on Treaty Days. He concluded by stating that they came close to their tagging goal (the goal has been reached in 9 out of 11 years), they were able to reduce mortality rates, and that the "new" equipment worked well but improvements are still needed.

VIII. Presentation by Battelle on Survival of Wild Hanford Reach and Priest Rapids Hatchery Fall Chinook Salmon Juveniles in the Columbia River

Ryan Harnish, Battelle, gave a presentation on survival of wild Hanford Reach and Priest Rapids Hatchery fall Chinook salmon juveniles in the Columbia River (see Attachment 2). Ryan began be giving a brief background on the study, including objectives and methods used to collect and tag fish. He noted that 200 wild Chinook between 80-100 mm were surgically implanted with JSATS transmitters on 5 June. A total of 200 hatchery fish between 80-100 mm were PIT tagged and surgically implanted with JSATS transmitters on 28 May. He then described the life of the JSATS tags and identified the locations of the 18 autonomous receiver arrays, the three cabled receiver arrays, and the PIT arrays.

Ryan explained that the cumulative survival of wild Chinook from the release site (rkm 595) to the head of McNary pool (rkm 552) was 82%, cumulative survival to McNary Dam (rkm 470) was 50%, and survival to Bonneville pool (rkm 275) was 28%. He also showed survival by reach and noted that the lowest relative survival rate was in the reach just upstream from McNary Dam (McNary forebay). Relative survival was also generally lower in reaches upstream of rkm 422 (mid-John Day pool). Survival was directly correlated with fish length. For hatchery fish, Ryan indicated that their cumulative survival from the release site (rkm 633) to the head of McNary pool was 66%, cumulative survival to McNary Dam was 50%, and survival to Bonneville pool was 28%. The lowest relative survival rate for hatchery fish was in the reaches just upstream from McNary and John Day

dams. As with wild fish, survival of hatchery fish was directly correlated with fish length.

Ryan then described travel times for both wild and hatchery tagged fish. The median travel time for wild fish from their release site to McNary Dam was 10.7 day. Hatchery fish travel time from their release site to McNary Dam was 11.6 days. Both groups showed high variability in travel times.

Ryan highlighted some of the study biases, noting that the survival of wild fish was higher than typical (based on PIT tag studies) and survival of hatchery fish was lower than typical (based on PIT tag studies). The former may be because of the larger size of wild fish tagged with JSATS; the latter may be related to tagging effects and tag loss. Because it is unknown when during the two-week period between tagging and volitional release that the tagging effect/tag loss occurred at Priest Rapids Hatchery, no bias correction can be applied. Nevertheless, Ryan noted that the biases are unlikely to change the conclusions from the study.

Ryan talked about the different predators that may be responsible for the loss of tagged fish. He identified both fish and bird predators and noted that populations of fish predators are likely causing significant mortality in juvenile fall Chinook. The high mortality rates near dams are probably associated with migration delays, disorientation, and increased predator densities. Ryan described some of the actions that are being done to reduce predation, including avian predator nesting dissuasion, avian wires and hazing at dams, northern pikeminnow programs, and changes in harvest limits on smallmouth bass, channel catfish, and walleye. He also identified some additional actions that can be done, including removal of daily harvest limits throughout the Columbia River, expanding the northern pikeminnow program to include other fish predators, and managing reservoir levels in such a way as to affect spawning activities and recruitment of fish predators. Ryan concluded his presentation by acknowledging the many people and organizations that contributed to the study.

IX. HRWG Activities

2014 Protection Program Implementation – Peter Graf said that the last spawning survey was conducted on 23 November. Paul Hoffarth noted that about 525 redds were counted on the Vernita Bar transect and that there were several redds counted at higher elevations, but most were below the 70 kcfs elevation. Paul estimated the escapement at about 150,000 Chinook, which was made up of mostly age-4 and 5 fish. Peter noted that 70 kcfs is the critical elevation for post hatching. Peter said that all temperature and flow data are displayed in the Fixed Site Monitoring – Monthly Summary files on the Grant PUD Water

Quality Website (http://www.gcpud.org/naturalResources/fishWaterWildlife/waterqualityMonitoring.html). The temperature unit tracking spreadsheet is found under "Fixed Site Monitoring – Monthly Summary."

Hanford Reach Annual Report – Tracy Hillman indicated that comments on the 2013-14 Hanford Reach Fall Chinook Protection Program Draft Report were due to Peter Graf on Friday, 28 November. Peter said that he received comments from Ecology. He is currently finalizing the report.

Hatchery Operations – Tracy Hillman reported that comments on the Draft 2013-2014 Priest Rapids Hatchery M&E Report were due to Todd Pearsons on Friday, 21 November 2014. Todd indicated that he did not receive any comments from the FCWG.

Todd reported that the real-time otolith analysis conducted this year during spawning at the Priest Rapids Hatchery was slower than anticipated. Nevertheless, it was useful and will be improved in the future. Todd also indicated that they are experimenting with an alternative mating strategy (i.e., one male crossed with four females). The effects of the mating strategy will be monitored over the next several years.

X. 2014 Return-Year Studies and Funding Opportunities

High-Escapement, Density-Dependence Studies – Geoff McMichael reported that he conducted his last snorkel survey in the Reach on 16 November. He noted lots of redd superimposition, but observed few eggs. He indicated that he has lots of video to review. Recall the purpose of this study is to evaluate egg loss due to redd superimposition.

Russell Langshaw indicated that this week is the last opportunity for Mission Support Alliance to get aerial photos of the Reach.

XI. Next Meeting

: The FCWG decided it would be most appropriate to next meet following the 90-day review period on the draft Final Report. Therefore, the FCWG will next meet on Tuesday morning, 17 February 2015 at Grant PUD in Ephrata, WA.

Attachment 1

Presentation by Jeff Fryer on Tagging Hanford Reach Fall Chinook with CWTs

Hanford Reach Fall Chinook Tagging Project

- Since 1987 CRITFC has coordinated a project to ad-clip and coded wire tag 200,000 juvenile upriver bright fall Chinook salmon on the Hanford Reach.
- CWT project has met goal 14 out of 27 years
  - Met goal 9 of 15 (60%) years with three crews and 12 days
  - Met goal 5 of 13 (38%) years with two crews and/or fewer than 12 days
- Concurrent PIT tagging programs have tagged Chinook in 19 out of 24 years between 1991-2014. In only 7 of these 19 years has there been any significant funding dedicated to PIT tagging.

Capture Gear

Stick seines are typically 11.0 to 18.3 m long and 1.8m deep

Beach seines are typically 36.6 m long and 3.0 m deep

For both, mesh size is 4.8 mm (¼").

CWT trailer operations

- Technicians visually cull out injured fish as well as Chinook that are too large (>80mm) and too small for tagging (typically <48mm):
- After tagging, fish are held, allowed to recover, and released on site.
- A goal this year was to decrease mortality

2013 LOA project was conducted in 2014

- Funded to increase the chance of tagging 200,000 fish by adding an extra day and capture crew to the project.
- The award was announced in spring 2013, however CRITFC was not officially awarded the funds until August 2013 and our auditors prevent spending of funds prior to their being awarded.
- Meanwhile, we were awarded a LOA project in 2014 that was similar to 2013 with the addition of a PIT tagging component. This was also delayed, so will be conducted in 2015.
- But part of this project relied on Grant PUD providing some funds and 5000 PIT tags. They went ahead with this, actually providing funds and tags to put out 10,000 PIT tagged sockeye.
- My time for PIT analysis is included in 2014 project, not 2013 project.

2014 Coded Wire Tagging

- 12 day, 3 tagging crew project from May 29-June 9, 2014.

• Coded wire tag output:	192,739	(178,426)
• Sorts (mostly too small):	38,251	(125,610)
• % Taggable (48-80 mm):	60.5%	(82.3%)
• QC (released with no tag):	1.2%	(0.2%)
• Sort and pre-tag mortalities:	5.0%	(1.2%)
• Immediate post-tag mortality:	2.6%	(2.8%)
• 24 hour mortality:	3.1%	(9.8%)
• Mean Flow at Priest Rapids:	204,100	(174,400)

2013 results in orange

2014 Coded Wire Tag Results

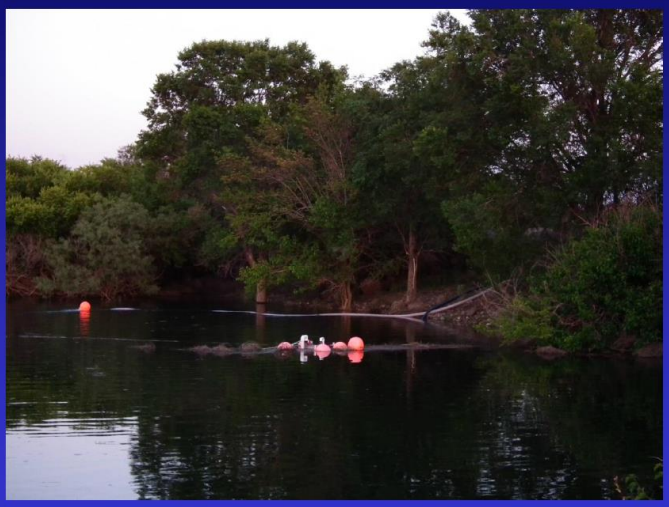
Date	Processed	Tagged	Cumu-lative	% Taggable	Recap-tures	24 hour mortality	Mean Flow (kcfs at PRD)
5/29	12,869	7,059	7,059	**54.9%**	0	5.4%	224.7
5/30	26,674	14,374	21,433	53.9%	0	8.4%	200.0
5/31	27,608	14,618	36,051	52.9%	0	3.4%	192.6
6/1*	30,811	15,421	51,472	50.1%	0	7.5%	**237.0**
6/2*	14,866	9,226	60,698	62.1%	0	5.7%	**228.2**
6/3	32,201	17,301	77,999	53.7%	**9**	2.0%	205.2
6/4	14,605	8,995	86,994	61.6%	**25**	2.1%	214.6
6/5	36,262	19,282	106,276	53.2%	**34**	0.9%	213.2
6/6	31,206	18,446	124,722	59.1%	**16**	1.5%	212.0
6/7	25,673	19,013	143,735	74.1%	**68**	1.5%	182.3
6/8	29,203	21,073	164,808	72.2%	**51**	0.8%	182.8
6/9	36,371	27,931	192,739	76.8%	**51**		193.5
2014	318,349	192,739		60.5%	203	3.1%	**204.1**
2013	216,677	178,426		82.3%	145	9.8%	**174.4**

How many tags can be attributable to LOA funding (3rd crew plus 12th day)?

- On the 12th day, we tagged 27,931 fish (despite being short one crew member). If not for the 12th day, tag output would be 164,808.
- Third capture crew accounted for approximately 30% of the fish caught despite boat problems (≈58,000 tags output or ≈48,800 tags for an 11 day project).
- 11 day 2 crew output=116,000??? (My guesstimate would be higher, perhaps 130-140,000.)

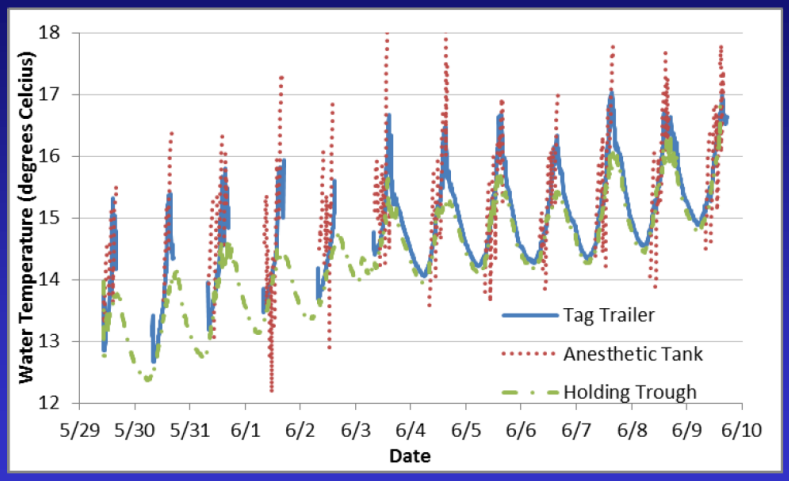

What worked-new recovery trough

Pump intake deeper (but not deep enough!)

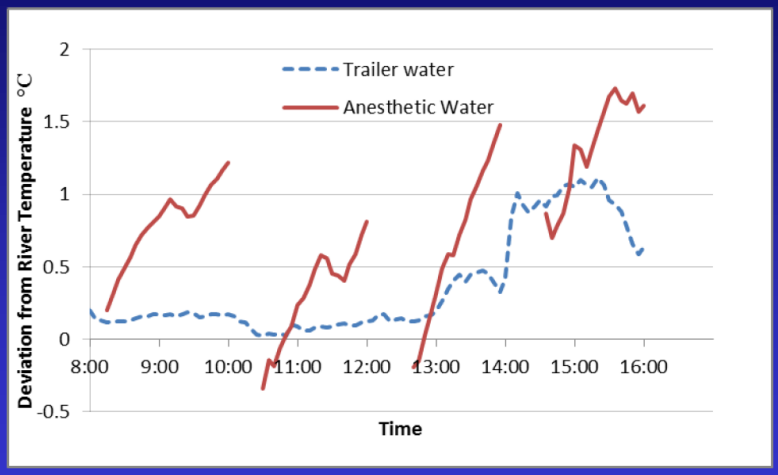


River Ice Machine!

Water Temperature Loggers



Water Temperature Loggers



Non Target Species

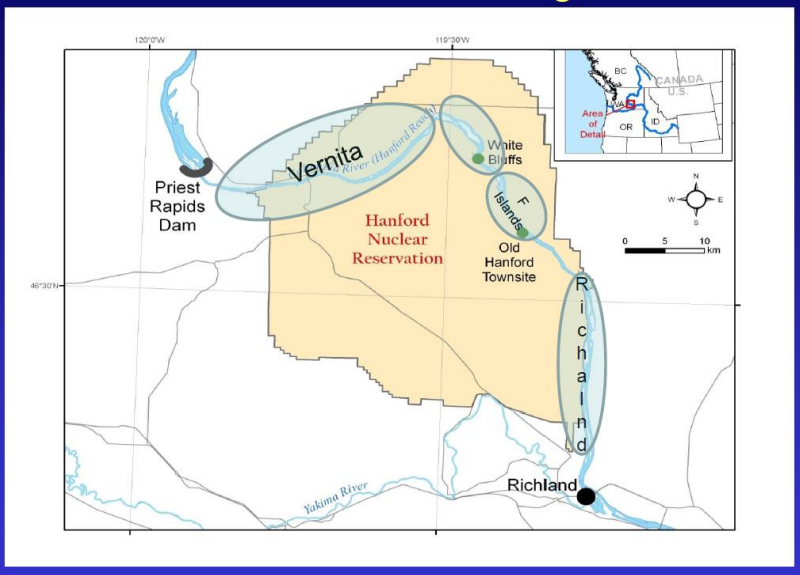
Species	Total	Live	Dead
Shiners	4,583	1,878	2,705
Pike Minnow	3,869	3,593	276
Sculpins	1,687	1,677	10
Stickleback	1,506	1,444	62
Whitefish	318	301	17
Dace	56	56	0
Peamouth	52	50	2
Smallmouth Bass	25	21	4
Yellow Perch	13	13	0
Sunfish	1	1	0
Total	12,110	9,034	3,076

Improvements in non-target holding conditions resulted in improved survival.

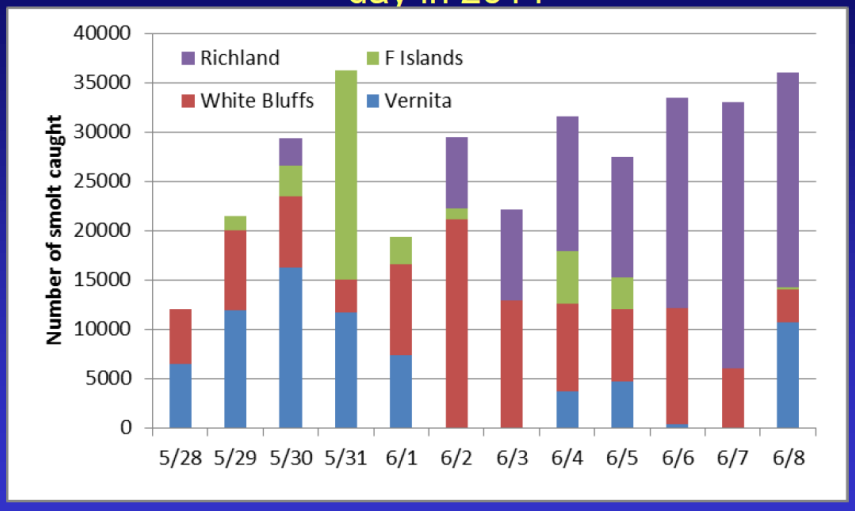
Why did we end up short?

- High flows! (far and away the biggest reason)
- Some decrease in tagging crew productivity due to Treaty Day celebrations at the end of the project (June 6-9)
- Loss of 3093 Chinook for PIT tagging that were not coded wire tagged.

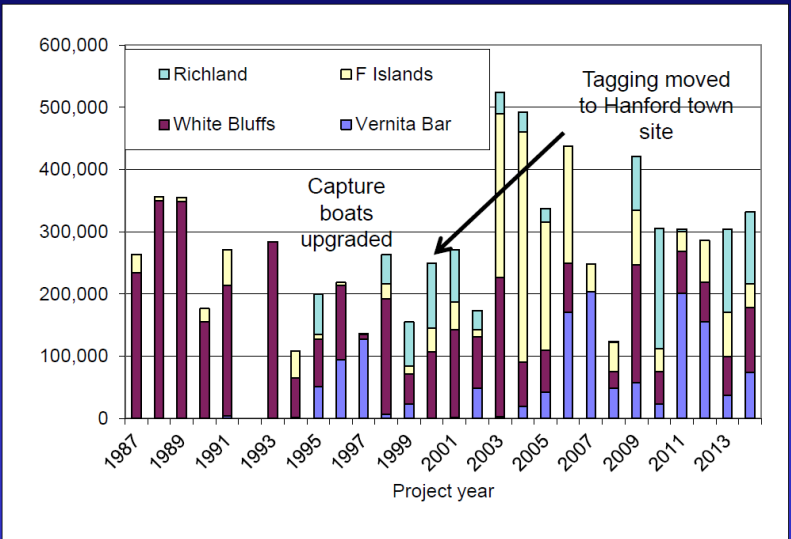
Hanford Reach and fishing areas



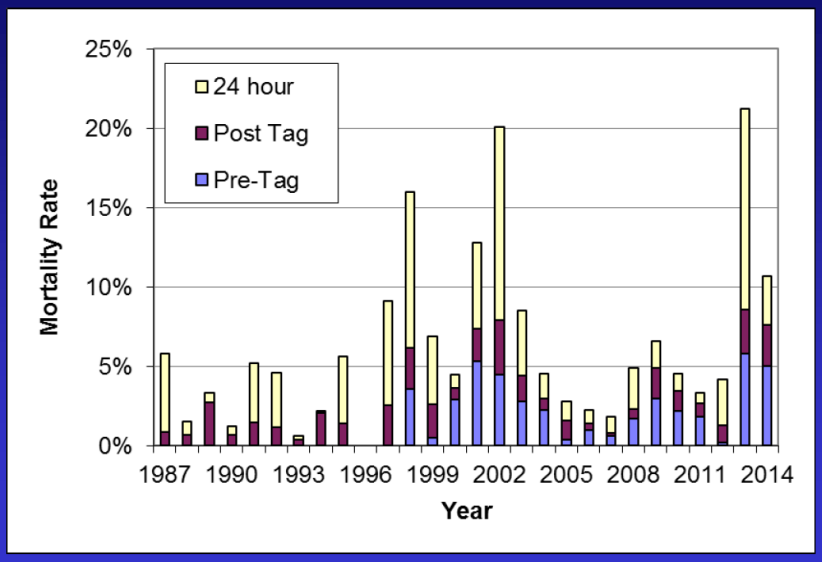
Number of fish tagged and captured by area by day in 2014



Number of fish captured by area 1987-2013



Mortality by Year at Hanford



2014 PIT tagging

- Tags and funding provided by Grant PUD
- Experienced crew of two, one from Blue Leaf Environmental and one from Biomark.
- Chinook greater than approximately 60 mm were adipose clipped and coded wire tagged, held overnight and PIT tagged. (No same day double tagging!)
  - Chinook >80 mm were sorted and PIT tagged only (held overnight after sorting)
  - About 1/3 were not coded wire tagged, but were adipose clipped, prior to PIT tagging.
- PIT tagged Chinook were released on site after being held overnight.

2014 PIT tagging Results

- Total Tagged: 10,088
- Mortality Rate: 1.5% (compared to 24.8% in 2013, 3.2% in 2012 and 1.5% in 2011)
- Total Released: 9,941

Survival Estimates all fish

Tag Location	CWT	N	Release-McNary Survival		McNary-John Day Survival	
			Mean	Std. Error	Mean	Std. Error
Hanford	No CWT	3,787	0.395	0.037	0.619	0.109
Hanford	CWT	6,153	0.313	0.022	0.996	0.172
Hanford	All	9,940	0.342	0.019	0.810	0.099
Priest Rapids	No CWT	2,988	0.769	0.073	0.856	0.205

Travel time all fish

Tag Location	CWT	N	Release-McNary (d)		Release-John Day (d)		Release-Bonneville (d)	
			Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.
Hanford	No CWT	3,787	24.0	9.6	28.2	8.5	30.2	8.7
Hanford	CWT	6,153	28.6	6.8	32.8	5.8	35.2	4.9
Hanford	All	9,940	26.8	8.4	30.9	7.3	33.2	7.1
Priest Rapids	No CWT	2,988	13.3	0.2	17.0	0.3	19.0	0.4

Survival Estimates by length group

Length Group	CWT?	N	Release-McNary Survival		McNary-John Day Survival	
			Mean	Std. Error	Mean	Std. Error
55-80 mm	NO	3,093	0.305	0.032	0.628	0.124
55-80 mm	YES	6,004	0.318	0.023	0.953	0.165
55-80 mm	All	9,097	0.327	0.018	0.827	0.103
>80 mm	All	771	0.720	0.121	0.732	0.269
Priest Rapids	NO	2,988	0.769	0.073	0.856	0.205

Travel time by length group

Length Group	CWT?	N	Release-McNary (d)		Release-John Day (d)		Release-Bonneville (d)	
			Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
55-80 mm	NO	3,093	28.7	6.5	32.3	5.9	33.3	7.0
55-80 mm	YES	6,004	28.9	6.7	33.1	5.4	35.3	4.8
55-80 mm	All	9,097	27.6	7.6	31.4	6.7	33.8	6.4
>80 mm	All	771	14.0	6.5	19.8	6.2	21.2	6.2
Priest Rapids	NO	2,988	13.3	4.9	17.0	4.4	19.0	5.3

Changes for 2015

- Continue and improve on successful changes from this year (recovery tank, ice machine, thermometers/loggers, improved non-target fish recovery buckets).
- Move pump intake out further (possibly float?).
- Consider taking Treaty Days off.
- Possibly delay the starting date after it's usual date of the Thursday after Memorial Day (which would be May 28 in 2015), since Memorial Day is early.
- PIT tag LOA project will take effect.
- VISITORS WELCOME! (Minimal notice required for U.S. citizens, possibly much longer for Canadian)

2015 PIT tagging

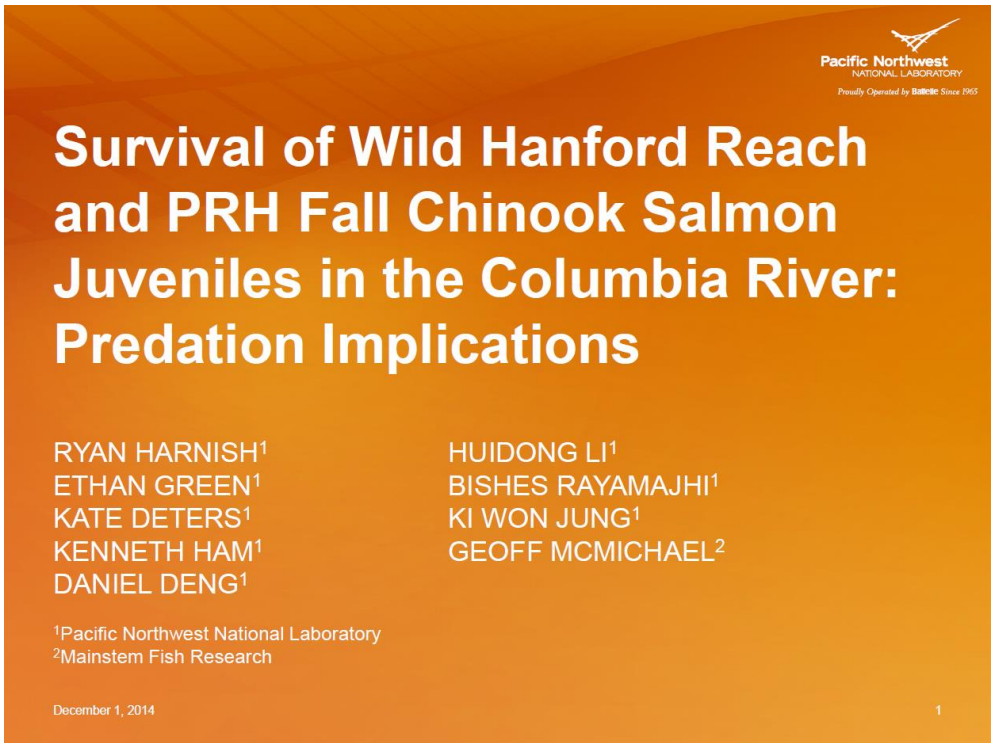
- 2014 PSC funding for PIT tagging will be available for 2015 project.
- Was funded with expectation of $5000 funding plus 5000 tags from Grant County PUD. However, GCPUD expected this to occur in 2014 and spent those funds (and more) plus contributed 10,000 tags.
- What are GCPUD plans for 2015? Will any tags and/or funding be available?
- If available, we plan to make use of the Battelle ice machine and recovery trough.

Conclusions

- Didn't make goal but came very close despite high flows. (The project has failed to reach it's goal 9 out of 11 years with a mean PRD flow during the project that is greater than 200 kcfs.)
- Mortality, especially 24 hour and PIT tagging, greatly reduced but more work needed.
- PIT + CWT tagged fish had survival similar to PIT-only tagged fish when length is taken into consideration. (This does not imply PIT + CWT tagged fish have similar survival to CWT-only tagged only fish.)
- New equipment worked out well and we will continue to make improvements.

Attachment 2

Presentation by Ryan Harnish on Survival of Wild and Hatchery Juvenile Fall Chinook Salmon in the Columbia River



Background

Pacific Northwest NATIONAL LABORATORY
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- Hanford Reach fall Chinook salmon population highly productive
  - BY 1975–2004 mean egg-to-presmolt survival = 35%
  - 2011 fertilized egg-to-fry survival = 70% (Oldenburg et al. 2012)
- High observed mortality between HR and MCN
  - Survival of PIT-only HR FC averaged 37% since 1995 (FPC 2013)
- Predator populations
  - Smallmouth bass, northern pikeminnow, walleye, channel catfish, terns, cormorants, gulls, pelicans

Objectives; fish collection, tagging, & release

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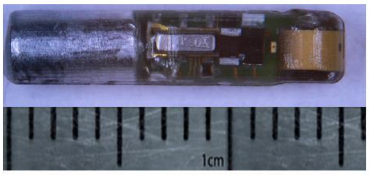
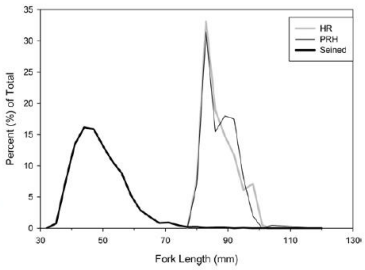
- Objectives
  - Estimate survival through multiple reaches
  - Identify mortality "hot spots"
  - Classify the putative source(s) of mortality
- Methods
  - Wild Hanford Reach fall Chinook
    - CRITFC seining
    - 80–100 mm FL (*n* = 200)
    - JSATS transmitter 15 mm × 3.3 mm diameter, 0.22 g (in air) + 12.5 mm PIT
    - Surgically implanted on June 5
    - Held 24 hours & released at rkm 595
      - 2 overnight morts
  - PRH fall Chinook
    - 80–100 mm FL (*n* = 200)
    - JSATS + PIT surgically implanted on May 28
    - Held 24 hours & released into channel ponds
    - Volitional release June 12–21



Fish selection & surgical method

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- PNNL lab studies conducted to identify the "best" surgical method and the minimum size fish that could be implanted
  - Compared injection (bevel up, bevel down) and surgical without suture
  - 60-d study (AT only, AT+PIT, marked control, unmarked control)
  - 75–104 mm FL fall Chinook salmon (n = 150 AT+PIT)
    - n = 700 total fish in the four groups
  - Fish handled weekly to day 28 and again at day 60 to measure growth and healing
  - No fish ≥ 80 mm FL lost their tag or died during the study

Receiver deployments

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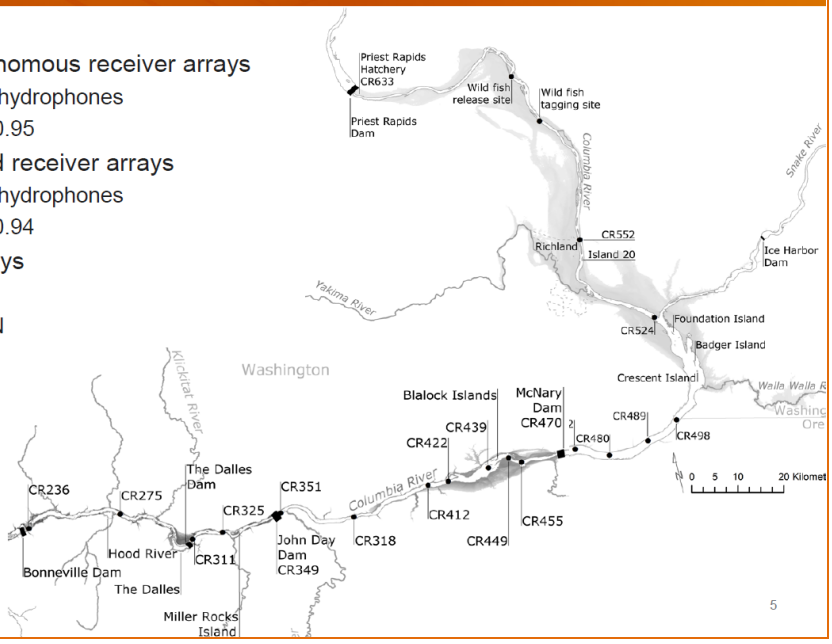
- 18 autonomous receiver arrays
  - 142 hydrophones
  - p > 0.95
- 3 cabled receiver arrays
  - 178 hydrophones
  - p > 0.94
- PIT arrays
  - PRH
  - MCN
  - JDA



Receiver deployments

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- PRH cabled acoustic & PIT arrays

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Tag life

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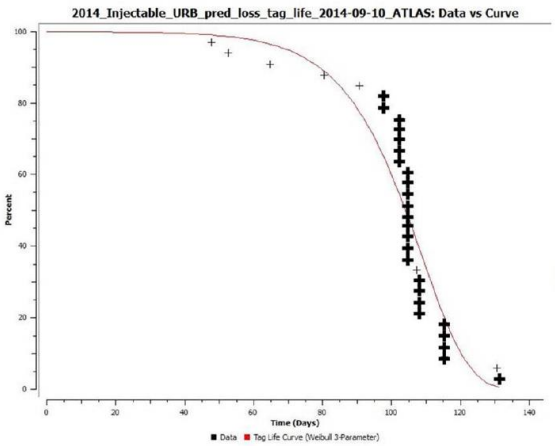
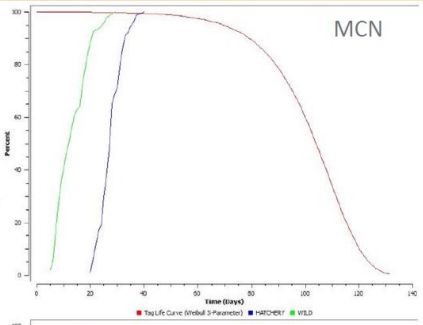
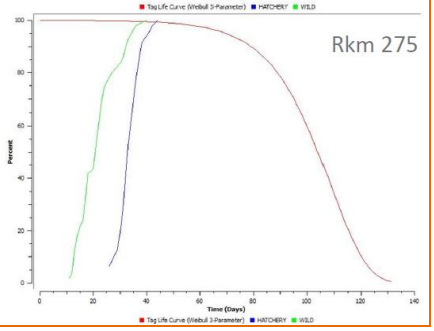
- 60 day nominal tag life
  - 30 of 32 (94%) tag-life tags lasted >60 d
  - 27 of 32 (84%) lasted >100 d







Wild HR fall Chinook survival

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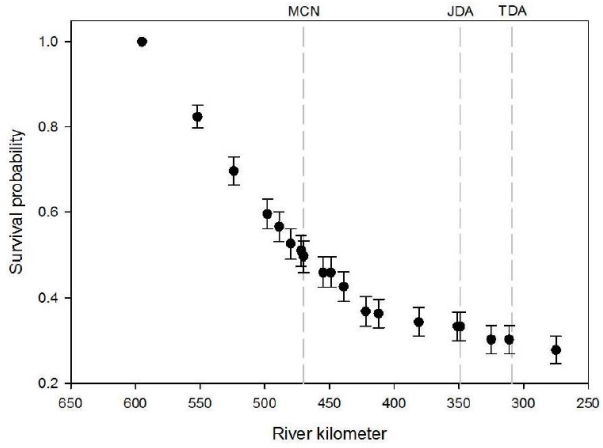
- Cumulative survival (from release [rkm 595])
  - To the head of MCN pool (rkm 552) = 0.82 (SE = 0.03)
  - To MCN (rkm 470) = 0.50 (0.04)
  - To BON pool (rkm 275) = 0.28 (0.03)



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Wild HR fall Chinook survival

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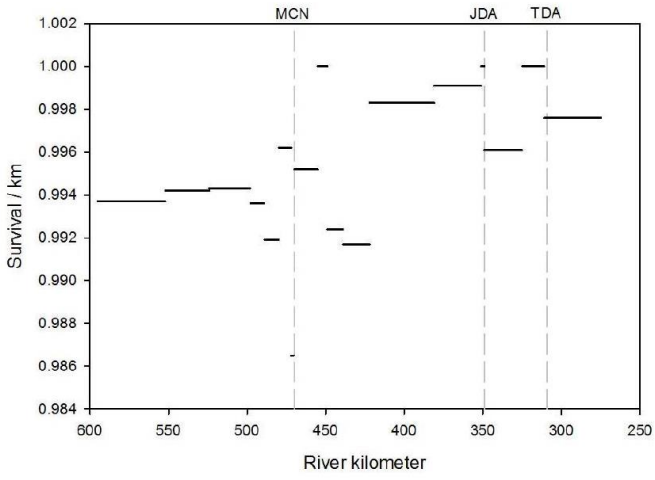
- Reach survival ($S^{1/km}$)
  - Lowest in immediate FB of MCN (rkm 472 to rkm 470)
  - Generally lower in reaches upstream of rkm 422 (mid-JDA pool)



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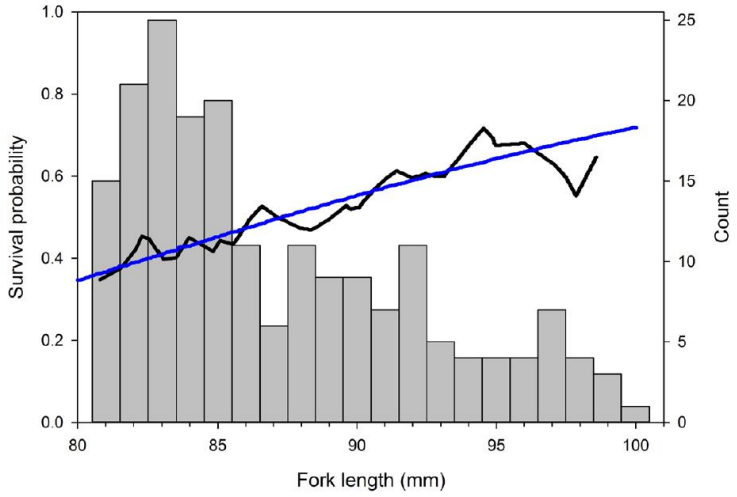
Wild HR fall Chinook survival

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Survival to MCN significantly correlated with FL



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PRH fall Chinook survival

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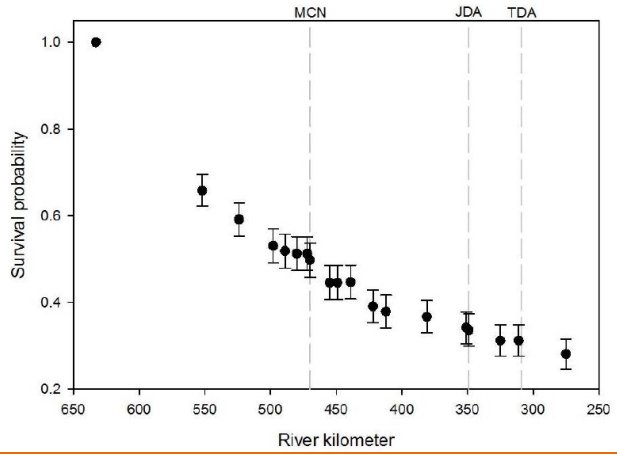
- Cumulative survival (from release [rkm 633])
  - To the head of MCN pool (rkm 552) = 0.66 (SE = 0.04)
  - To MCN (rkm 470) = 0.50 (0.04)
  - To BON pool (rkm 275) = 0.28 (0.04)



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PRH fall Chinook survival

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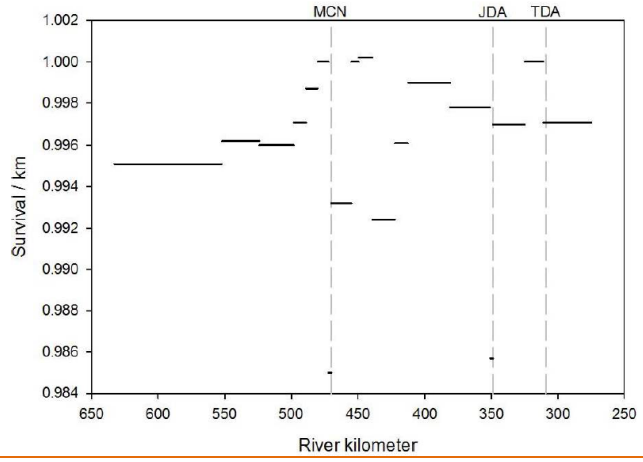
- Reach survival ($S^{1/km}$)
  - Lowest in immediate FB of MCN (rkm 472 to rkm 470) and JDA (rkm 351 to rkm 349)
  - Low in the reach that included MCN passage (rkm 470 to rkm 455) and from Boardman to Crow Butte (rkm 439 to rkm 422)



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PRH fall Chinook survival

Pacific Northwest NATIONAL LABORATORY
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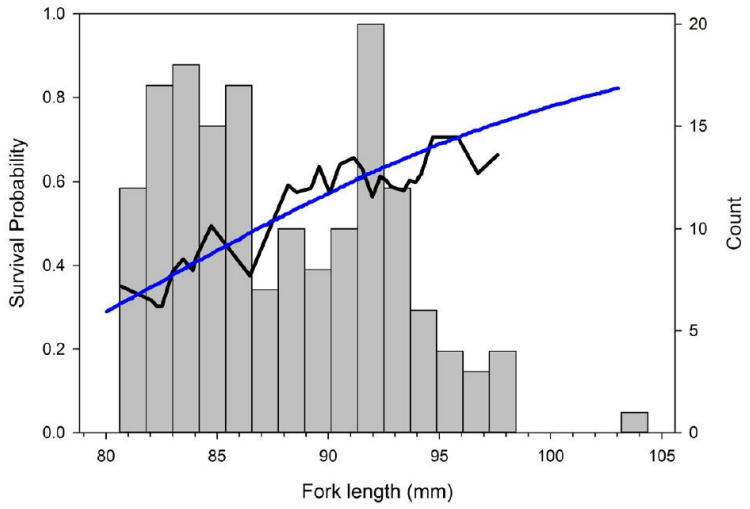
- Survival to MCN significantly correlated with FL



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Wild HR fall Chinook travel time

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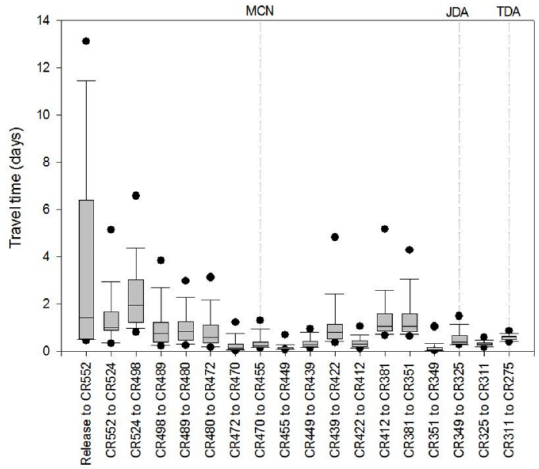
- Median travel time <2 d through each reach
- High variability in Hanford Reach (release [rkm 595] to rkm 522)
- Median travel time to MCN = 10.7 d



Wild HR fall Chinook travel rate

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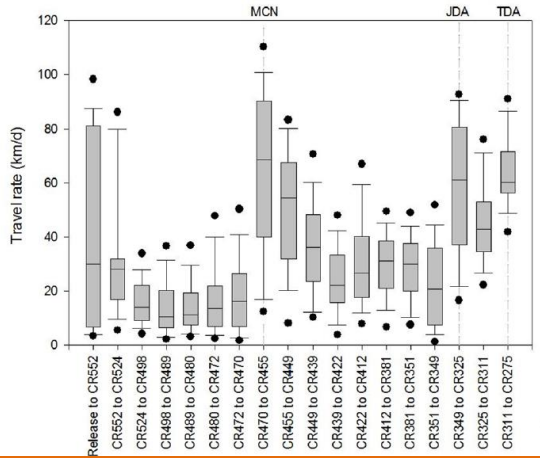
- Migrated most quickly (with greatest variability) through flowing reaches (HR, MCN TR, JDA TR, TDA TR)
  - Median rates: 30–60 km/d
- Migrated slowest through MCN pool
  - Median rates: ~10 km/d



PRH fall Chinook travel time

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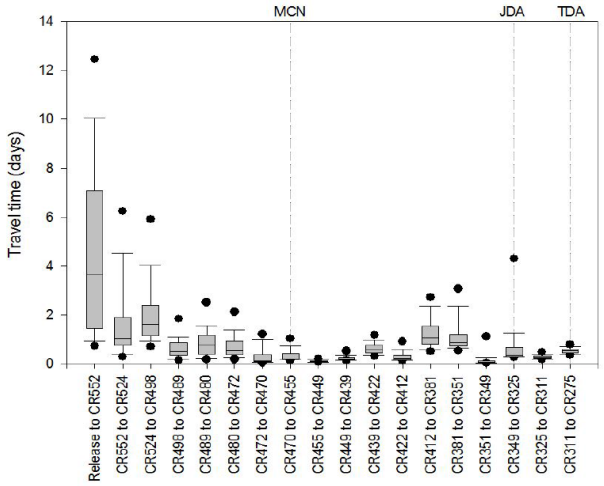
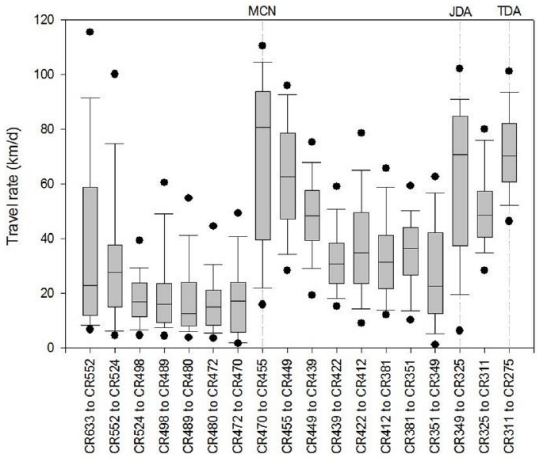
- Median travel rates <2 d through all reaches except Hanford Reach
- High variability in the Hanford Reach
- Median travel time to MCN = 11.6 d



PRH fall Chinook travel rate

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Migrated most quickly (with greatest variability) through flowing reaches (HR, MCN TR, JDA TR, TDA TR)
  - Median rates: 20–80 km/d
- Migrated slowest through MCN pool
  - Median rates: ~15 km/d
- Higher median travel rates than wild HR FC through all reaches downstream of CR524



Study biases

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- Wild HR & PRH fall Chinook had 0.50 survival probability to MCN
  - Higher than typical for wild HR fall Chinook (2014 PIT-only = 0.34)
  - Lower than typical for PRH fall Chinook (2014 PIT-only = 0.66)
- Wild HR size bias
  - 2014 PIT-only <80 mm FL = 0.31
- PRH tagging effect/tag loss bias
  - 0.82 probability of survival & tag retention from release into the channel pond to PRH cabled array
  - 2014 PIT-only = 0.97 survival to PIT array
  - 8/167 (5%) of AT+PIT PRH juveniles detected by PIT array were not detected by cabled AT array indicating acoustic tag loss
  - 2/21 (10%) and 2/27 (7%) AT+PIT PRH juveniles detected by PIT arrays at MCN and JDA, respectively, were not detected by adjacent AT arrays indicating continued acoustic tag loss in-river

Study biases

Pacific Northwest NATIONAL LABORATORY
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- Combination of tagging effect + tag loss likely resulted in underestimation of wild HR FC survival to MCN
  - 2014 PIT-only ≥80 mm FL = 0.72 survival probability to MCN
  - Compared to 0.50 for AT+PIT
- Because we don't know when during the 2 week period between tagging and volitional release the tag/tagging effect occurred at PRH (and the large variability in travel times) we can't apply a correction
- These biases likely don't change study conclusions

Predator populations

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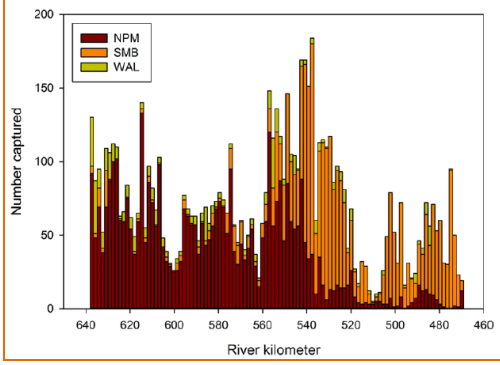
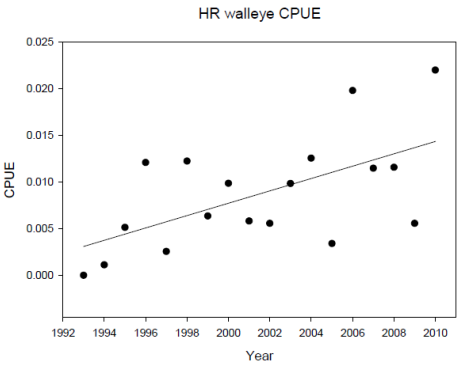
- PRD to MCN – fish
  - NPM and WAL more abundant in the HR than MCN pool (ODFW e-fishing data)
    - Mark-recapture population abundance estimate of NPM ≥228 mm FL ~37,000 in HR
    - WAL CPUE increasing in HR
  - SMB more abundant in MCN pool – large spawning population in Yakima River
  - Channel catfish present in Columbia, Yakima, Snake, & Walla Walla rivers
  - Primary predator may differ by reach/habitat type





Predator populations

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- PRD to MCN – birds
  - Goose Island (Potholes Reservoir) Caspian tern colony
    - 340 breeding pairs in 2014 (Bird Research Northwest)
  - Island 20 (near Richland) California and ring-billed gull colonies
    - 12,500 individuals in 2014
  - Foundation, Badger, and Crescent islands
    - 390 nesting pairs of double-crested cormorants on Foundation Island in 2014
    - 273 American white pelicans on Badger Island in 2014
    - 395 nesting pairs of Caspian terns and 6,200 California gulls on Crescent Island in 2014

Predator populations

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- MCN to BON – fish
  - Rieman et al. (1991) estimated there to be 85,000 NPM & 10,000 WAL >250 mm & 35,000 SMB >200 mm in JDA pool
  - 1,700 acres of backwater sloughs/embayments (MCN to JDA) and many miles of rip-rapped shorelines provide flow refugia, spawning, and foraging habitat for nonnative piscivorous fish

- MCN to BON – birds
  - Blalock Islands
    - 199 terns (Caspian & Forster's) in 2014
    - 4,630 gulls (California and ring-billed) in 2014
  - Miller Rocks Island California gull colony
    - 3,100 individuals in 2014

Predator populations

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- Diet studies – fish
  - Juvenile salmonids accounted for 67% to >84% of NPM diets, 59% of SMB diets, and 14% of WAL diets in the CR (Poe et al. 1991; Tabor et al. 1993; Zimmerman 1999)
  - SMB consume >200,000 juvenile salmonids (mostly fall Chinook) annually in Yakima River (Fritts and Pearsons 2004)
  - ~80% of NPM, 60% of CCF, 15% of WAL, and <5% of SMB diets were composed of juvenile salmonids in the immediate TR of MCN (Poe et al. 1991)
  - Rieman et al. (1991) estimated an average of 2.7 million juvenile salmonids were consumed annually from 1983–1986 by NPM, WAL, & SMB between MCN and JDA, representing 9% to 19% of all salmonids that passed MCN
    - Much of the loss (21%) occurred in the immediate TR of MCN
  - Piscivorous fishes may be consuming 17% of juvenile salmon that enter JDA reservoir in June, July, and August when most salmon smolts are FC (Rieman et al. 1991)

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Predator populations

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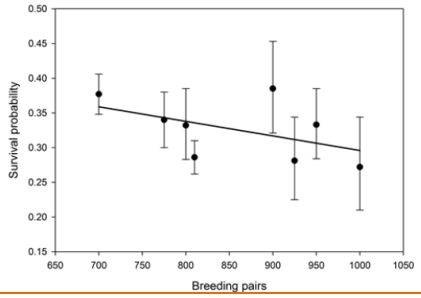
- Diet studies – birds
  - Outmigration timing of URB fall Chinook from the HR coincides with chick rearing for avian predator colonies – highest energy demand
  - Goose Island tern colony predation rate average 0.2% of PIT-tagged summer/fall Chinook previously detected at Rock Island between 2009–2012 (Roby et al. 2013)
  - Salmonids accounted for 60–70% of Crescent Island tern diet during the period of FC outmigration between 2000–2011(Roby et al. 2012)
    - Negative relationship between PIT-only wild HR FC survival to MCN and # of Columbia Plateau tern breeding pairs (p = 0.21; R^2 = 0.25)



Predator populations

Pacific Northwest NATIONAL LABORATORY
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  - Salmonids accounted for 60–70% of Crescent Island tern diet during the period of FC outmigration between 2000–2011(Roby et al. 2012)
    - Negative relationship between PIT-only wild HR FC survival to MCN and # of Columbia Plateau tern breeding pairs (p = 0.21; R^2 = 0.25)
  - Salmonids accounted for 10% of Foundation Island cormorant diet during the period of FC outmigration
  - Seems like a lot, but may not represent a significant % of the smolt population
    - Between 2007–2010 Evans et al. (2012) estimated all bird colonies in MCN pool consumed 1.6% of PIT-tagged SR FC last detected at LMN (76 km upstream)
  - High predation rates in dam TR due to disorientation of fish after passage
    - Gull predation rate of 6% on RT FC in TDA TR
  - On average, Blalock Island terns consumed <0.1% and Miller Rocks Island gulls consumed 0.4% of SR FC from 2007–2010 (Evans et al. 2012)

Summary & Conclusions

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- Relatively consistent mortality rates and lack of mortality "hot spots" around avian predator nesting colonies indicate predation from fish may be a more important source of mortality than bird predation
- Previous studies have found relatively high predation rates from piscivorous fishes and low predation rates from avian predators
- High mortality rates near dams likely associated with migration delays, disorientation, & increased predator densities
- If piscivorous fish consume 17% of FC smolts that enter JDA pool, ~2.7 million URB FC juveniles would be consumed annually in JDA pool
  - If predation rates are of similar magnitude in other reservoirs, this clearly represents an important source of mortality

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What's being done?

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- Avian predator nesting dissuasion
  - Goose and Crescent islands
    - Fencing, vegetation planting, hazing, egg collection
- Avian wires and hazing at dams
- Northern Pikeminnow Management Program
  - Sport-reward fishery & dam-angling
  - A 10–20% ER on NPM would reduce predation on juvenile salmonids by 50% (Rieman and Beamesderfer 1990)
  - CPUE and abundance index data show a continued & persistent decrease in NPM >250 mm in SR & CR since NPMP was implemented (Gardner et al. 2013; Barr et al. 2014)
    - SMB and WAL abundance & predation index values have increased in some areas of Snake and Columbia river reservoirs, which may be an early indication of a compensatory response to NPM removal
- WDFW removed daily limits for CR SMB, CCF, & WAL

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What else could be done?

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- Remove daily limits on SMB, CCF, & WAL for entire CR
- Expand NPMP to include other predatory species
- Identify predator spawning areas and evaluate the potential to manage reservoir levels in such a way as to disrupt spawning activities or recruitment success
  - Fluctuations in discharge may negatively affect reproductive success by flooding nests with cooler water, depositing silt on nests, driving away adults guarding nests, exposing eggs to desiccation, or stranding emerged fry
  - Need to occur throughout major spawning areas for sufficient duration over multiple years to cause year-class failures
- Tough sell due to the popularity of SMB and WAL sport fisheries in the CR
- If salmon survival is to be prioritized, there is a need to identify and test potential management actions to reduce predation from resident piscivorous fishes

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Acknowledgements

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