FINAL

23 S. Wenatchee Avenue, Suite 220
Wenatchee, Washington 98801
509.888.2070

ANCHOR QEA

# Memorandum

To: Wells, Rocky Reach, and Rock Island HCP Hatchery Committees, and Priest Rapids Coordinating Committee Hatchery Subcommittee

Date: January 20, 2021

From: Tracy Hillman, HCP Hatchery Committees Chairman and PRCC Hatchery Subcommittee Facilitator

cc: Sarah Montgomery and Larissa Rohrbach, Anchor QEA, LLC

**Re: Final Minutes of the December 16, 2020, HCP Hatchery Committees and PRCC Hatchery Subcommittee Meetings**

The Wells, Rocky Reach, and Rock Island Hydroelectric Projects Habitat Conservation Plan Hatchery Committees (HCP-HCs) and Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC) meetings were held by conference call and web-share on Wednesday, December 16, 2020, from 9:00 a.m. to 10:15 a.m. Attendees are listed in Attachment A to these meeting minutes.

## Action Item Summary

### Joint HCP-HCs and PRCC HSC

- Brett Farman will discuss with National Oceanic and Atmospheric Administration (NOAA) staff and Mike Tonseth the potential use of a multipopulation model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A). *(Note: this item is ongoing.)*
- Greg Mackey will work with Mike Tonseth to test a modeling approach and prepare a white paper on the method for determining a range for the number of females to be collected for a given broodstock in the upcoming year (Item I-A). (*Note this item is ongoing.*)
- Greg Mackey will prepare a plan for alternative mating strategies based on findings described in his previously distributed literature review (Item I-A). (*Note this item is ongoing.*)
- Mike Tonseth will distribute the analysis showing feasibility of the Methow Spring Chinook Outplanting plan based on historic run-size data (Item I-A). (*Note this item is ongoing.*)
- All parties will provide updates on changes to monitoring and evaluation plans due to the impacts of COVID-19 on operations as updates become available (Item I-A). (*Note this item is ongoing.*)
- Kirk Truscott will determine the number of scales that should be collected from spring Chinook at Wells Dam for elemental signature analysis to discern Okanogan River spring Chinook from Methow River spring Chinook (Item I-A). (*Note this item is ongoing.*)
- Mike Tonseth will check whether the scales from spring Chinook salmon sampled at Wells Dam are archived, and if so, whether any contamination from the acetate impression process could affect elemental signature analysis (Item I-A).

- Andrew Murdoch (Washington Department of Fish and Wildlife [WDFW]) will present pre-spawn mortality data during the February 2021 HCP-HC and PRCC HSC meeting (Item I-A). (*Note: this item is ongoing.*)
- Kirk Truscott will work with Colville Confederated Tribes (CCT) staff to develop a model that addresses the probability of encountering natural-origin Okanogan spring Chinook at Wells Dam (Item I-A). (*Note: this item is ongoing.*)
- Keely Murdoch and Mike Tonseth will update the retrospective analysis for Wenatchee spring Chinook salmon using estimates of female pre-spawn mortality (Item I-A). (*Note: this item is ongoing.*)
- Brett Farman will provide a listing of NOAA points-of-contact for programs and permits related to the HCP-HCs and PRCC HSC, and update the HCP-HCs and PRCC HSC on who is covering Allyson Purcell's (NOAA) duties while she is on leave (Item I-A). (*Note: Farman distributed this information on December 18, 2020).*
- HCP Hatchery Committees and PRCC HSC Representatives will consider desired outputs of Mark Sorel's (University of Washington) model (Item I-A). (*Note: this item is ongoing.*)
- Mike Tonseth will check on the WDFW policy for releasing unmarked surplus fish (Item I-A). (*Note: this item is ongoing.*)
- Mike Tonseth and Greg Mackey will solicit input from hatchery managers on the methods used to quantify surplus fish (Item II-B).
- Representatives will review the NOAA research summary and Hatchery and Genetic Management Plans (HGMPs) presentation distributed by Tracy Hillman and consider whether to request the authors attend a future committee meeting to discuss their research (Item IV-B).

### PRCC HSC

- None.

## Decision Summary

- None.

## Agreements

- None.

## Review Items

- There are no items currently available for review.

# Finalized Documents

- Douglas PUD's *Final 2021 Wells Complex M&E Implementation Plan* was distributed via email by Sarah Montgomery on December 11, 2020.
- Douglas PUD's final report, *Monitoring and Evaluation of the Wells Hatchery and Methow Hatchery Programs – 2019 Annual Report,* was distributed via email by Sarah Montgomery on December 11, 2020.

# I. Welcome

## A. Review Agenda, Announcements, Approve Past Meeting Minutes, Review Last Meeting Action Items

Tracy Hillman welcomed the HCP-HCs and PRCC HSC to the meeting and read the list of attendees signed into the meeting. The meeting was held via conference call and web-share because of travel and group meeting restrictions resulting from the COVID-19 pandemic. Hillman reviewed the agenda and asked for any additions or changes to the agenda. Hillman added an agenda item regarding an update on research conducted by NOAA that was recently presented to the Northwest Power and Conservation Council. Representatives present approved the agenda.

Sarah Montgomery said due to a delay in providing the November 18, 2020, meeting minutes for review, the review period will continue through Friday, December 18, 2020. The revised minutes will be available for approval via email the following week. Montgomery asked for feedback from representatives present on the best way to phrase committees' approval of Douglas PUD's Wells 2021 Hatchery Monitoring and Evaluation (M&E) Implementation Plan. She noted that aspects of the implementation plan apply to Chelan PUD and Grant PUD programs; however, historically Chelan PUD and Grant PUD have not formalized approval of Douglas PUD's plan. She asked whether this is necessary. Greg Mackey said that programs are more complicated now than previously, and in many cases programs that are particular to a given PUD may have different programmatic attributes than other programs. He said it would be important that in the potential instance where one committee does not approve the plan, the ability for the other PUD(s) to move forward with contracting or program implementation not be restricted. He said this would not be appropriate because the approval of each committee should apply only to programs within that committee's purview and not necessarily to an entire plan where details for other programs are included. He said in the instance that Douglas PUD's plan includes something that a committee other than the Wells HCP Hatchery Committee does not approve, it would be important to work through a compromise so that there are no delays in program implementation. Tracy Hillman noted that the annual reports for each HCP should also reflect approval of plans and reports that are pertinent to their programs. Representatives present reworded the agreement to show that the Rocky Reach HCP Hatchery

Committee and the PRCC HSC approved the portions of the plan pertaining to Chelan PUD and Grant PUD programs.

Catherine Willard reminded representatives to review the Okanagan Nation Alliance's comprehensive evaluation summaries and documents. She said these items will be discussed at both the January and February meetings.

Action items from the HCP-HCs and PRCC HSC meeting on November 18, 2020, were reviewed, and follow-up discussions were addressed *(note that italicized text below corresponds to action items from the previous meeting)*:

## *Joint HCP-HCs and PRCC HSC*

- *Brett Farman will discuss with NOAA staff and Mike Tonseth the potential use of a multipopulation model for estimating proportionate natural influence (PNI) for the Nason and Chiwawa spring Chinook salmon programs (Item I-A).*
  Farman said he and Tonseth plan to meet next week to discuss this item.
- *Greg Mackey will work with Mike Tonseth to test a modeling approach and prepare a white paper on the method for determining a range for the number of females to be collected for a given broodstock in the upcoming year (Item I-A).*
  Mackey said he hopes to share this approach with Tonseth this week and is making progress.
- *Greg Mackey will prepare a plan for alternative mating strategies based on findings described in his previously distributed literature review (Item I-A).*
  Mackey said this item is ongoing.
- *Mike Tonseth will distribute the analysis showing feasibility of the Methow Spring Chinook Outplanting plan based on historic run-size data (Item I-A).*
  Tonseth said this item is ongoing.
- *All parties will provide updates on changes to monitoring and evaluation plans due to the impacts of COVID-19 on operations as updates become available (Item I-A).*
  This item will be discussed today.
- *Kirk Truscott will determine the number of scales that should be collected from spring Chinook at Wells Dam for elemental signature analysis to discern Okanogan River spring Chinook from Methow River spring Chinook (Item I-A).*
  Truscott said this item is ongoing. He said he would not want to remove more scales than necessary. He asked Mike Tonseth what the lab does with scales from spring Chinook (sampled at Wells Dam) after their origin is determined. Tonseth said in the past, scale cards have been archived. He said typically, an acetate impression of the scale is used to read the scale. He said he will check with the lab on the archiving and sampling procedures. Truscott said if the scales are archived, it may be possible to perform the elemental signature analysis without collecting

additional scales. Tonseth said he will also check with the lab whether any part of the acetate impression process would contaminate the scales such that they could not be used for elemental signature analysis.

- *Andrew Murdoch (WDFW) will present pre-spawn mortality data during the February 2021 HCP-HC and PRCC HSC meeting (Item I-A).*
  This item is ongoing. Sarah Montgomery said the February meeting already has at least a 2-hour period set aside for discussions about the Okanagan Lake and Skaha programs, so she will coordinate with Murdoch to find a time for his discussion.
- *Kirk Truscott will work with CCT staff to develop a model that addresses the probability of encountering natural-origin Okanogan spring Chinook at Wells Dam (Item I-A).*
  Truscott said this item is ongoing. He said he has been discussing this item with Casey Baldwin. They are getting input on the best methods to conduct a probability analysis and will resume this task in 2021.
- *Keely Murdoch and Mike Tonseth will update the retrospective analysis for Wenatchee spring Chinook salmon using estimates of female pre-spawn mortality (Item I-A).*
  Murdoch said this item is ongoing. Tonseth said Andrew Murdoch's presentation in February may help update the analysis.
- *Brett Farman will provide a listing of NOAA points-of-contact for programs and permits related to the HCP-HCs and PRCC HSC, and update the HCP-HCs and PRCC HSC on who is covering Allyson Purcell's duties while she is on leave (Item I-A).*
  Farman said he is putting this information together and will distribute it when complete. He said Lance Kruzic (NOAA) is acting in Purcell's place until March 2021, at which time Emi Melton will take over duties until June 2021.
- *HCP Hatchery Committees and PRCC HSC Representatives will consider desired outputs of Mark Sorel's (University of Washington) model (Item II-A).*
  Tracy Hillman said this item will be discussed in January. He asked representatives present whether they have any input on this topic. Todd Pearsons said Sorel's model is oriented towards making management decisions and takes into account different life history strategies. Hillman asked how Sorel's model compares or relates to Jeff Jorgensen's (NOAA) life cycle model for Wenatchee spring Chinook. Pearsons said Sorel's model is a standalone model. He said because there are multiple models available for Wenatchee spring Chinook, with a variety of inputs and outputs, it would be interesting to compare models that have the same outputs (e.g., predicted number of spawners).
- *Mike Tonseth will check on the WDFW policy for releasing unmarked surplus fish (Item II-B).*
  Tonseth said he is still working internally to respond to this discussion item. He said there is a section of the Revised Code of Washington (RCW) addressing tagging requirements for fish for which there could be multiple interpretations. He said WDFW may need to get input from the

Attorney General's (AG) office on the intent of the RCW. He said because the language governing the release of unmarked fish is encompassed in an RCW, if there is a question of how to interpret it, WDFW may not be able to make that determination without input from the AG's office.

- *Catherine Willard will check on previous guidance or agreements about which entity pays the costs for ad-clipping surplus fish (Item II-B).*
  Willard said she found a letter from Chelan PUD to WDFW documenting an agreement between Chelan PUD and WDFW that all production fish will be marked, but any production over 110% of the program target will be marked at the expense of the state. Hillman said this partially addresses Kirk Truscott's previous inquiry about whether fish up to the 110% threshold need to be marked.
- *HCP Hatchery Committees and PRCC HSC Representatives will consider Mike Tonseth's discussion points for Appendix G of the Broodstock Collection Protocols, which will be included in the meeting minutes (Item II-B).*
  Tracy Hillman said this item will be discussed today.
- *Greg Mackey, Mike Tonseth, and Brett Farman will review conditions regarding surplus in the NMFS permit for the Wells HCP programs for discussion in December 2020 (Item II-B).*
  Tracy Hillman said this will be discussed today.

*PRCC HSC*

- *Mike Tonseth will review prior assessments of groundwater and surface water connectivity in the Methow sub-basin and provide any relevant information to the PRCC HSC (Item IV-A).*
  Tonseth said he's been researching this and has not found anything relevant to the committees' question. He said because the rearing strategy for the current brood is already determined, he recommended removing this action item; Tracy Hillman agreed.
- *Todd Pearsons will send his presentation from the meeting about the Carlton Acclimation Facility and the water chemistry report he referenced to the PRCC HSC (Item IV-A).*
  Sarah Montgomery distributed these items to the PRCC HSC via email on November 23, 2020.

# II. Joint HCP-HCs and PRCC HSC

## A. Updated Retrospective Analysis of Wenatchee Spring Chinook Salmon Conservation Program Size

Keely Murdoch said she has no updates on this item and it can be carried forward.

## B. Broodstock Collection Protocols

Tracy Hillman shared the revised document, *Topics for HCP-HC and PRCC HSC Discussion in 2020*, and reviewed the topics in the document.

Regarding Chiwawa spring Chinook, Hillman said this topic will be discussed in January 2021.

Regarding the options for differentiating natural-origin spring Chinook salmon from other natural-origin Chinook salmon during broodstock collection, Kirk Truscott said no additional discussion is needed on this item currently (but see Action Item Summary), and he will provide an update when one is available.

Regarding options for outplanting surplus Methow Composite spring Chinook salmon adults, Mike Tonseth said this item will probably be drafted and ready for discussion in January 2021. He said he is currently working on it.

Regarding Wenatchee spring Chinook pre-spawn survival estimates, Tonseth said this item will be discussed in February 2021 with Andrew Murdoch's presentation.

Regarding the sizing of upper Columbia River conservation programs, see Item II-A, above.

Regarding requests for HCP adults or juveniles for HCP-specific research or other requests (surplus to HCP broodstock needs), representatives present did not have additional input on other requests that would occur in 2021, so this discussion is complete.

Regarding authorship of sections needing to be revised, Greg Mackey said he rewrote the section for steelhead release methods in the Methow basin. He shortened the section but maintained the logical flow of broodstock collection, so this discussion is also complete.

Regarding the Angler Broodstock Collection Fishery, Todd Pearsons said this discussion is complete for 2020.

Regarding consistent declarations of surplus (contained in Appendix G), representatives continued their discussion from the November 18, 2020 meeting. Hillman shared the bulleted items that Tonseth listed for the committees to consider as items to include in a notification of surplus:

- Brood year/stock-program/age class (egg/juvenile/adult)
- Target release number/number currently on hand/number being retained for the program (needs to be accurate count – not estimate)
- Number identified as surplus (after tagging there should be an accurate count so round numbers like 12K should not be provided – unless that is the true count)
- Target destination of surplus
- Confirmation that surplus has been adipose clipped and provide approximate size at transfer
- Summary of conversations with other program operators that surplus is not needed for other programs

- Explanation as to why the surplus occurred (could be as simple as better-than-expected in-hatchery survival, higher fecundities, etc.)

Hillman said Tonseth will update Appendix G of the Broodstock Collection Protocols with the language that the committees agree to.

Mackey said the point of the notification is that the committees should have a full understanding of what the surplus is and what is happening with the surplus. He said the explanation does not have to be long.

Pearsons said the two items still up for discussion include the fifth bullet "confirmation that surplus has been adipose clipped," and the third bullet, "number identified as surplus (after tagging there should be an accurate count so round numbers like 12K should not be provided – unless that is the true count)," which he said fish culturalists could provide more input on. Regarding the accurate quantification of the surplus, Mackey said hatchery staff can provide this number.

Tonseth said if all of the fish are not being marked, he would be looking for an agreed upon method for how the number of unmarked fish is determined. He said fish can be counted at the eyed-egg stage but there is a lot of variability between that number and the number at marking. He said if the unmarked fish are not going to be run through the marking trailer and marked, there should be an agreed upon method for how to inventory those fish.

Hillman asked Tonseth whether he has a standardized methodology in mind for counting the unmarked fish. Tonseth said he is open to approaches recommended by fish culturalists. He said estimating by weight or displacement are both options, and he would seek feedback from hatchery operators on the best methods. Mackey said at Wells Fish Hatchery, the number of viable eyed eggs are counted and then a running tally of mortalities is kept. He said this is Douglas PUD's standard for knowing how many fish are in each pond. Tonseth said large rearing vessels may have mortalities that are not counted (e.g., losses due to predation). He said counting the surplus fish is also important because receiving waterbodies have carrying capacities that should not be exceeded by overplanting.

Tonseth said he will reach out to hatchery staff for input on methods for determining the number of surplus fish available that are not marked and he asked Mackey to do the same.

Tonseth said these two bullets can be further discussed when the committees review the draft 2021 Broodstock Collection Protocols.

### C. Effect of COVID-19 Pandemic on Monitoring and Evaluation Activities

Tracy Hillman asked each committee member to provide an update on impacts of the COVID-19 pandemic on monitoring and evaluation activities.

Brett Farman reported no changes from NOAA related to COVID-19.

Keely Murdoch reported no changes from Yakama Nation.

Kirk Truscott said he has no updates related to COVID-19.

Matt Cooper said he has no updates.

Mike Tonseth reported no changes.

Catherine Willard reported no changes.

Greg Mackey said Douglas PUD has no changes to report since the previous meeting.

Todd Pearsons said Grant PUD has no changes to report related to COVID-19 but provided an update on M&E work in general. He said field work in the Hanford Reach is nearly complete and he thanked the contractors and staff who worked on this project for their diligence and safe practices, noting that it was a challenge to collect so much data while dealing with the pandemic.

## III. PRCC HSC

### A. Review Agenda, Announcements, Approve Past Meeting Minutes

The PRCC HSC representatives are still reviewing the November 18, 2020, meeting minutes.

## IV. Administrative Items

### A. Anchor QEA Support Staff

Sarah Montgomery said Larissa Rohrbach is returning from leave and will return to supporting the committees starting in January 2021. Tracy Hillman and representatives present thanked Montgomery for her support of the committees in 2020.

### B. NOAA Research Presentations

Tracy Hillman said scientists from the Northwest Fisheries Science Center recently presented updates on three Bonneville Power Administration-funded projects related to hatchery science and management to the Northwest Power and Conservation Council. Hillman said he listened to the presentations and thought they would be of interest to the committees. He said the presentations are summarized in a document, *BPA sponsored research informing hatchery activities in the Columbia*

*River Basin: Projects 1999-056-00, 2002-031-00, and 1989-056-00* (Attachment B), which he distributed to the committees following the meeting on December 16, 2020. As stated in the document, the three projects can be summarized as follows:

- Chris Tatara's research: Advance Hatchery Reform Research (Project 1993-056-00)

  *This project is designed to provide information on whether hatchery culture coupled with natural steelhead growth patterns, behavior, and physiology, can limit domestication effects. Importantly too, the project will help elucidate the mechanisms responsible for domestication and provide insights into how or whether inadvertent domestication can be alleviated when steelhead are artificially reared.*

- Don Larsen and Brian Beckman's research: Growth Modulation in Salmon Supplementation (Project 2002-031-00)

  *This is a highly relevant and practical research project that addresses key uncertainties involving survival and maturation rates of hatchery Chinook salmon and the potential effects of hatchery supplementation on natural and hatchery production. Results from this project may be used to help develop hatchery rearing regimes that minimize early male maturation rates and improve hatchery smolt-to-adult survival rates (SARs) while minimizing negative impacts to protected natural stocks, including resident fishes. Based on the findings of this project, all Chinook salmon hatcheries in the Columbia Basin should test for and estimate the production of minijacks.*

- Ewann Berntson's research: Genetic Monitoring and Evaluation (M&E) Program for Salmon and Steelhead (Project 1989-056-00)

  *This is a well-developed and well-designed proposal to increase our understanding of the effects of artificial propagation on salmonid populations. The project is credited with pioneering many of the genetic monitoring tools now widely used by salmon researchers. It has consistently provided valuable information to regional managers and helped others within and outside of the Basin to address issues raised in Federal Columbia River Power System Biological Opinion Reasonable and Prudent Alternatives and the Fish and Wildlife Program.*

Hillman said he thought the presentations were very interesting, although short, and asked whether representatives would like to review the research summaries. Representatives present said they will review the summaries and consider their pertinence to HCP and PRCC HSC programs. Hillman offered to coordinate a request to any of the researchers to attend a committees' meeting to discuss aspects of their research that representatives find interesting. Todd Pearsons said he looks forward to reviewing the research summaries and said because early 2021 looks to be very busy, the middle of

the year might be a better time to consider these topics. Hillman agreed and said the committees can revisit this discussion after the Broodstock Collection Protocols are finalized.

Hillman said he also recently attended a presentation by Lance Kruzic, titled *Hatchery and Genetic Management Plans: NOAA's Update* (Attachment C, which was distributed to the committees following the meeting on December 16, 2020). Hillman said the presentation discussed the history of HGMPs and the evolution of how HGMPs have become more accepted by managers over time. He said the presentation gave him some perspective about the challenges that hatchery managers face. Representatives present said they will also review this presentation and consider its relevancy to HCP and PRCC HSC programs. Hillman said he would also be happy to coordinate with Kruzic to request that he discuss his findings with the committees if the committees find it useful.

## V. Next Meetings

The next HCP-HCs and PRCC HSC meetings will be Wednesday January 20, 2021; Wednesday February 17, 2021; and Wednesday March 17, 2021, held by conference call and web-share until further notice.

## VI. List of Attachments

Attachment A List of Attendees
Attachment B BPA sponsored research informing hatchery activities in the Columbia River Basin: Projects 1999-056-00, 2002-031-00, and 1989-056-00
Attachment C Hatchery and Genetic Management Plans: NOAA's Update

**Attachment A**
**List of Attendees**

| Name | Organization |
|---|---|
| Sarah Montgomery | Anchor QEA, LLC |
| Tracy Hillman | BioAnalysts, Inc. |
| Catherine Willard* | Chelan PUD |
| Kirk Truscott*‡ | Colville Confederated Tribes |
| Greg Mackey* | Douglas PUD |
| Deanne Pavlik-Kunkel | Grant PUD |
| Todd Pearsons‡ | Grant PUD |
| Brett Farman*‡ | National Marine Fisheries Service |
| Matt Cooper*‡ | U.S. Fish and Wildlife Service |
| Mike Tonseth*‡ | Washington Department of Fish and Wildlife |
| Katy Shelby | Washington Department of Fish and Wildlife |
| Keely Murdoch*‡ | Yakama Nation |

Notes:
* Denotes HCP-HCs member or alternate
‡ Denotes PRCC HSC member or alternate

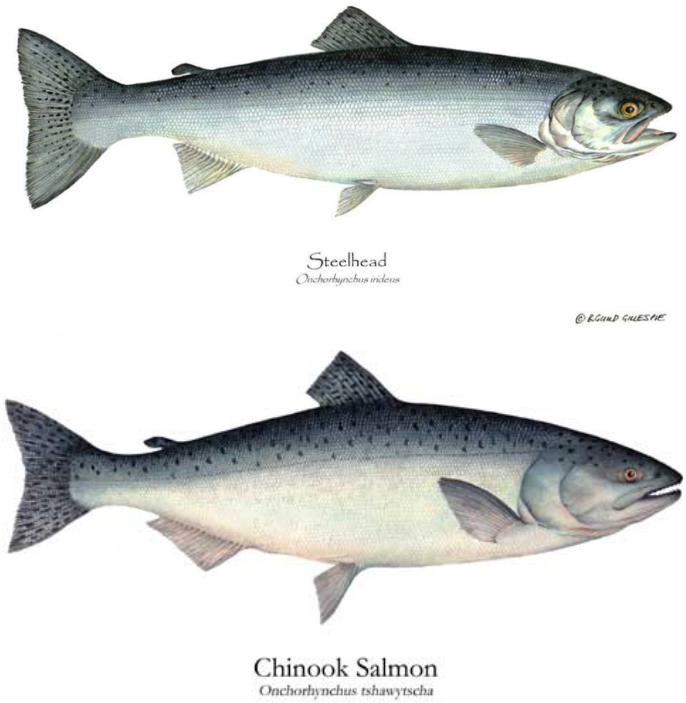
**Attachment B**
**BPA sponsored research informing hatchery activities in the Columbia River Basin: Projects 1999-056-00, 2002-031-00, and 1989-056-00**

# BPA sponsored research informing hatchery activities in the Columbia River Basin: Projects 1993-056-00, 2002-031-00, and 1989-056-00

Prepared by:
**Christopher P. Tatara**, P.I. Project 1993-056-00, Advance Hatchery Reform Research
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Environmental and Fisheries Sciences Division, Manchester Research Station, 7305 Beach Drive East, Port Orchard, WA 98366

**Don Larsen and Brian Beckman** P.I.s Project 2002-031-00, Growth Modulation in Salmon Supplementation
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Environmental and Fisheries Sciences Division, 2725 Montlake Boulevard East, Seattle, WA 98112

**Ewann Berntson**, P.I. Project 1989-056-00, Genetic Monitoring and Evaluation (M&E) Program for Salmon and Steelhead
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Conservation Biology Division, Manchester Research Station, 7305 Beach Drive East, Port Orchard, WA 98366



**Executive Summary**

This report was prepared by NOAA Fisheries, Northwest Fisheries Science Center (NWFSC) project Principal Investigators in response to a request by Northwest Power and Conservation Council (NWPCC) staff.

In this report we briefly review three separate, on-going Bonneville Power Administration (BPA) sponsored research projects that examine issues related to hatchery rearing and supplementation of Chinook salmon and steelhead in the Columbia and Snake River Basins. Two projects focus on the effects of hatchery rearing environments on resulting phenotypes of both smolts and returning adults. The third project is concerned with evaluating the nature and extent of genetic impacts on out planted hatchery stocks to both targeted and non-targeted natural stocks.

The first two projects have clearly demonstrated that choices made about hatchery rearing conditions have profound effects on smolt performance, adult phenotypes, and may potentially reduce the effects of domestication selection. The 2019 ISRP review (https://www.nwcouncil.org/reports/isrp2019-2) recognized the implications of project results on Columbia River Basin Hatchery Programs.

199305600 - Advance Hatchery Reform Research

*"This project is designed to provide information on whether hatchery culture coupled with natural steelhead growth patterns, behavior, and physiology, can limit domestication effects. Importantly too, the project will help elucidate the mechanisms responsible for domestication and provide insights into how or whether inadvertent domestication can be alleviated when steelhead are artificially reared."*

200203100 - Growth Modulation in Salmon Supplementation

*"This is a highly relevant and practical research project that addresses key uncertainties involving survival and maturation rates of hatchery Chinook salmon and the potential effects of hatchery supplementation on natural and hatchery production. Results from this project may be used to help develop hatchery rearing regimes that minimize early male maturation rates and improve hatchery smolt-to-adult survival rates (SARs) while minimizing negative impacts to protected natural stocks, including resident fishes. Based on the findings of this project, all Chinook salmon hatcheries in the Columbia Basin should test for and estimate the production of minijacks."*

The third project continues to document intended and unintended effects of outplanting hatchery-reared fish into targeted and nontargeted (wild) populations in the Snake River Basin. Annual genetic monitoring of juveniles from reference sites combined with an intensive investigation of relative reproductive success (RRS) of hatchery and natural fish in three river systems makes it an essential part of hatchery reform and provides information that is critical when using widespread hatchery propagation for recovery of natural populations. Remarks in the 2019 ISRP review reflect the essential and innovative nature of this project's investigations (https://www.nwcouncil.org/reports/isrp2019-2):

198909600 - Genetic Monitoring and Evaluation (M&E) Program for Salmon and Steelhead

*"This is a well-developed and well-designed proposal to increase our understanding of the effects of artificial propagation on salmonid populations. The project is credited with pioneering many of the genetic monitoring tools now widely used by salmon researchers. It has consistently provided valuable information to regional managers and helped others within and outside of the Basin to address issues raised in FCRPS BiOp RPAs and the Fish and Wildlife Program."*

Among the three NWFSC projects, hatchery managers receive comprehensive information directly relevant to both "nature" and "nurture" aspects of artificial propagation in general and supplementation of threatened populations in particular. These studies continue to respond to specific management problems with the most advanced molecular and bioanalytical methods available. Many results have been actionable, but even when managers were unable to act on new information, BPA-funded supplementation research at the NWFSC has transformed understanding of Columbia and Snake River Basin Chinook and steelhead. We know a great deal more about these animals, and we have infinitely more powerful tools to measure the results of management action.

The broad application of the results described for these projects could be focused by a better understanding and categorization of hatchery rearing programs and environments in the Columbia and Snake River Basins. At the end of this report, we make direct recommendations regarding what information is needed to initiate this effort.

**Background**

The Northwest Power and Conservation Council (NWPCC) and Bonneville Power Administration (BPA) programs support numerous supplementation programs to assist in recovery of Chinook salmon and steelhead trout listed as threatened or endangered under the Federal Endangered Species Act (ESA). In an effort to release fish that are ecologically, genetically, and phenotypically similar to their wild cohorts a number of rearing guidelines for supplementation programs have been made by the Hatchery Scientific Review Group (HSRG) (http://www.hatcheryreform.us/hrp/reports/system/welcome_show.action). Hatchery Reform Efforts in the Columbia River Basin have focused on two central themes

- Genetic management of broodstocks and escapement of natural spawners (i.e., the proportions of hatchery- and natural-origin fish)
- Hatchery culture practices.

Whereas the genetic composition of hatchery brood stocks can have a significant effect on fitness and performance, it is undeniable that husbandry practices and the hatchery environment also play an important role, and that the genetic and environmental factors ultimately interact to determine the outcomes and performance of hatchery programs. Research conducted at the NOAA Fisheries, Northwest Fisheries Science Center, Seattle, WA directly address these two major themes in hatchery steelhead and Chinook salmon. Project # 198909600 "Genetic Monitoring and Evaluation (M&E) Program for Salmon and Steelhead" is focused on brood stock management and interactions among spawning individuals on natural spawning grounds.

Project #200203100 "Growth Modulation in Salmon Supplementation" and Project #199305600 "Advance Hatchery Reform Science" focus on hatchery culture practices for Chinook salmon and steelhead, respectively. It is important to note that Chinook salmon and steelhead have very unique and complex life history differences including, but not limited to the following:

- Chinook salmon are semelparous and steelhead trout are iteroparous
- Freshwater residency – Chinook salmon (moderate and only males) vs. steelhead trout (extensive and both males and females)
- Chinook salmon resident life-histories provide a modest source of genetic variability. Steelhead residents may provide a significant source of genetic variability.
- Spawn timing of Chinook (Summer-Fall) vs. steelhead (Winter-Spring)
- Anthropogenic alterations (hatchery culture, dams, climate change) could have very unique and complex life history and environmental differences

These life history differences demand the need for independent research tracks for these two species, but extensive collaboration among projects across hatchery facilities in the Columbia River Basin and at the NWFSC provides a unique economy of scale with regard to facilities, diagnostic tools and expertise.

**Project #199305600 "Advance Hatchery Reform Science"**

Project #199305600 "Advance Hatchery Reform Science" focuses on Basin-wide efforts to improve the management and performance of hatchery programs for steelhead trout and the methods used to improve conservation hatchery operations. Research is conducted at hatchery (Winthrop National Fish Hatchery) and laboratory scales (NWFSC, Manchester Research Station) using the Methow River summer steelhead population (ESA-listed Threatened). Rearing methods were developed and tested with conservation hatcheries and natural-origin broodstock in mind, but apply to hatchery steelhead populations across the Columbia and Snake River Basins to support harvest and recovery

This project focuses on understanding the mechanisms of fitness loss in hatchery-reared steelhead, and using this information to manipulate hatchery rearing practices to reduce domestication selection and improve fitness. The project aims to provide hatchery rearing solutions that provide for sustainable fisheries and align with ESA recovery efforts including:

- Improve smoltification rates
- Improve post-release survival
- Increase migration speed
- Reduce precocious male maturation
- Reduce residualism rates
- Reduce potential for ecological interactions
- Minimize fitness loss
- Reduce domestication
- Maintain life history diversity
- Improve smolt-to-adult return

Primary Research Hypotheses:

(1) The mismatch between hatchery-imposed life history and natural life history of steelhead contributes toward domestication selection for rapid growth resulting in fitness loss.

(2) Hatcheries with a fixed age-at-smoltification (age-1 or age-2) reduce the natural life history diversity required for conservation and recovery of ESA-listed populations.

(3) Simple modifications to existing hatchery practices for steelhead can reduce selective pressure of the hatchery environment and improve fitness of hatchery-reared steelhead.

Hatchery steelhead are almost exclusively raised as 1-year-old smolts (S1), rather than the more typical 2-and 3-year-old (S2 and S3) natural smolt life history patterns (Berejikian et al. 2012). How steelhead are raised in hatcheries alters the proportions of smolts, parr, and precocious males at release (Figure 1). High growth rates associated with accelerated hatchery rearing to a 1-year-old smolt life history may contribute to maladaptive behavioral traits and reduced post-release survival and may constitute a primary mechanism leading to reduced fitness in hatchery steelhead (Berejikian et al. 2017, Tatara et al., accepted). The project has also focused on how and when to extend hatchery rearing to produce S2 smolts. S2 rearing can provide the following benefits when compared to S1 rearing (Berejikian et al. 2012, 2019; Tatara et al. 2017, 2019):

- Increased use of natural origin broodstock
- Maintenance of natural spawn timing
- Reduced selection for rapid growth
- More uniform size distribution [lower coefficient of variation (CV)]
- Increased smoltification
- Greater or equivalent survival
- Faster migration
- Similar residualism rates
- Similar reproductive success of females spawning naturally


Figure 1: Developmental state of hatchery steelhead prior to release. Four classes of steelhead are typical of hatchery rearing (parr, transitional, smolt, and mature male) and the proportions vary with rearing methodology and broodstock source. It is desirable to produce a high proportion of smolts and transitional steelhead, as parr and mature males residualize with consequences for limiting ecological interactions and genetic management of integrated populations. (Photo credit, Michael Humling, USFWS)

Further refinements that tailor hatchery environments to juvenile growth rate hold promise for improving smoltification and reducing precocious maturation. Instead of using a fixed age-at-release for all steelhead (S1 or S2), the new method sorts steelhead fry within 9 weeks of ponding. The growth of larger fry is accelerated to produce S1 smolts, while growth is restrained during extended rearing for the remaining fry to produce S2 smolts. The proportion to allocate to S1 and S2 rearing depends on the spawning date of the broodstock and the thermal profile of the hatchery rearing water, which vary considerably among hatchery programs. We are currently developing high throughput automated sorting procedures and proportional allocation guidance according to these two variables for application of the method across Columbia Basin steelhead hatcheries (see deliverable 6).

Table 1. Current research timelines for deliverables of proposed research for Project 1993-056-00. Details regarding each deliverable are available in the 2019 proposal (link to full proposal provided below). Note all timelines were derived prior to the COVID-19 pandemic and may need to be revised.

| Deliverable | Description | Timeline |
|---|---|---|
| 1 | Assess how growth in culture under a split rearing regime (BY18-21) affects life history pathways and smolt quality. | Initiated April 2018, Complete 2023 |
| 2 | Determine effects of a split-rearing regime on post-release behavior and survival, and selection on body size. | Initiated April 2018, Complete 2023 |
| 3 | Determine effects of age-at-release on the fecundity of returning anadromous females. | Initiate 2021, Complete 2023 |
| 4 | Determine effects of a split-rearing regime on survival throughout the migratory lifecycle. | Initiate 2023, Complete 2025 |
| 5 | Identify behavioral and physiological traits under selection through laboratory-scale research. | Initiate 2021, Complete 2023 |
| 6 | A tool for hatcheries to optimize smolt production using natural-origin steelhead broodstock. | Initiated 2019, Complete 2022 |

Most recent proposal: NPCC19-1993-056-00 – Advance Hatchery Reform Research (1993-56-00)

https://www.cbfish.org/Proposal.mvc/Summary/NPCC19-1993-056-00

2018 Annual Report: Advance Hatchery Reform Research (1993-056-00)

https://www.cbfish.org/Document.mvc/Viewer/P163756D

2019 Annual Report: Advance Hatchery Reform Research (1993-056-00)

https://www.cbfish.org/Document.mvc/Viewer/P170272D

**Proposed research beyond 2023**

The 2020 Biological Opinion for operations of the Columbia River System (NMFS 2020) addresses Conservation and Safety Net hatchery programs for steelhead and Chinook salmon. The Winthrop Steelhead Program is the only steelhead program specifically mentioned in the 2020 Biological Opinion for the Columbia River System. It is managed as an Integrated Conservation program and it is the research focus of project 1993-056-00. The Conservation hatchery program has a unique relationship to the Safety Net hatchery program for Methow River steelhead and to the Harvest hatchery program for steelhead at the Wells Dam Hatchery. The broodstocks used in these programs are derived from a common population but are separated by a minimum of two generations of hatchery influence. The Conservation program uses natural-origin broodstock (minimal hatchery influence), the Safety Net program uses broodstock that are the progeny from the Conservation program (one generation removed), and the Harvest program uses hatchery-origin broodstock (minimum of 2 hatchery generations removed from natural-origin broodstock). Future research efforts (beyond 2023) will focus on the differences in fitness related traits of steelhead produced in the three types of hatchery programs (Conservation, Safety Net, and Harvest) all derived from the ESA-threatened Upper Columbia River steelhead DPS. Impacts of domestication selection and fitness loss are hypothesized to become progressively stronger with each generation of hatchery influence experienced by the broodstock. Experimental designs measuring fitness, performance, and genetic parameters for the three programs will be developed and pursued. Comparisons among the three hatchery program types would provide information to guide hatchery operations, recovery efforts, and address critical uncertainties across the spectrum of artificial propagation activities for steelhead in the Columbia and Snake River systems.

**Project 200203100 “Growth Modulation in Salmon Supplementation”**

The title "Growth Modulation in Salmon Supplementation" acknowledges that growth is a central driver of life-history ‘decisions’ in salmonid fishes and that hatchery rearing induced variation in growth may result in either advantageous or deleterious life history variation in smolts released from hatcheries. The project highlights the importance of understanding how hatchery rearing protocols may alter seasonal growth and size of juvenile fish and the subsequent smolt quality and life history variation of the fish

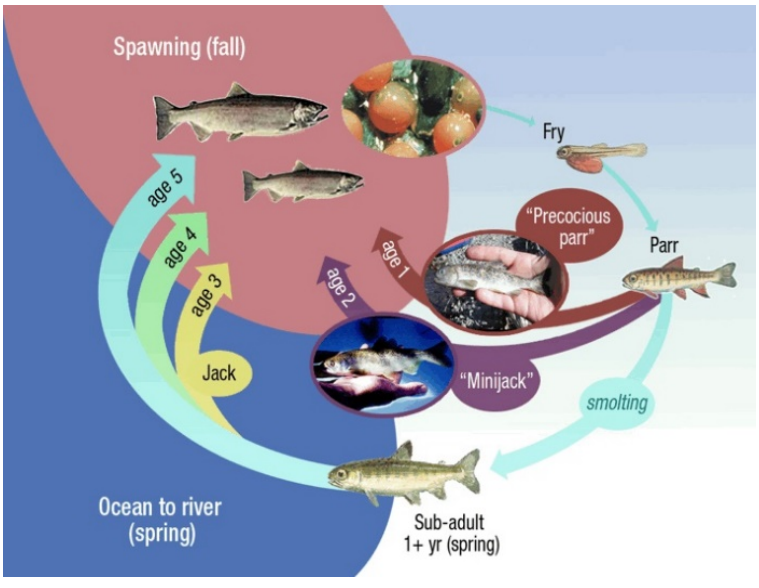



Figure 2. Life-history of Spring Chinook Salmon

hatcheries release. This project has a significant historical base in the Yakima River basin (Beckman and Larsen 2005; Larsen et al. 2004, 2006, 2010, 2014, 2019), but has broad scope and application in Chinook salmon hatchery reform throughout the Columbia and Snake River Basins (Harstad et al. 2013, 2018 Spangenberg et al. 2014; 2015, Beckman et al. 2017).

Guidelines for rearing of local broodstocks in supplementation programs have recommend that "naturally selected populations should provide the model for successful artificially reared populations, in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics (Columbia River Basin Fish & Wildlife Program Nov. 14, 2000)" In this project we refer to this guiding principle as the "Wild Fish Template (Beckman et al. 2000) " and include focus on the following:

- Seasonal growth rate, size and dietary lipid composition should match wild fish
- Mismatches in these factors may result in life-history differences including altered smolt migration timing, residualism, early age/small size at maturation, and reduced SARs.

Salmon hatcheries often rear fish with unnatural growth regimes and high lipid diets that can result in earlier age at maturity, most notably in males. We have documented that hundreds of thousands of age-2 minijacks are released each year from Chinook salmon hatchery programs throughout the Columbia and Snake River basins (range 7.9-71.4% of males depending on the program; Larsen et al. 2004, 2015; Harstad et al. 2014; Spangenberg et al. 2014; 2015; Beckman et al. 2017; Harstad et al. 2018). Minijack rates of hatchery fish have been estimated to be approximately 10x that of wild fish (Larsen et al. 2013).

The release of minijacks results in:

- Potential domestication of hatchery broodlines
- Significant loss in anadromous adult production
- Increased error in SAR estimates used for hatchery and hydroelectric project evaluations as these fish are not smolts (although they are enumerated as such)
- Increased residualism and interbreeding (via a 'sneaker strategy') with wild fish
- Contribute to low relative reproductive success in supplementation programs that produce high minijack rates (Ford et al. 2012)
- Competition with native fish for food and habitat.
- Wasted hatchery resources.
- Impediments to recovery via reduction in SARs.

Project Objectives

- Assess proportion of precociously maturing males produced in supplementation and conservation hatcheries for Chinook salmon in the Columbia River Basin
- Conduct both basic and applied research to determine causative affecting life-history
- Devise rearing protocols to enhance smolt development, reduce domestication selection.
- Produce fish with similar physiological, morphological and behavioral attributes as their wild cohorts.

Overarching Hypothesis: The use of the "Wild Fish Template" to guide hatchery reform efforts will.

- Reduce unnaturally high rates of early male maturation
- Limit domestication of hatchery broodstocks
- Decrease opportunity for unwanted hatchery/wild genetic introgression and ecological interactions
- Improve smolt development and increase SARs for hatchery Chinook salmon.

Links to most recent proposal

Proposal NPCC19-2002-031-00 - Growth Modulation in Salmon Supplementation (2002-031-00)

https://www.cbfish.org/FileResource.mvc/GetImageFile/8282ae03-e2e3-4926-b5b3-7c18b9d973e2

Links to last 2 annual reports

Growth Modulation in Salmon Supplementation (2002-031-00) Annual Report 2018
https://www.cbfish.org/Document.mvc/Viewer/P163602

Growth Modulation in Salmon Supplementation (2002-031-00) Annual Report 2019
https://www.cbfish.org/Document.mvc/Viewer/P170639

The research outlined in the current proposal has eight deliverables (Table 2).

Table 2. Current research timelines for deliverables of proposed research for Project 2002-031-00. Details regarding each deliverable are available in the 2019 proposal (link to full proposal provided below). Note all timelines were derived prior to the COVID-19 pandemic and may need to be revised.

| Deliverable | Description | Timeline |
|---|---|---|
| 1 | Complete manuscript describing multi-brood year Growth Modulation Expt. With URB Umatilla R. Fall Chinook salmon | Initiated April 2011, Complete 2023 |
| 2 | Complete manuscript exploring effects of alterations in emergence time on life-history of URB Fall Chinook salmon | Initiated April 2011, Complete 2021 |
| 3 | Survey integrated and segregated Idaho hatchery Chinook salmon stocks for minijack maturation | Initiate 2015, Complete 2023 |
| 4 | Analysis of relationship between minijack and jack maturation in Idaho hatchery Chinook salmon | Initiate 2015, Complete 2023 |

| | | |
|---|---|---|
| 5 | Complete manuscript describing interactive effects of stock and environment on minijack rates in McCall Chinook salmon | Initiate 2015, Complete 2021 |
| 6 | Complete manuscript examining genetic variation in minijack rates and threshold for early male maturation in Chinook salmon | Initiated 2014, Complete 2020 |
| 7 | Experiment – The interaction of genetic and environmental effects on minijack and jack production in hatchery spring Chinook salmon | Initiated 2018, Completed 2023 |
| 8 | Production scale PRAS Growth Modulation Experiment, Leavenworth Nation Fish Hat. | Initiate 2021, Completed 2029 |

**Proposed Research beyond 2023**

How do we apply the principals of the "wild fish template" to Partial Recycling Aquaculture Systems (PRAS)?

BPA, USFWS and PUD sponsored hatchery facilities throughout the Columbia River Basin are implementing use of partial recycling aquaculture systems (PRAS) for yearling Chinook salmon. However, few controlled studies with salmonids have been conducted, thus, there is need to monitor and evaluate their effects on the quality of smolts released and their subsequent effects on adult age structure and SAR's. Our proposed research will design, monitor and evaluate a newly implemented PRAS systems being implemented at the Leavenworth National Fish Hatchery, Leavenworth WA over the next 2-4 years. This program provides an ideal opportunity to conduct these studies due to the following 1) the Chinook salmon are not ESA listed 2) they have a robust M&E program for monitoring downstream migration and survival, 3) the proposed system is sufficiently sized for controlled experiments with over 200K smolts in 4 rearing vessels, 4) PRAS and raceway stocks can be compared.

**Project # 198905600 “Genetic Monitoring and Evaluation (M&E) Program for Salmon and Steelhead”**

This genetic monitoring program was designed to evaluate the effects of outplanting hatchery reared fish on natural and wild populations of spring/summer Chinook salmon and steelhead in the Snake River Basin. The two major goals of this project are to 1) evaluate the nature and extent of genetic changes in outplanted hatchery stocks, and 2) quantify the genetic impact of out planting on targeted and non-targeted natural stocks. This study was designed as a two-tiered approach: genetic monitoring through annual sampling of juveniles at a number of reference sites in the Snake/Salmon River sub basins (Tier 2), and an intensive investigation of relative reproductive success (RRS) of hatchery and natural fish in three river systems through sampling of juveniles, residents (for steelhead) and returning adults (Tier 3). We have three ongoing reproductive success projects: Little Sheep Creek (Imnaha Basin) for steelhead, and Catherine Creek and Lostine River (Grande Ronde basin) for Chinook salmon. The reproductive success work has been pursued since 2000, while the gene frequency monitoring has been a central component since the study’s inception in 1989.

The greatest strength of this genetic monitoring program lies in the breadth and depth of its sampling design; we have collections for both steelhead and Chinook across multiple river basins, multiple life stages, and multiple life histories, every year since 1989. We've employed historical samples predating supplementation, and we've leveraged our resources by relying heavily on the annual efforts of other field crews. Whether annual samples are genotyped right away or are stored for future use, we have produced an invaluable resource for understanding subtle effects of hatchery propagation throughout the basin. We've made those samples available to other BPA-funded labs, and each year we prioritized (in part) genotyping and analysis in response to specific co-manager directives.

This project continues to implement cutting-edge ecological genetic and genomic tools to accommodate new challenges and exploit new opportunities (see below). New DNA sequencing technologies offer significant power to address old problems in artificial propagation, such as domestication and the genetic/environmental determinants of morphological traits such as size and age at maturity, reproductive behavior, and juvenile migration. Advances in technology and biological understanding in the areas of genetics, physiology, and behavior are all converging to offer unprecedented opportunities in artificial propagation in general and supplementation of threatened populations in particular.

## Project Objectives

*Qualitative Objectives*

This genetic monitoring program has extensively evaluated the effects of outplanting hatchery reared fish on natural and wild populations of spring/summer Chinook salmon and steelhead in the Snake River Basin.

The two primary qualitative objectives are the following:

1) Evaluate the nature and extent of genetic changes in hatchery stocks to be used for outplanting, and
2) Quantify the genetic impact of outplanting on targeted natural stocks and non-targeted wild stocks.

The information obtained from this study directly addresses a critical remaining knowledge gap identified by comanagers: under what conditions does hatchery supplementation provide a sustained contribution to natural production? Our previous results disproved many misconceptions and alleviated some concerns about hatchery propagation (e.g., Van Doornik et al. 2011; Van Doornik et al. 2013); however, we also identified potential for substantial improvement in some programs and opportunities to avoid problems in others (e.g., Berntson et al. 2011). Our goal has always been to provide practical support for management in evaluating effectiveness of propagation improvements toward achieving supplementation goals. Without this continued monitoring, there would be no measure of on-going efforts to increase relative reproductive success (and sustained productivity) of naturally-spawning hatchery fish.

*Quantitative Objectives*

Our analyses of Tier 2 and Tier 3 data relate to the following quantitative objectives:

1) Characterize population genetic relationships within and among populations of Chinook and steelhead in the Snake River basin.

2) Use allele frequency changes over time, genetic linkage disequilibrium, and population pedigrees to estimate effective population sizes and rates of inbreeding and introgression in Chinook and steelhead populations in the Snake River Basin.

3) Estimate the relative reproductive success (RRS) of hatchery fish spawning in the wild using genetic pedigrees. Currently we have three rivers with ongoing RRS projects: Little Sheep Creek, Imnaha Basin (steelhead), and Catherine Creek and Lostine River, Grande Ronde basin (Chinook).

4) Measure associations of physical and behavioral characteristics associated with RS.

**Results**

This study has made numerous contributions to management and research in the Snake River basin over the past 3 decades, highlighting a few:

- Provided data pertaining to population genetic structure and geographic distribution of genetic variation for Chinook and steelhead NMFS status reviews, as well as to the US v. Oregon dispute resolution.
- Examined genetic effects in hatchery and natural systems over the 20+ year span of this project (Van Doornik et al. 2011, Van Doornik et al. 2013). We provided evidence of populations where hatchery fish appear to have contributed to natural production, and others where genetic effects of the hatchery supplementation are less apparent.
- Continues to provide best available estimates in Snake Basin salmon populations for important genetic parameters, Nm, Ne, and Nb to N ratios. The studies above produced Nb estimates for Salmon River Chinook populations over the span of 3-5 generations, and found that in most populations Ne didn't fall low enough to reduce heterozygosity or allelic richness over that time span. The geometric mean of Nb/N was significantly higher in non-supplemented populations (0.3) compared to supplemented populations (0.23) compared to hatchery populations (0.15).
- Produced individual-specific, full life-cycle reproductive success estimates in steelhead and Chinook salmon over multiple brood years. Documented low RRS in hatchery steelhead (~0.4) and variable but overall nearly equal RRS in Chinook (~1.0), and suggested the low acclimation site and high hatchery spawner densities contributed to the low RS in Little Sheep Creek.
- Provided quantitative genetic analysis of a mixed hatchery and natural steelhead population
- Documented reproductive contributions of kelts, resident rainbow trout, and residualized hatchery fish in Little Sheep Creek steelhead, and precocious male parr in Catherine Creek and Lostine River Chinook).

The most recent Biological Opinion (NMFS 2020) listed the Snake River spring/summer Chinook populations almost entirely as "high risk," and noted that 2017-2019 saw the lowest returns since 1999, and that estimates of total spawners in Snake River populations were experiencing a similar downward trend. The report suggested the driving force behind these declines may be tied to declining ocean conditions and ocean productivity during this time period. Our continued annual monitoring will keep co-managers apprised of life-stage-specific changes in relative survival and reproductive success of hatchery and natural fish.

Table 3. Current research timelines for deliverables of proposed research for Project 1989-096-00. Details regarding each deliverable are available in the 2019 proposal (link to full proposal provided below). Note all timelines were derived prior to the COVID-19 pandemic and may need to be revised.

| Deliverable | Description | Timeline |
|---|---|---|
| 1 | Collect Chinook and steelhead genetic samples from multiple locations within Snake River Basin | Initiated 1989, Ongoing |
| 2 | Genotype Chinook and steelhead samples for current CRITFC/IDFG SNP panels for Tier-2 monitoring (conventional monitoring) | Initiated 2014, Ongoing |
| 3 | Genotype Chinook and steelhead samples for current CRITFC/IDFG SNP panels for Tier-3 studies (relative reproductive success) | Initiated 2014, Ongoing |
| 4 | Test for changes in diversity and gene flow at Tier-2 study sites since our last major publications | Initiated 2020, Complete 2023 |
| 5 | Analyze data and interpret results for Tier-3 sampling | Initiated 2020, Complete 2023 |
| 6 | Evaluate ability of eDNA sampling to replace electrofishing | Initiated 2020, Complete 2022 |
| 7 | Identify potential microhaplotypes contained in the current GT-Seq SNP panels | Initiated 2020, Complete 2020 |
| 8 | Screen parent and offspring data for microhaplotype information | Initiate 2021, Complete 2023 |
| 9 | Analyze eDNA samples for allele frequencies of Chinook and steelhead populations | Initiate 2023, Complete 2024 |

**Proposed research beyond 2023**

We are initiating a project during the current 2020 contract in conjunction with BPA Project #2003-039-00 (Monitor and Evaluate (M&E) Reproductive Success and Survival in Wenatchee River) to use Whole-Genome Sequencing (WGS) to compare natural-origin Chinook (and potentially steelhead) with their hatchery-origin counterparts, as well as fish from differing hatchery programs (e.g., captive broodstock vs. conventional programs).

High water temperatures have kept us from sampling one of our Tier-2 sites for the past 2 years. We anticipate increasing limitations on handling fish for traditional genetic sampling, e.g. electrofishing, seine netting, or trapping. Our most recent proposal included evaluating the utility of eDNA filtered from river water or extracted from sediments as a substitute for electrofishing and direct tissue sampling (Deliverable #6 and 9 above). The first goal is to estimate allele frequencies in natural populations from eDNA. This will give at least some limited information for populations that can't be sampled because of temperature limitations. However, complete population genetic monitoring requires genotypes for individual fish, which is a much greater challenge to obtain from eDNA analysis. Despite, significant molecular and bioinformatic barriers, we are optimistic about current collaboration among cetacean and salmon geneticists with similar interests and study organisms that are not easily sampled directly. Technology is advancing rapidly and even since our last proposal we are more hopeful about obtaining genotypes for individual fish (whales) from eDNA samples, whether filtrates, sediments or feces. It now appears that for this project, with proper field collection and laboratory preparation, a combination of currently available commercial services and reagent kits might be used to genotype individual Chinook and steelhead from complex eDNA samples. Genotyping is not only relevant to obtaining full population information for Tier-2 conventional monitoring. If we succeed in implementing this exciting new method, our Tier-3 pedigree studies could also be conducted, at least in part if not eventually in total, from eDNA. Combined with our genomics research on age at maturity, and deep linkage disequilibrium, we look forward to a time when hatchery origin, life-history type and many aspects of phenotype can be associated with reproductive success and multi-generational productivity in the wild and in the hatchery without ever actually touching fish.

**Link to most recent proposal:**

Proposal NPCC19-1989-096-00- Genetic Monitoring and Evaluation (M&E) Program for Salmon and Steelhead (1989-096-00)
https://www.cbfish.org/Proposal.mvc/SummaryAsPdf/NPCC19-1989-096-00

**Links to the past two annual reports:**

Monitor and Evaluate the Genetic Characteristics of Supplemented Salmon and Steelhead (1989-096-00) Annual report 2018
https://www.cbfish.org/Document.mvc/Viewer/P164684

Monitor and Evaluate the Genetic Characteristics of Supplemented Salmon and Steelhead (1989-096-00) Annual report 2019
https://www.cbfish.org/Document.mvc/DocumentViewer/P171338/46273-165-1.pdf

**Information needs to further inform hatchery operations in the Columbia and Snake Basins**

While the research results reported by these three projects currently inform hatchery operations across the states of Washington, Idaho, and Oregon, the principal investigators, ISRP, and NWPCC envision greater application to additional hatchery programs operating in the Columbia and Snake Basin hatchery systems. Unfortunately, this effort is hampered by the availability of aggregated data regarding environmental, broodstock management, and life history metrics for Chinook and steelhead hatchery programs funded through the BPA (Table 4). The authors recognize that some of these data are available in the Hatchery Genetic Management Plans (HGMP) developed for individual hatchery programs. However, these data lack standardization across programs, are not updated annually, and are not aggregated into a centralized accessible source (i.e., spreadsheet or database). The *2020-2021 Habitat and Hatchery Program Review* process provides an opportunity for the NWPCC to work with hatchery operators to collect this basic data and aggregate it as a resource. Doing so would provide greater opportunity for the research results of the three NWFSC-sponsored projects to inform tailored rearing strategies to optimize hatchery performance and benefit recovery of salmon and steelhead populations within the Columbia and Snake Basins (Table 5). The three projects are well positioned and look forward to continued interaction with program staff as a resource to inform and improve BPA sponsored hatchery programs throughout the region.

Table 4. Recommended environmental, broodstock management, and life history metrics useful for extrapolating research results to inform and optimize hatchery operations in the Columbia and Snake River Basins by hatchery program and species.

| | **Reported metric category** | | |
|---|---|---|---|
| **Program** | **Environmental** | **Broodstock management** | **Life history** |
| Species | Water source | Broodstock origin (natural, hatchery, or mixture) | Age-at-release (in months from spawning) |
| Production target (# smolts released) | Monthly average water temperature (incubation to release) | Spawning dates (first, last, peak) | Ponding date |
| Five-year average production (# smolts) | | Spawning matrix design | |
| Target release size (choose unit still) | | | |
| Five-year average release size (unit?) | | | |
| Number of returns | | | |

Table 5. Potential uses of hatchery metrics to inform performance of steelhead and Chinook salmon hatcheries in the Columbia and Snake River Basins.

| Steelhead | Chinook salmon |
|---|---|
| Facilitate use of natural-origin broodstock | Design and develop seasonal growth rate profile<br>• Minimize minijack rate |
| Determine age-at-release<br>• Age-1<br>• Age-2<br>• Split-rearing age (and proportions) | Maximize smoltification and survival |
| Improve survival and migration speed | Optimize age structure of adults |
| Minimize residualism<br>• Immature parr (failure to smolt)<br>• Precociously mature males | Increase size-at-age of adults |
| Improve RS of hatchery-origin fish spawning in natural environments for supplementation hatcheries | Improve (or maintain) RS of hatchery-origin fish spawning in natural environments for supplementation hatcheries |

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**Attachment B**
**Hatchery and Genetic Management Plans: NOAA's Update**

NOAA FISHERIES

# Hatchery and Genetic Management Plans: NOAA's Update

Lance Kruzic
Hatcheries & Inland Fisheries Branch


NOAA FISHERIES

# For Today

- History of Hatchery and Genetic Management Plans (HGMPs).
- Highlight Some of the Region's Accomplishments Through HGMPs.


NOAA FISHERIES

# What is a Hatchery and Genetic Management Plan (HGMP)?

- Document describing all aspects of a particular hatchery program:
- Program Objectives & Standards
- Hatchery Operations
- Adult Management (fisheries, spawning)
- Research, Monitoring, Evaluation
- Coordinated Among the Co-managers
- Adaptive

# Status of ESA Listings & Critical Habitat Designations for West Coast Salmon & Steelhead

**Puget Sound Domain**

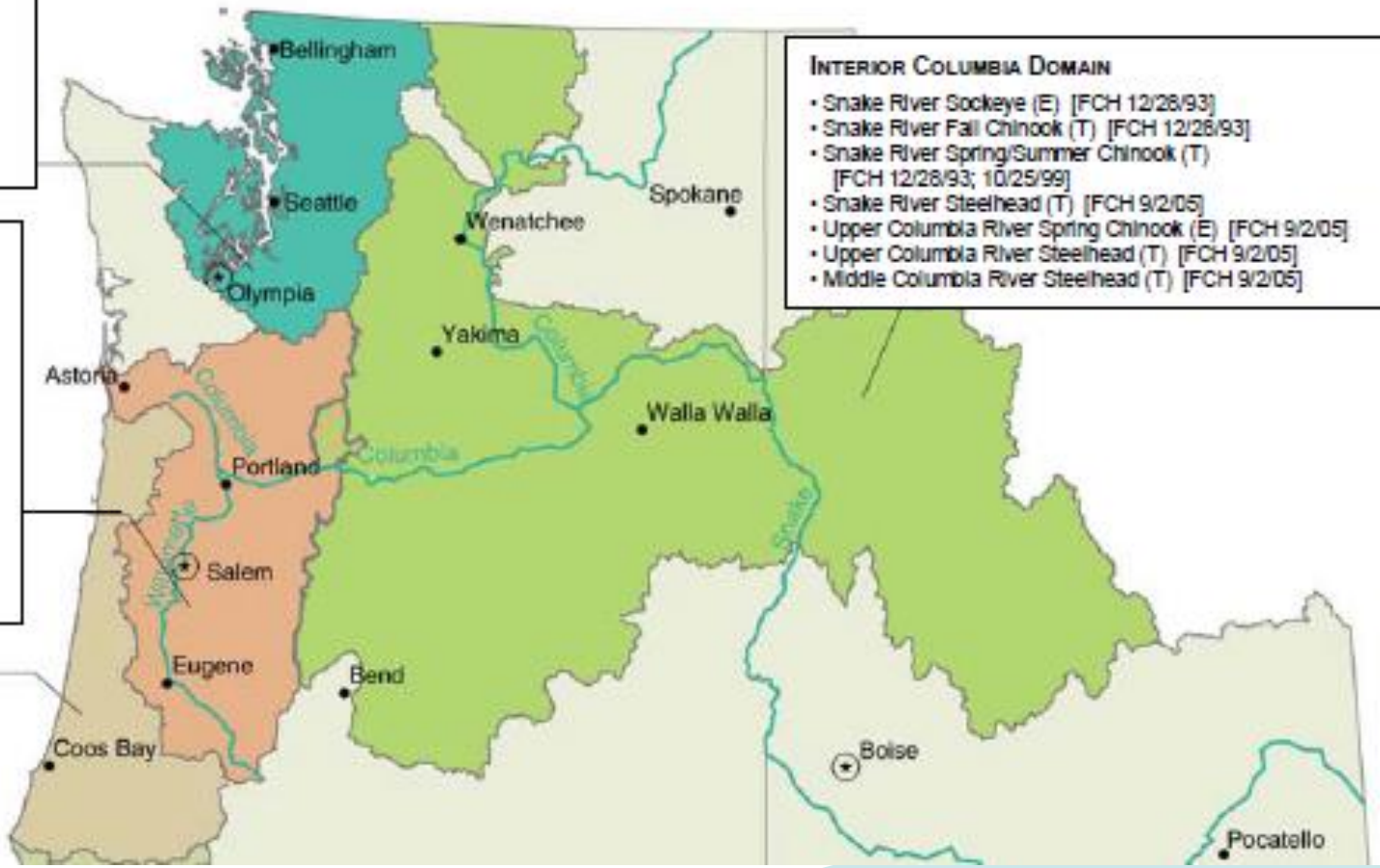
- Puget Sound Chinook (T) [FCH 9/2/05]
- Hood Canal Summer Chum (T) [FCH 9/2/05]
- Ozette Lake Sockeye (T) [FCH 9/2/05]
- Puget Sound Steelhead (T) [CH under dev.; ANPR 1/10/11]

**Willamette/Lower Columbia Domain**

- Columbia River Chum (T) [FCH 9/2/05]
- Lower Columbia River Coho (T) [CH Under dev.; ANPR 1/10/11]
- Lower Columbia River Chinook (T) [FCH 9/2/05]
- Lower Columbia River Steelhead (T) [FCH 9/2/05]
- Upper Willamette River Chinook (T) [FCH 9/2/05]
- Upper Willamette River Steelhead (T) [FCH 9/2/05]

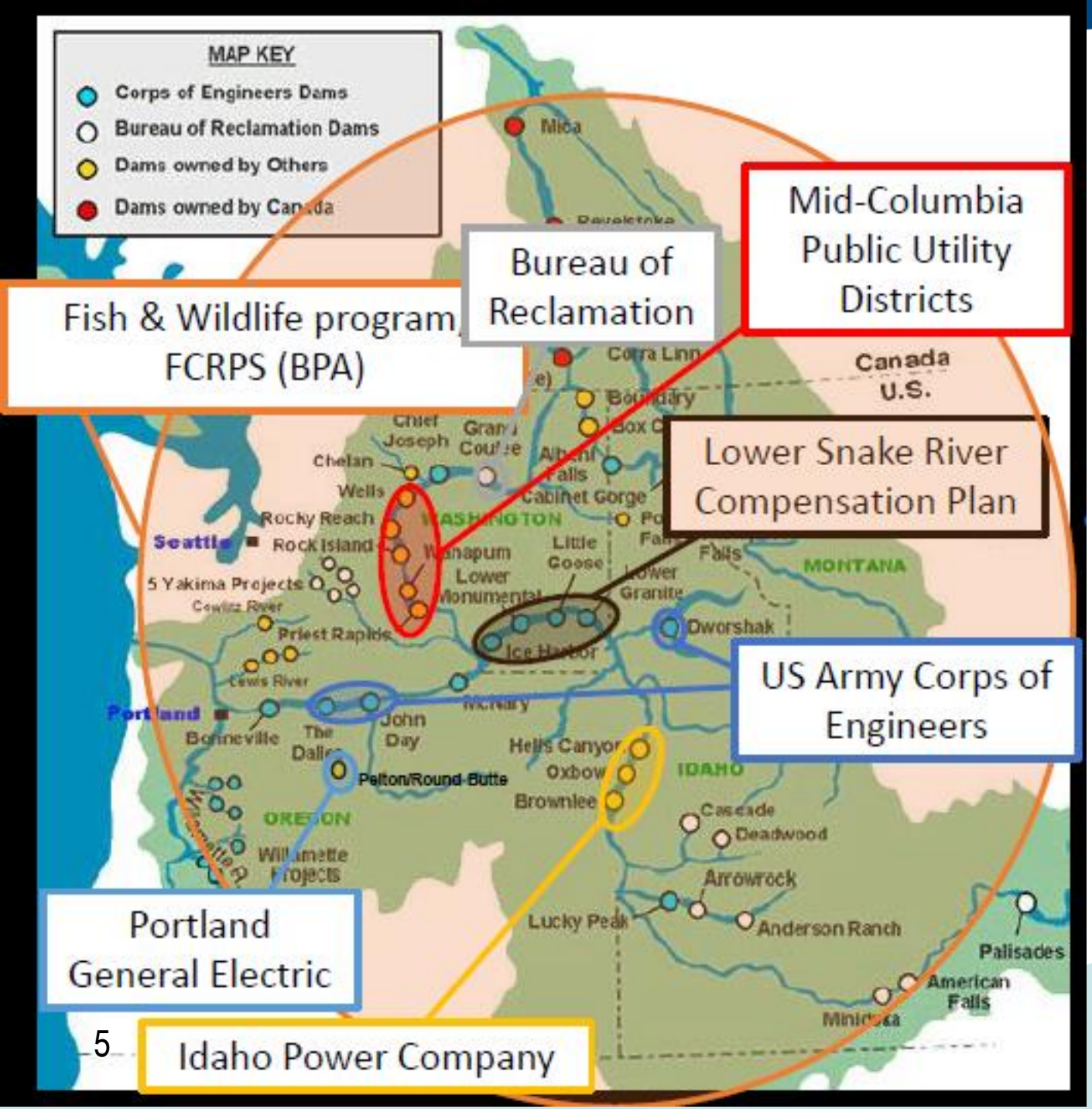
**Oregon Coast Domain**

- Oregon Coast Coho (T) [FCH 2/11/08]




**Interior Columbia Domain**

- Snake River Sockeye (E) [FCH 12/28/93]
- Snake River Fall Chinook (T) [FCH 12/28/93]
- Snake River Spring/Summer Chinook (T) [FCH 12/28/93; 10/25/99]
- Snake River Steelhead (T) [FCH 9/2/05]
- Upper Columbia River Spring Chinook (E) [FCH 9/2/05]
- Upper Columbia River Steelhead (T) [FCH 9/2/05]
- Middle Columbia River Steelhead (T) [FCH 9/2/05]




# 191 Hatchery Programs Columbia Basin !

And other hatchery programs funded by:

- Oregon, Washington, Idaho
- Mitchell Act
- Pacific Salmon Recovery Fund

**Graphic from Becky Johnson, Nez Perce Tribe, 2020.**

# History of HGMPs

- Effects analysis required.
- Coordination Among the Co-Managers.
- Accountability.
- Adaptive Management.

Not Enough Fish

Too Many Fish

ESA

NEPA

Ocean fisheries

Clean Water Act

License Sales

Litigation

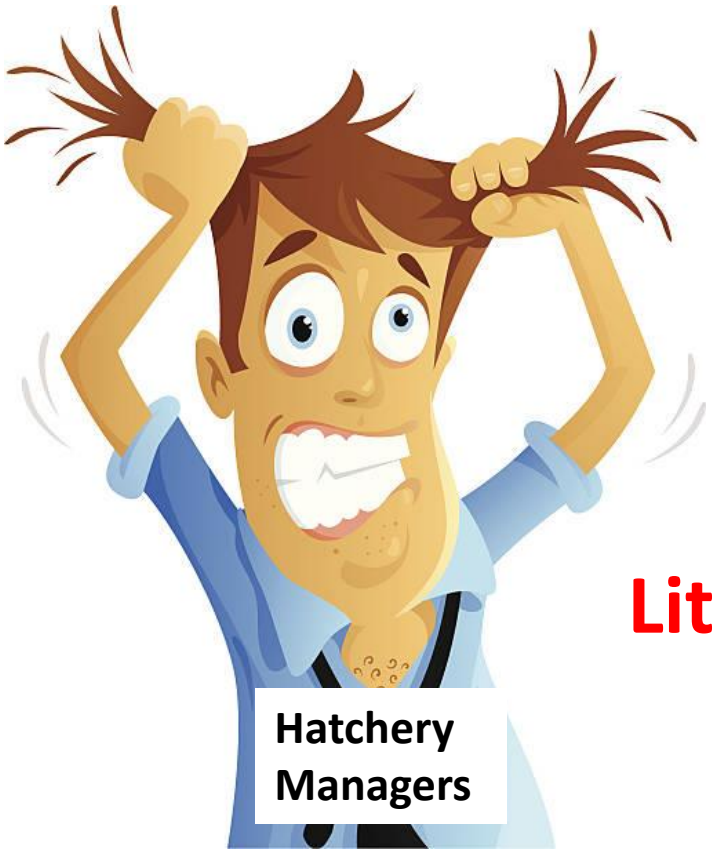
Public Reviews

Treaty Harvest Rights

Write Your HGMPs

Strays

State Policies



# Where Are We Now? HGMP Consultations

NOAA FISHERIES

- 90%+ hatchery programs have (or have had) ESA authorization
- Some programs have gone through many consultations over the last 20+ years.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# Snapshot of HGMP Implementation

# What Has the Region Accomplished?

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- Disclaimer:
- A Few Examples.
- Not All Inclusive.
- Only Some Aspects of Hatchery Management.
- You Might Have Better Examples.

# Implementing Hatchery Reform Takes:

- Agreement from the Co-Managers (and sometimes many others) on what action should be taken.
- Funding for the project.
- Actions on the ground.
- Benefits to the fish. Sometimes years out.
- A LOT of COORDINATION, $$$$, TIME.

# Region's Accomplishments: Coordination Among the Co-Managers

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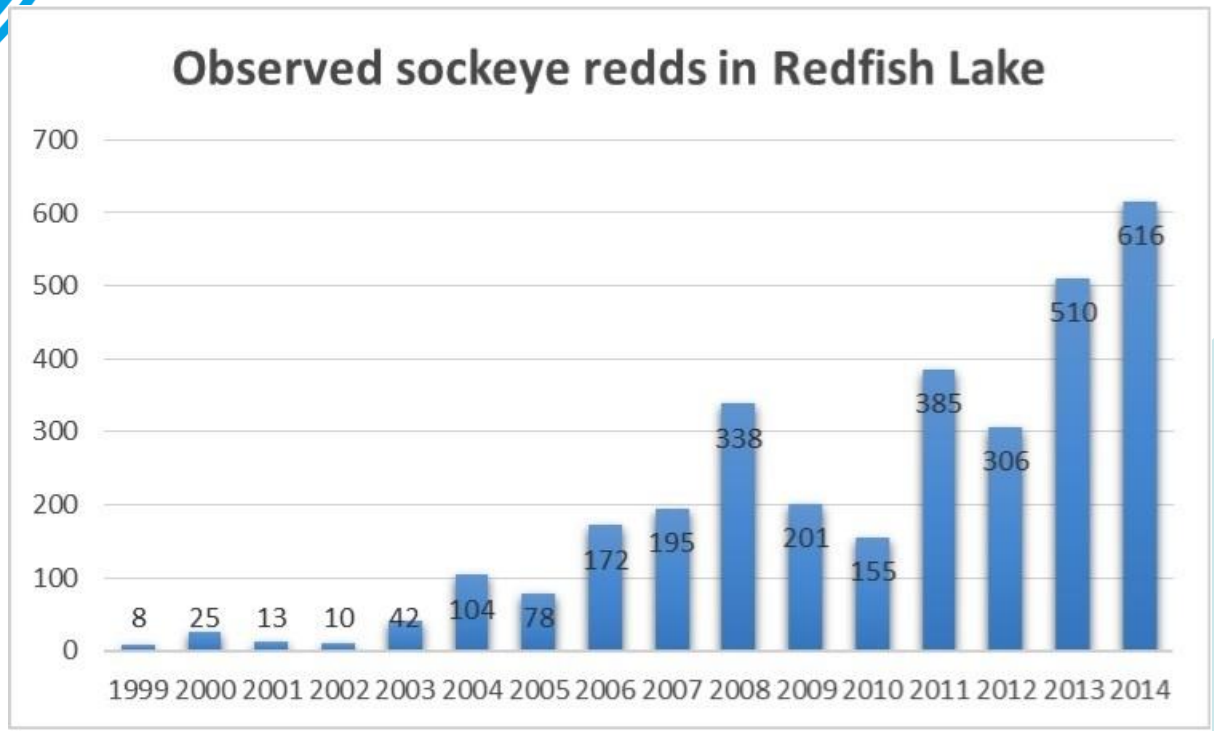
- US v Oregon Management Agreements
- Mitchell Act
- ESA consultations
- Funding Reviews
- Great coordination & collaboration

# Region's Accomplishments: Avoiding Extinction

- Snake River Sockeye Captive Broodstock Program



# Region's Accomplishments: Increasing Spawning Abundance

- Supplementation/Reintroduction using hatchery fish.
- Reduce demographic risks while other factors are being addressed.
- Genetic pedigree analyses shows benefits.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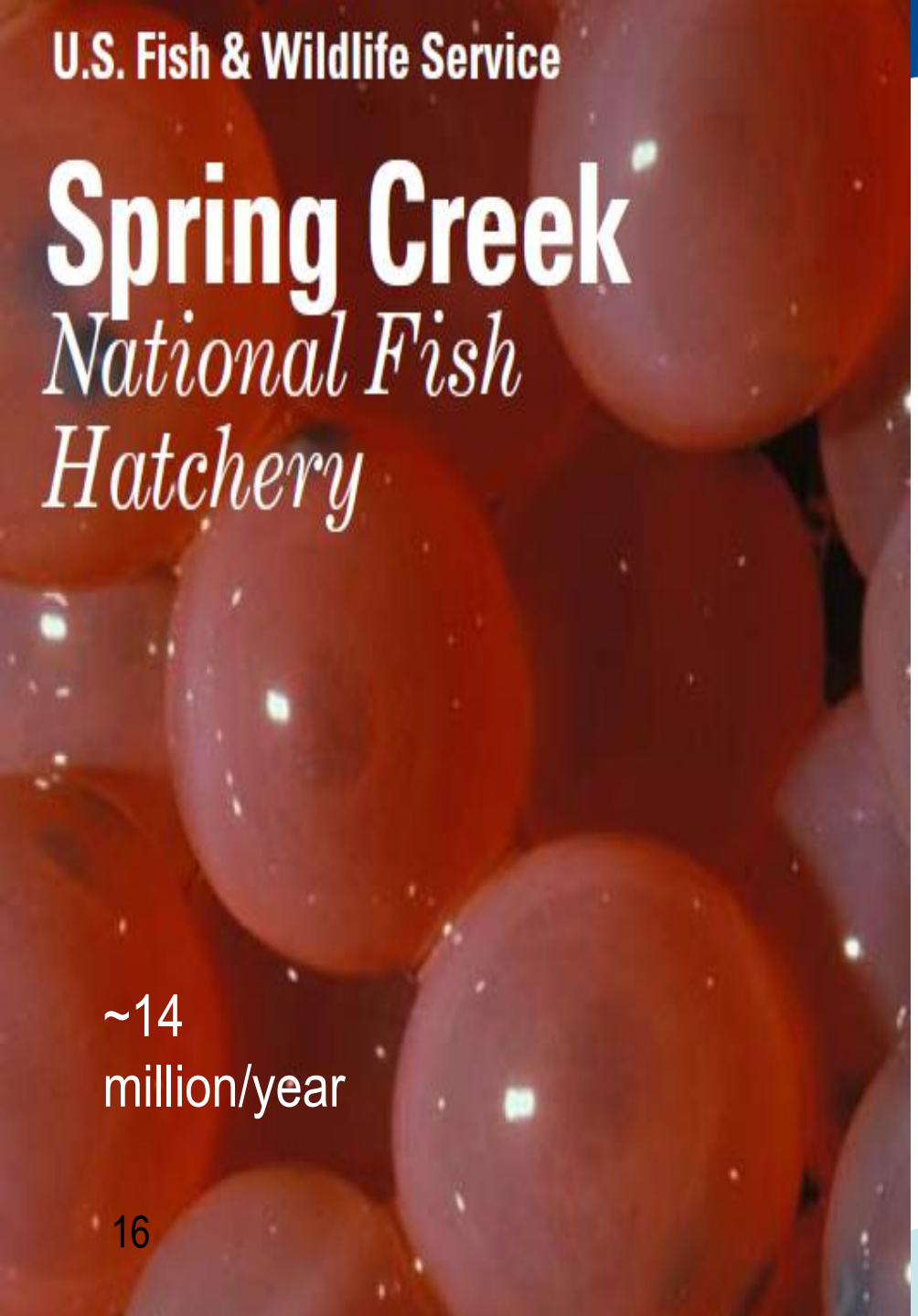
# Region's Accomplishments: Managing Hatchery Fish Spawning in the Wild

- "Natural production emphasis" or "Sanctuary" areas for natural-origin fish where hatchery influence is minimized.
- Manage proportion of hatchery fish depending upon population recovery goals.
- Not "one size fits all."



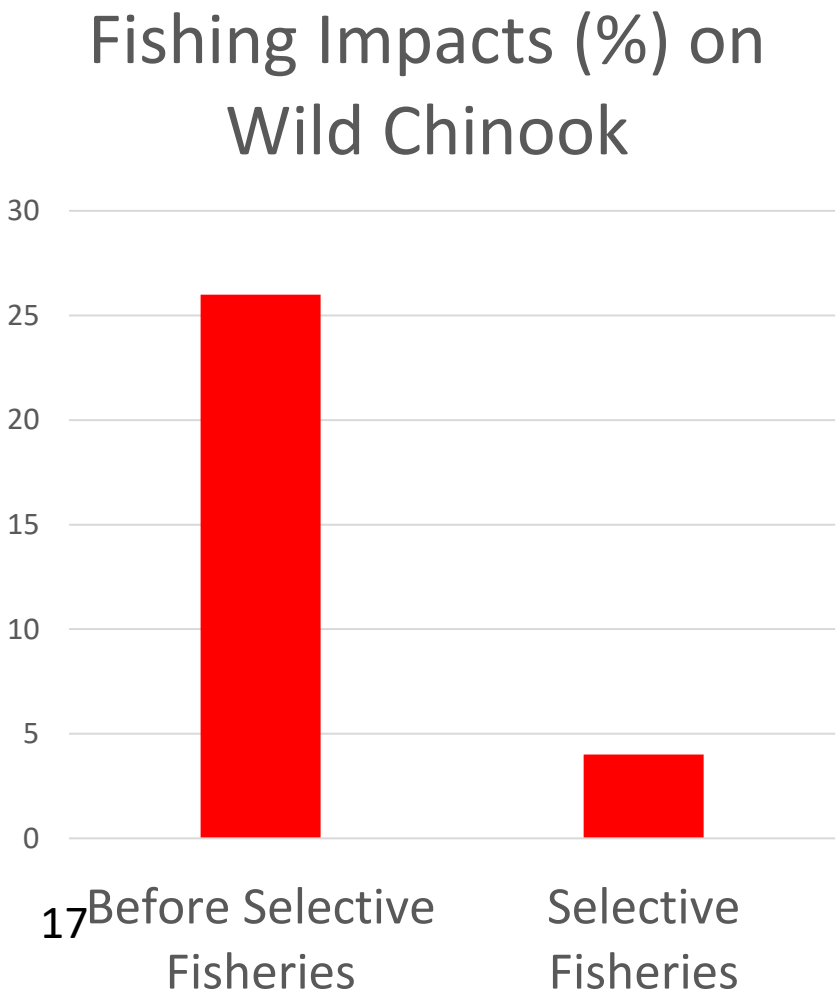

# Region's Accomplishments: Hatchery Fish Marking

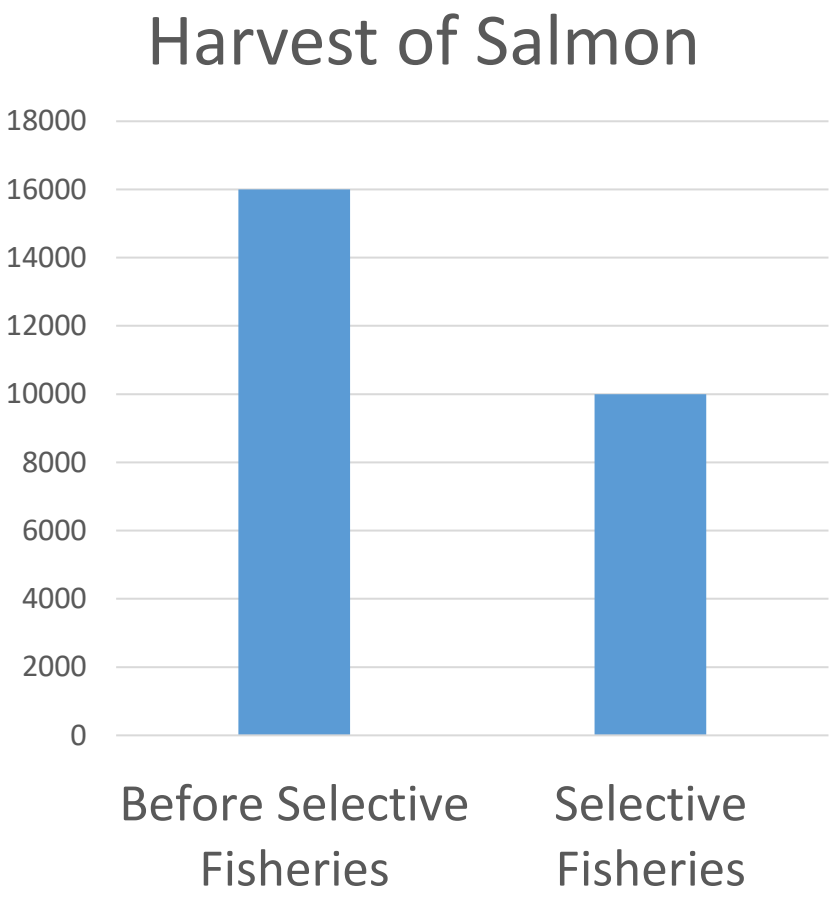
- Mass marking of Lower Columbia tule fall Chinook.
- Clarity on Wild Population status
- Fisheries management.

Region's Accomplishments:

# Fishery Mitigation

## Lower Willamette Spring Chinook Fishery

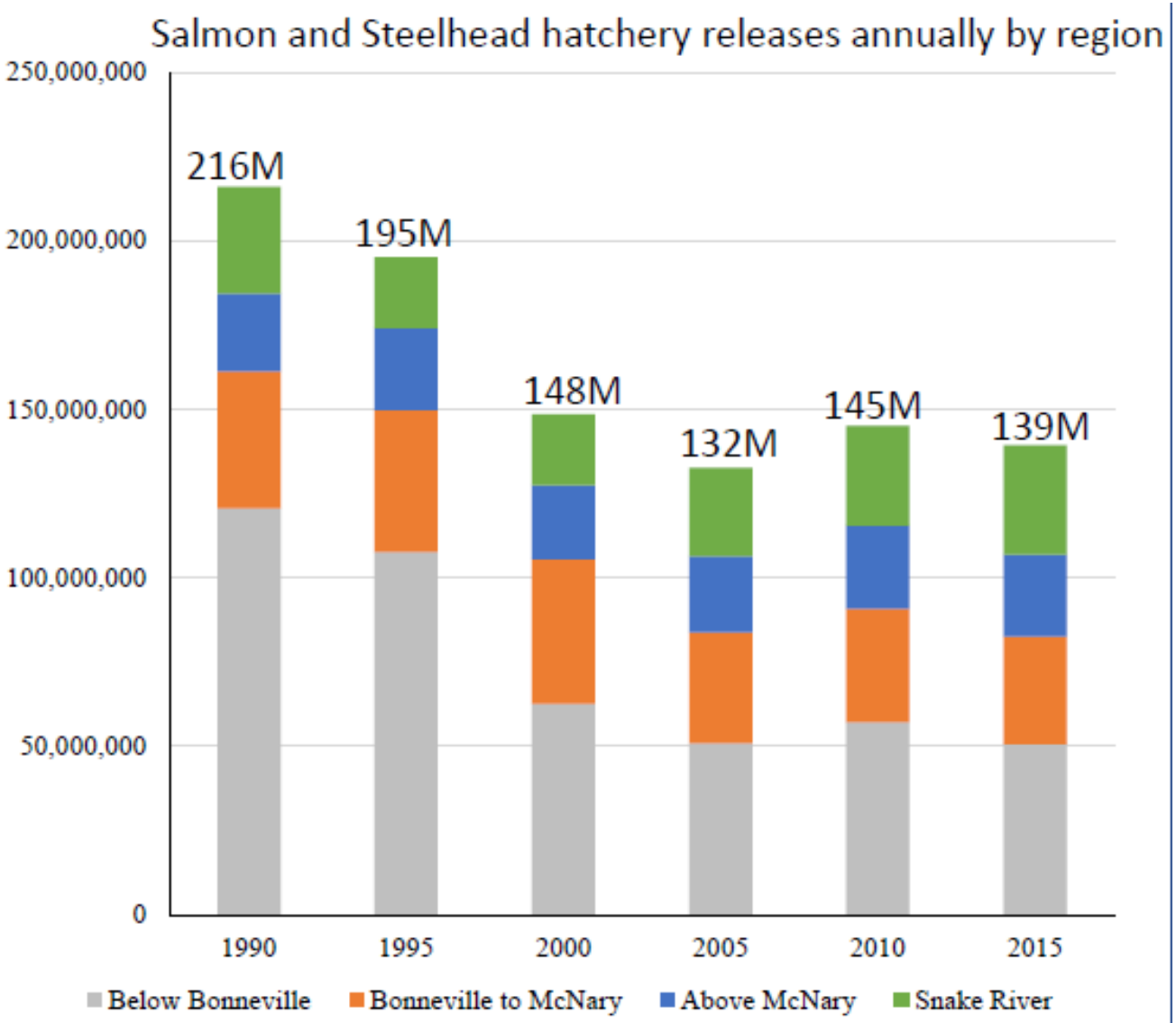


# Region's Accomplishments: Broodstock Management

- More emphasis on locally-adapted broodstocks integrated with natural populations.
- Minimizing inter-population transfers.
- Discontinue use of out of ESU/DPS hatchery stocks.

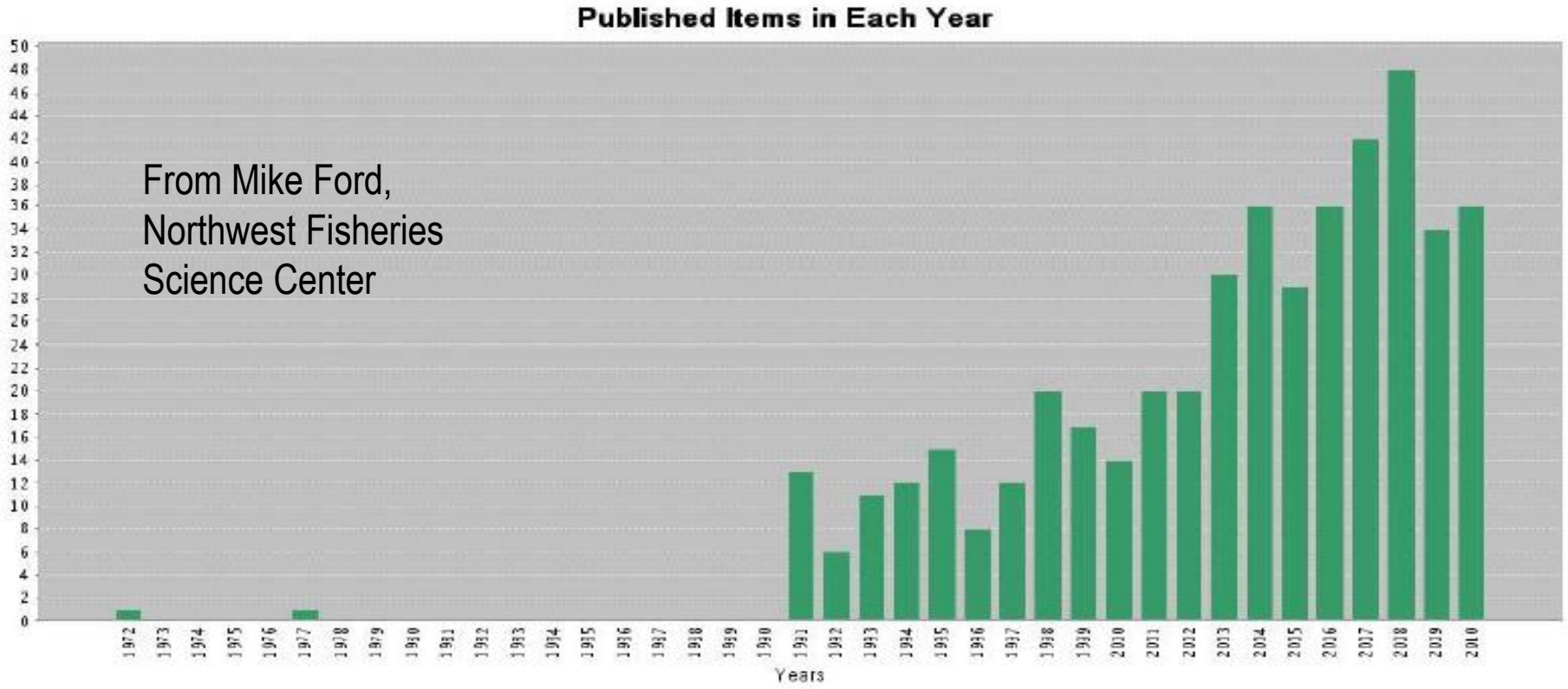
# Region's Accomplishments:
# Smolts: Quality, Not Quantity




From Becky Johnson, Nez Perce Tribe

# Region's Accomplishments:
# Facility Upgrades

# Region's Accomplishments: Research, Monitoring, Evaluation




Topic=(hatchery AND (wild OR natural) AND (salmon OR trout) AND ( fitness OR reproductive success OR survival))

# Relative Reproductive Success Studies

- Hood River steelhead (Araki et al.)
- Wenatchee spring Chinook (Ford et al.)
- Johnson Creek summer Chinook (Hess et al.)
- Willamette spring Chinook (Banks et al.)

# Have Hatchery Reforms Helped Natural Populations?

- Absolutely, YES !
- Poor survival from drought, Blob, El Nino; still major limiting factor for hatchery and natural salmon
- If no reforms, runs would be in much worse shape now.

# Where Are We Going?


- Continued Need for Hatcheries – Conservation, Fisheries
- Manage risks accordingly.
- Climate change impacts – tough times for hatcheries (water quality), and survival of fish in the wild.

# Thanks For Your Time

Credit USFWS