Northwest **Power** and **Conservation** Council

October 1, 2018

MEMORANDUM

TO: **Council Members**

FROM: **Erik Merrill, Manager, Independent Scientific Review**

SUBJECT: **ISRP 2018 Research Project Status Review**

BACKGROUND:

Presenter: Steve Schroder, ISRP Chair

Summary: At the Council's request, the ISRP reviewed the results of 25 research-focused projects and evaluated which critical uncertainties in the Council's 2017 Research Plan were being addressed by the projects. The ISRP will present its findings on the projects and on programmatic issues that apply across the projects (ISRP 2018-8). Ten projects met the ISRP's scientific review criteria. The ISRP believes these ten projects do not need further ISRP review in the upcoming Category Reviews of Fish and Wildlife Projects unless the projects change in scope or propose new methods. Eleven projects met scientific criteria with some qualifications either for clarification or improvement of research approaches. The ISRP expects that the qualifications will be addressed during the Council's upcoming Category Reviews. Four other projects are completed or nearing completion. They were evaluated solely for contributions to the Fish and Wildlife Program and 2017 Research Plan. The ISRP found that collectively these projects address an appropriate diversity of critical uncertainties and provide valuable results to the Program.

Relevance: Section 4(h)(10)(D) of the Northwest Power Act guides the Council in recommending projects to implement the Fish and Wildlife. The ISRP's

2018 Research Project Status Review will help inform Council staff's recommendations for addressing critical research uncertainties in the Program for Council consideration. These recommendations will provide context for the formal review of projects in the Basinwide, Mainstem, and Research Category scheduled to begin in late 2018.

Workplan: Project reviews are an integral part of the Fish and Wildlife Program's workplan.

Background: The 25 research projects reviewed fall into three broad categories: (a) fish and wildlife populations, (b) habitat and the effectiveness of restoration actions, and (c) fish propagation and the effectiveness of supplementation. Collectively, these projects address an appropriate diversity of critical uncertainties and are providing valuable results to the Program. The ISRP also notes that there is collaboration among researchers supported by BPA funds and that the projects are addressing many key uncertainties in the 2017 Research Plan and producing numerous peer-reviewed publications. These publications provide evidence for well-designed studies that advance scientific knowledge while also communicating the findings to others within and beyond the Columbia Basin. The Council and BPA should take pride in the forward thinking and innovative research that they are supporting in the Basin. Opportunities for further progress are summarized below.

Evaluating Fish and Wildlife Populations

Support long-term studies. Due to the large number of environmental factors at play and their inherent variability in complex ecosystems, spatially extensive, long-term studies are required for estimating the effects of factors affecting population processes. Although it is wise to periodically review the objectives of any long-term monitoring plan, decisions to interrupt, modify or terminate long-term studies must be made very carefully. The value of incremental information acquired from each additional year of research can be extremely high, particularly as the frequency of extreme weather events increases.

Support and expand monitoring of salmon survival in the ocean. NOAA Fisheries' Ocean Survival of Salmonids Project (199801400) will continue to provide critical information into the future with benefits to the Program growing with each additional year. The project should continue to evolve to address key management questions and existing data gaps (e.g., effects of forage fish abundance on salmon survival).

Evaluate predation at an ecosystem scale and consider density dependent effects. The Avian Predation Project (199702400) has enabled managers to reduce avian predation on salmonids at key points in the Basin. As management actions are implemented to reduce avian

predation and disperse local bird populations, outcomes for both salmonids and avian predators should continue to be monitored by participating agencies. Furthermore, additional research on the impacts of predation should assess the relative impacts of fish, bird, and mammal predation at all stages in salmonid life history and at an ecosystem scale. The critical question to be addressed is whether predation at successive stages is compensatory, depensatory, or additive.

Support and apply advances in molecular genetics. Genetic and pedigree assessment methods are changing rapidly, making it possible to answer questions that seemed intractable only a decade ago. On first consideration, the development of independent molecular genetics laboratories within the Basin may not seem cost effective, but the ISRP believes the partial redundancy confers important benefits like resilience in the face of technical or institutional problems, and greater opportunities for innovation and wider collaboration to advance genetic techniques and software.

Given the recent success of genetic laboratories working cooperatively with others in the Basin, California, British Columbia, and Alaska, it may be time again to examine the potential of using parent-based tagging (PBT) and genetic stock identification (GSI) to identify the origin of salmonids caught in ocean fisheries. The ISRP is uncertain if existing genetic baselines, processing technology and capacity, and sampling infrastructure are adequate yet, or could be expanded sufficiently, to replace or supplement the present role of thermal marks and coded-wire tags in fisheries management. Ideally, an economic analysis should be conducted, informed by independent scientists with expertise in fisheries monitoring.

Evaluating Habitat

Consider climate change in project design and prioritization. Climate change is expected to alter habitat conditions in the Basin from those experienced today. Additionally, substantial changes in land use are projected to occur in the future. Synergistic interactions between these two factors will create new environmental conditions. Project proponents should examine how climate change, coupled with changes in land use, may impact the long-term benefits of their project and provide information on how to ameliorate impacts. Climate and land use changes may determine where restoration is most beneficial and should be considered in prioritization of investments.

Review assessment of reintroduction of anadromous salmon to blocked areas. The Habitat Assessment in Blocked Areas Project (201600300) provides useful estimates of available habitat and quality, but a more detailed discussion of the limits of the assessment methods is

needed. The ISRP recommends that the comprehensive set of Phase 1 documents and results, as well as successive phases, be reviewed by the ISRP and/or ISAB to ensure that the assessment of potential for reintroduction is scientifically sound.

Incorporate lessons learned in plans for habitat status and restoration effectiveness monitoring. Habitat monitoring must be adequate to cover a wide range of spatial and temporal scales. The Columbia Habitat and Monitoring Program (CHaMP, 201100600) used a spatially balanced design to sample a representative snapshot of habitat diversity. A fraction of sites was visited annually to understand changes in habitat from year to year, while remaining sites were visited every three years to assess longer-term trends. The BPA Project Action Effectiveness Monitoring (AEM) Programmatic effort (201600100) is investigating how fine-grained measurements of habitat at site scales can be combined to assess impacts at a larger spatial scale. The investment in the Integrated Status and Effectiveness Monitoring Program (ISEMP, 200301700) and CHaMP has produced a substantial body of habitat data, methodological advances, analytical tools, and invigorated life-cycle models, which provide a foundation on which to build future monitoring programs. This legacy should be carefully considered when developing the new tributary habitat RME strategy co-led by BPA, Council, and NOAA. The ISRP recommends that design of future monitoring should incorporate many of the 54 monitoring protocols and 800 CHaMP monitoring sites to take advantage of the seven-year database for future trend analysis. One of the innovative organizational aspects of the Integrated Final Report for ISEMP/CHaMP is the concise and informative summaries of the individual sub-projects. The Council and BPA should consider using similar formats for other reports and products.

Review compatibility of methods and support long-term data storage and access. Monitoring at many different spatial and temporal scales (sites, reaches, subbasins, ESUs, or Basin) requires a high degree of coordination in the design of each project so that local monitoring can be integrated with watershed and Basin-wide monitoring. A habitat-monitoring working group (e.g., similar to the Pacific Northwest Aquatic Monitoring Partnership, PNAMP) could be charged with reviewing all habitat monitoring projects to ensure they are compatible, as well as to ensure that data are collected with standardized methods. Additionally, the ISRP recommends that the Program support data repositories to facilitate access to and long-term storage of data from BPA-funded projects.

Fish Propagation

Improve practices for hatchery supplementation. Eight projects are designed to improve or evaluate hatcheries as a conservation tool for supplementing wild populations. Standard hatchery rearing protocols have

been shown to amplify the precocious maturation of Chinook and steelhead as residuals or minijacks that do not migrate to the ocean. Releasing large numbers of fish that become residuals or minijacks has consequences for both fisheries' management and population recovery. First, minijacks represent a potential loss of harvestable adults. Second, misreporting them as smolts in hatchery-release statistics leads to erroneous conclusions about smolt survival and the contribution of hatchery smolts to overall production. Because minijacks typically go unnoticed by hatchery managers, more monitoring is needed to confirm (and convince hatchery personnel) that large numbers are being released. The ISRP encourages the Program to support a comprehensive survey of minijack production in hatcheries that are releasing yearling Chinook juveniles in the Basin, as proposed and initiated in the Growth Modulation in Chinook Salmon Supplementation project (200203100).

Continue studies of relative reproductive success (RRS). The ISRP compared progress achieved by six research projects investigating the fitness of hatchery-origin fish spawning naturally. Collective results from these projects confirm that hatchery-origin fish, on average, have less reproductive success than natural origin fish when they spawn naturally in the wild (i.e., RRS < 1). Experimental research is now underway to distinguish ecological and genetic effects on RRS, and it warrants continued support. Concerns about "carry-over" genetic effects of supplementation on the future productivity and adaptability of wild populations are greatly diminished if reduced RRS is purely an environmental effect. Studies to date indicate that genetic effects are less pronounced in Chinook salmon than steelhead. Many of the projects reviewed are expected to report their most valuable results over the next few years. At that time, an updated synthesis of findings will be especially valuable. The ISRP is reassured that the RRS studies are on track and that proponents are collaborating and sharing information effectively.

Sharing Information

Support publications and conferences. The ISRP strongly encourages the publication of peer-reviewed scientific papers to reliably disseminate research results to those with specific technical skills. On the other hand, newspaper articles, Basin-wide newsletters, TV and podcasts are needed to inform and gain the trust of the broader public. Well-structured conferences are also an efficient way to quickly disseminate key research findings among researchers and stakeholders throughout the Basin. Conferences are effective for directing participants to new sources of information, classifying and prioritizing that information, and initiating communication and establishing new collaborations. Additionally, posting results on web-pages or communicating with local media, such as the Columbia Basin Bulletin, can potentially reach a very broad audience.

Foster communication between researchers and decision makers. Researchers should be encouraged to provide information applicable to management issues throughout the life of a monitoring program, not just at the end. Such communication requires that project proponents understand and agree on the kind of information and the format for reporting that decision makers and managers are willing to accept. More discussion of formats and schedules for delivery of interim information at the outset of future monitoring programs will be useful. The new RME strategy co-led by BPA, Council, and NOAA should include a detailed adaptive management framework with explicit guidance and requirements to ensure that research meets the needs of restoration practitioners and decision makers.

More Info: The full report is available online (ISRP 2018-8) and through BOX (Word version).

INDEPENDENT SCIENTIFIC REVIEW PANEL

2018 Research Project Status Review

for the Columbia River Basin Fish and Wildlife Program and 2017 Research Plan

ISRP 2018-8 SEPTEMBER 28, 2018

ISRP

Presentation to the Northwest Power and Conservation Council, October 9, 2018

ISRP and Peer Review Group (PRG)

- ***Independent Scientific Review Panel***
  - Stan Gregory, Ph.D.
  - Dave Heller, M.S.
  - Wayne Hubert, Ph.D.
  - Scott Lutz, Ph.D.
  - Alec Maule, Ph.D.
  - Robert Naiman, Ph.D.
  - Greg Ruggerone, Ph.D.
  - Steve Schroder, Ph.D.
  - Carl Schwarz, Ph.D.
  - Desiree Tullos, Ph.D.
  - Chris Wood, Ph.D.
- ***Peer Review Group***
  - Kurt Fausch, Ph.D.
  - Katherine Myers, Ph.D.
- ***Coordinator***
  - Erik Merrill, J.D.

Research Project Status Review

- 25 projects were reviewed in 2018

- Last review of RME projects occurred in 2010

Photo from Methow Steelhead project

Research Project Status Review

Review Showed

- Collaboration among projects
- Critical uncertainties are being addressed
- Results are published in the scientific literature

NW Fishletter #378: photo by Milstein BPA

Research Project Status Review

- 10 projects met scientific review
- 4 projects were completed
- 11 met criteria with some qualifications

Photo from USGS

Research Project Status Review

Qualifications

- Clarification
  - Adaptive management
  - Objectives & Hypotheses
  - Public outreach

- Research
  - Methods/approaches
  - Suggestions for new areas of research
  - Ecosystem context

Photo credit: Scott Learn, The Oregonian

Research Project Status Review

Projects fell into three categories

- Fish and Wildlife Populations
  - **Survival, growth, migration**
  - **Genetic diversity**

Photo credit: Ted Sickinger, The Oregonian

Research Project Status Review

Projects fell into three categories

- Habitat & Effectiveness of Restoration
  - **Limiting Factors**
  - **Effectiveness at different spatial scales**

Bridge Creek photo by Utah State University

Research Project Status Review

Projects fell into three categories

- Fish Propagation
  - **Improvement of fish culture methods**
  - **Supplementation effects**

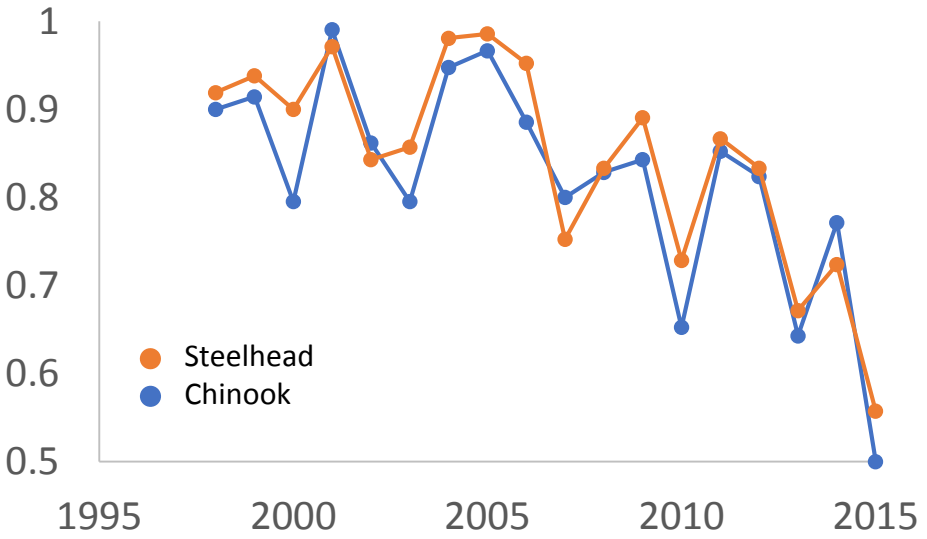
Photos from Peter Galbreath

Fish & Wildlife Populations

Migration, Survival & Growth

Lower Granite Dam

Photo from Wikipedia



Probability of at least one PIT tag detection in the hydrosystem

Data from New Marking and Monitoring Techniques project

Fish & Wildlife Populations

Migration, Survival & Growth

Photo: Sergey Gorshkov/Minden Pictures

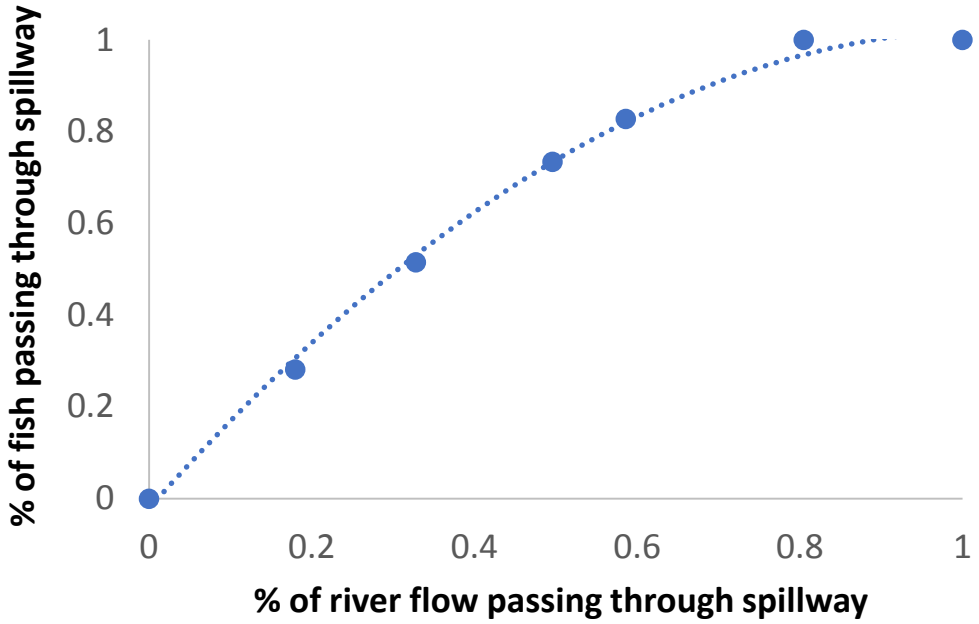


Figure from Zabel et al. 2008 Hydrobiologia 609:289-300

Fish & Wildlife Populations

Migration, Survival & Growth

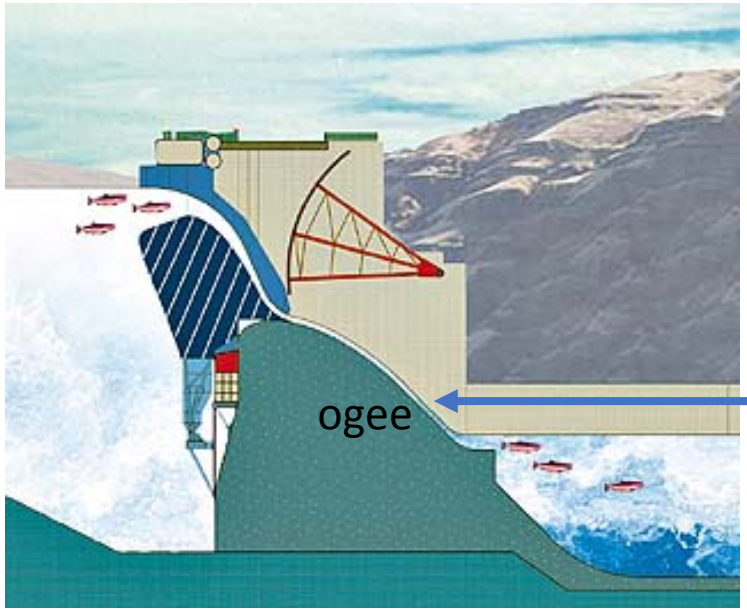
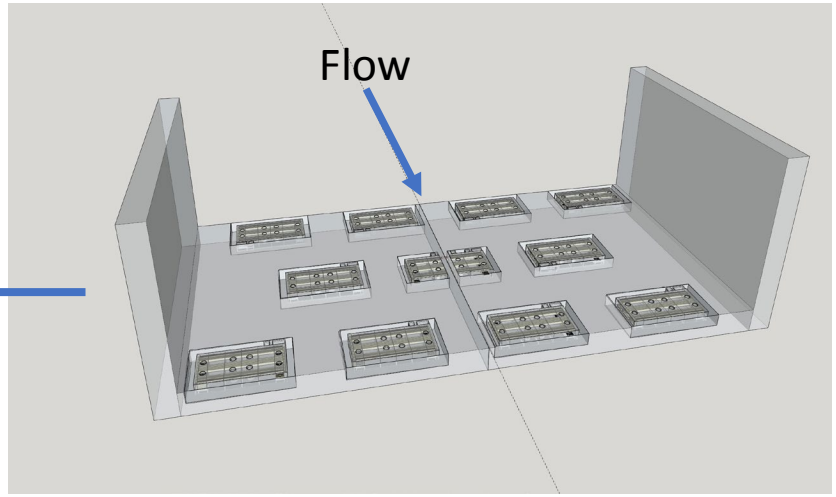


Illustration by Jacobs Civii



Spillway PIT Tag detector array

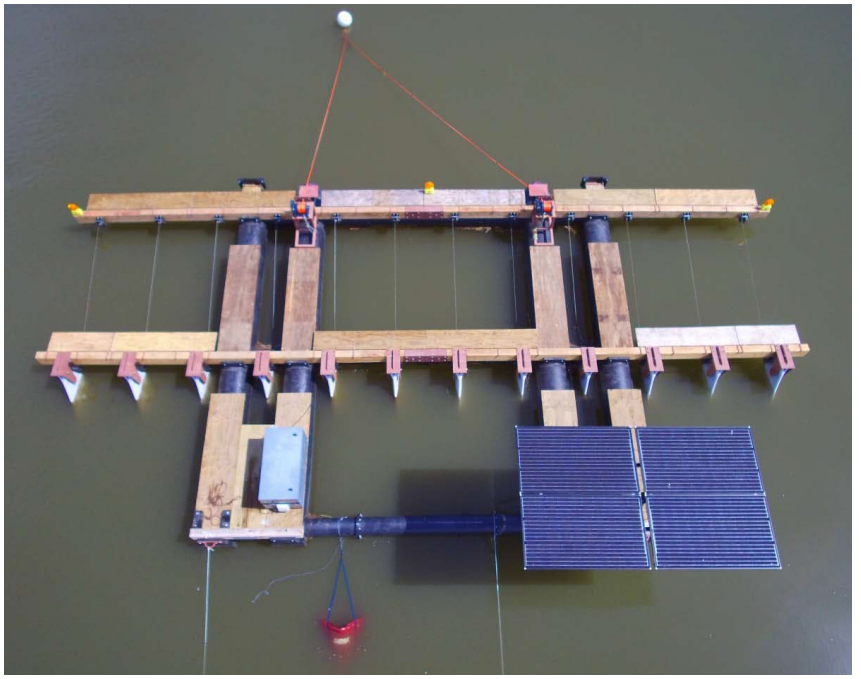
	Conditions:
Depth	~ 2.5 to 5 feet
Flow	~60 to 75 fps
Detection	28” for SST-1 Tag
	14” for SST-1 HT Tag

Fish & Wildlife Populations

Migration, Survival & Growth

Detecting PIT tagged fish in broad and deep river Environments

Testing vertical detection arrays



Upper photo: Travis Olson CTUIR
Lower photo: New Marking and Monitoring Techniques project

Fish & Wildlife Populations

Migration, Survival & Growth

Why Study the Ocean

- Ocean was a “black box”
- Effects of ocean conditions on salmon growth and survival provide context for freshwater recovery actions
- NOAA ocean surveys in ocean plume, & coastal Oregon and Washington waters began in 1998

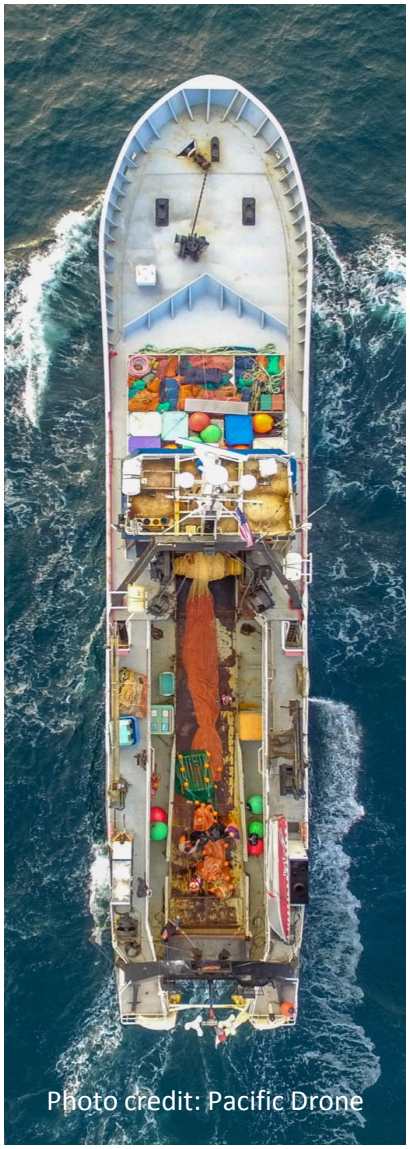


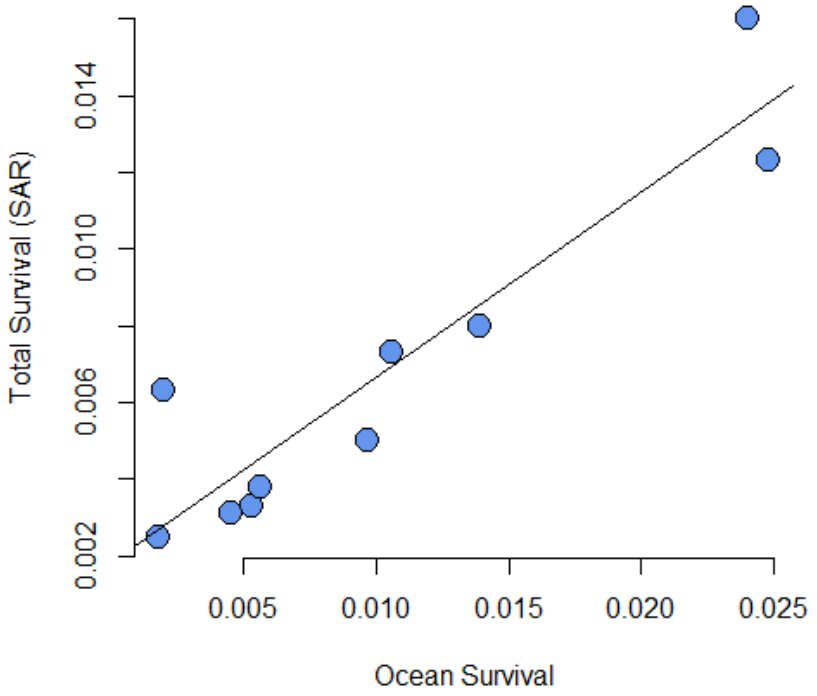
Photo credit: Pacific Drone

Fish & Wildlife Populations

Migration, Survival & Growth

Photo credit: Eiko Jones

Strong relationship between SARs & ocean conditions

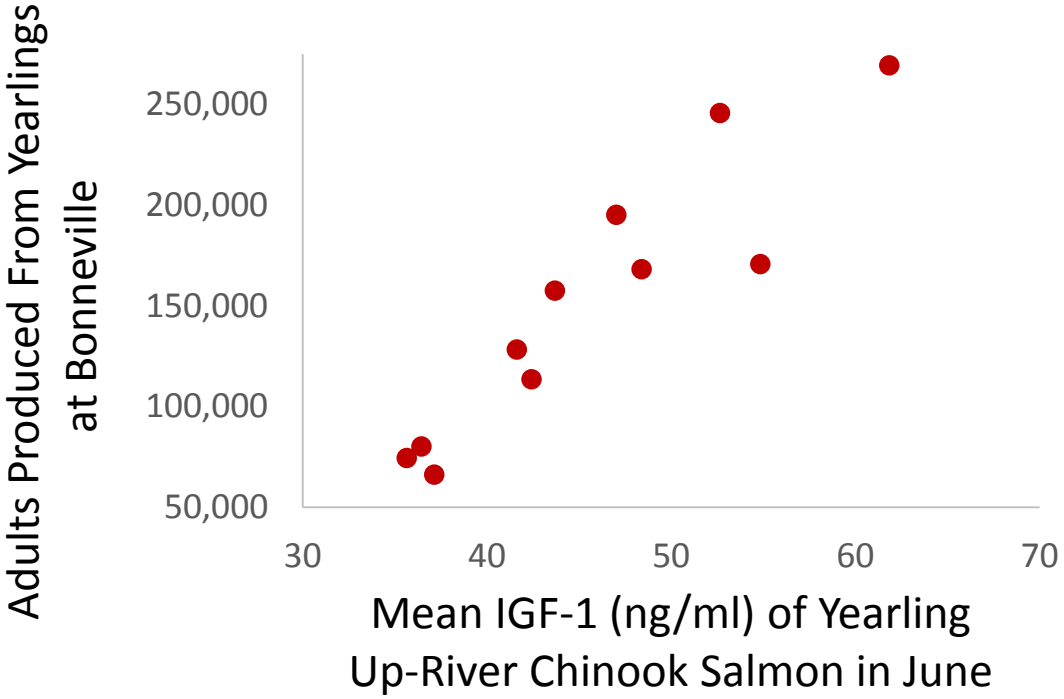


Graph from K. Fresh and S. Hayes, NOAA-Fisheries

Fish & Wildlife Populations

Migration, Survival & Growth

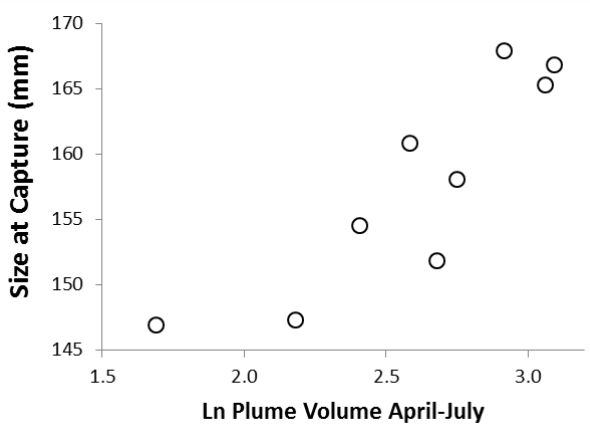
Bonneville Dam: Photo USACE

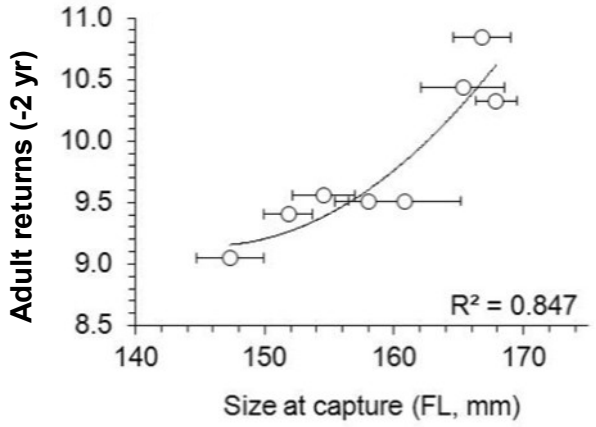


From Fresh & Hayes, NOAA-Fisheries

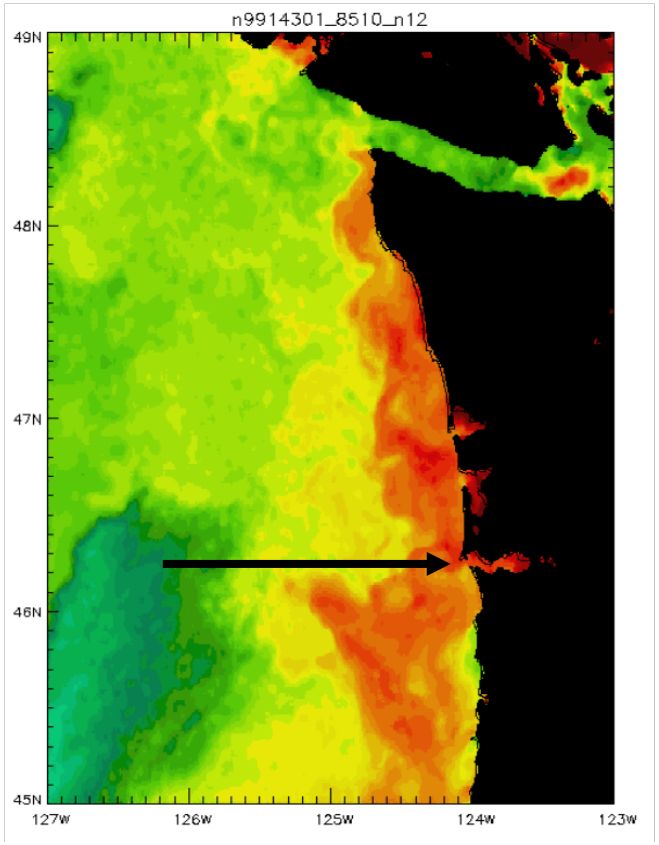
Fish & Wildlife Populations

Migration, Survival & Growth





Mid Columbia River Chinook



Factors affecting plume volume

- Bonneville Discharge, 44%
- Surface winds 30%

From Fresh & Hayes, NOAA-Fisheries

Fish & Wildlife Populations

Migration, Survival & Growth

Indicators	Year																			
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PDO & ONI	17	6	3	12	7	19	11	15	13	9	5	1	14	4	2	8	10	20	18	16
	10	4	6	5	11	16	15	17	12	13	2	9	7	3	1	8	18	20	19	14
	19	1	1	6	13	15	14	16	8	11	3	10	17	4	5	7	9	18	20	12
Surface Temp Deep Temp Salinity	16	9	3	4	1	8	20	15	5	17	2	10	7	11	12	13	14	19	18	6
	19	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2	20	18	17
	16	12	14	4	1	3	20	18	7	8	2	5	13	10	6	17	19	9	15	11
	20	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	19	18	13	17
	19	3	9	4	5	16	17	10	7	1	2	14	18	13	12	11	20	15	8	6
Biological Metrics Copepods Ichthyoplankton Transition date Catches of juvenile Chinook Coho	18	2	1	7	6	13	12	17	15	10	8	9	16	4	5	3	11	19	20	14
	18	13	9	10	3	15	12	19	14	11	6	8	7	1	2	4	5	16	20	17
	20	2	5	4	3	13	14	19	12	10	1	7	15	9	8	6	11	17	18	16
	17	8	5	7	9	14	13	18	12	2	1	3	15	6	10	4	11	20	20	16
	20	11	3	7	9	18	17	13	16	15	2	12	4	14	10	8	19	5	6	1
	9	13	1	6	4	10	18	16	3	12	2	14	15	11	5	7	8	17	20	19
	18	4	5	15	8	12	16	19	11	9	1	6	7	14	3	2	10	13	17	20
	18	7	12	5	6	2	15	19	16	4	3	9	10	14	17	1	11	8	13	20
Mean of ranks	17.1	7.0	5.8	6.9	5.8	12.4	15.1	16.2	10.9	8.9	2.7	8.3	12.2	8.2	6.5	7.6	12.3	15.9	16.4	13.9
	20	6	2	5	2	14	16	18	11	10	1	9	12	8	4	7	13	17	19	15

Credit: https://www.nwfsc.noaagov/oceanconditions

Fish & Wildlife Populations

Genetic Applications: Abundance & Diversity

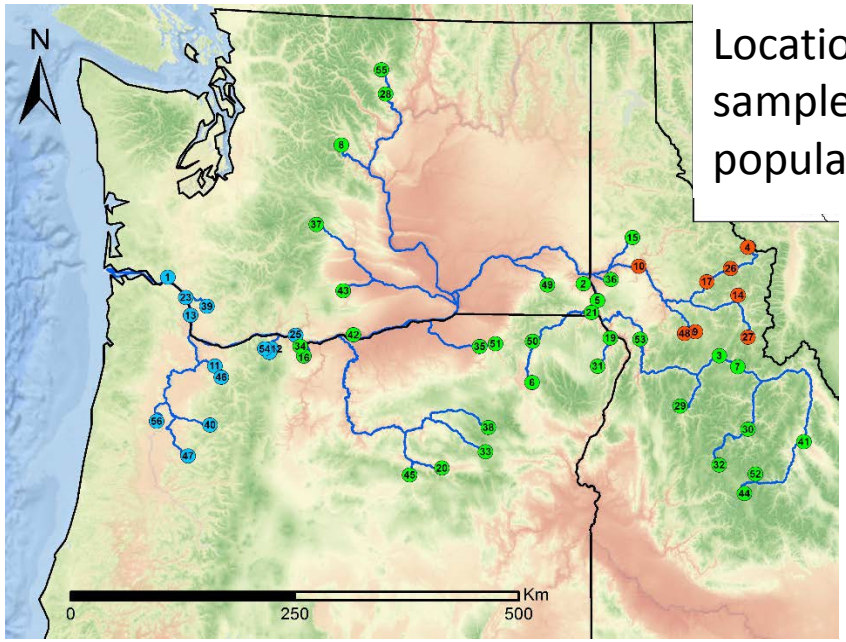
Genetic Tools & Methods
(CRITFC's Hagerman Laboratory)

- Expand & create genetic baselines for anadromous fishes
- Discovering new genetic markers (SNPs) via gene association studies
- Using Parentage-Based Tagging (hatchery) & Genetic Stock Identification (wild) to:
  - Track abundance and migration timing of Chinook, steelhead, sockeye, & coho stocks at Bonneville Dam.
  - Monitor mainstem harvest
  - Characterize white sturgeon & Pacific Lamprey populations

Fish & Wildlife Populations

Chinook & Steelhead Genetic Diversity Across the Basin

CRITFC Hagerman Laboratory



Location of sampled populations

Micheletti et al. 2018 *Mol. Ecol*

Environmental Drivers of Local Adaptation

- Chinook
  - Migration Distance
  - Precipitation
  - Temperature
- Steelhead
  - Precipitation
  - Temperature
  - **Migration corridor**

Habitat & Effectiveness of Restoration Actions

Three Key Questions

Deer Creek Floodplain Enhancement
Photo credit: USFS

- What factors limit habitat capacity & salmonid productivity by life stage?
- What is the effectiveness of individual projects at the site/reach scale?
- What is the combined effectiveness of restoration actions across watersheds /subbasins?

Habitat & Effectiveness of Restoration Actions

Limiting Factors: An Example in the Upper Grande Ronde & Catherine Cr.

Photo Seth White, CRITFC

Identified limiting factors via:

- Annual CHaMP surveys
- Heat source model
- Structural Equation Modeling

Limiting Factors Found:

- Large pools—too few
- Mean August water temperatures—too high
- Stream power (erosive potential)—too high

Habitat & Effectiveness of Restoration Actions

CRITFC Grande Ronde Spring Chinook Habitat

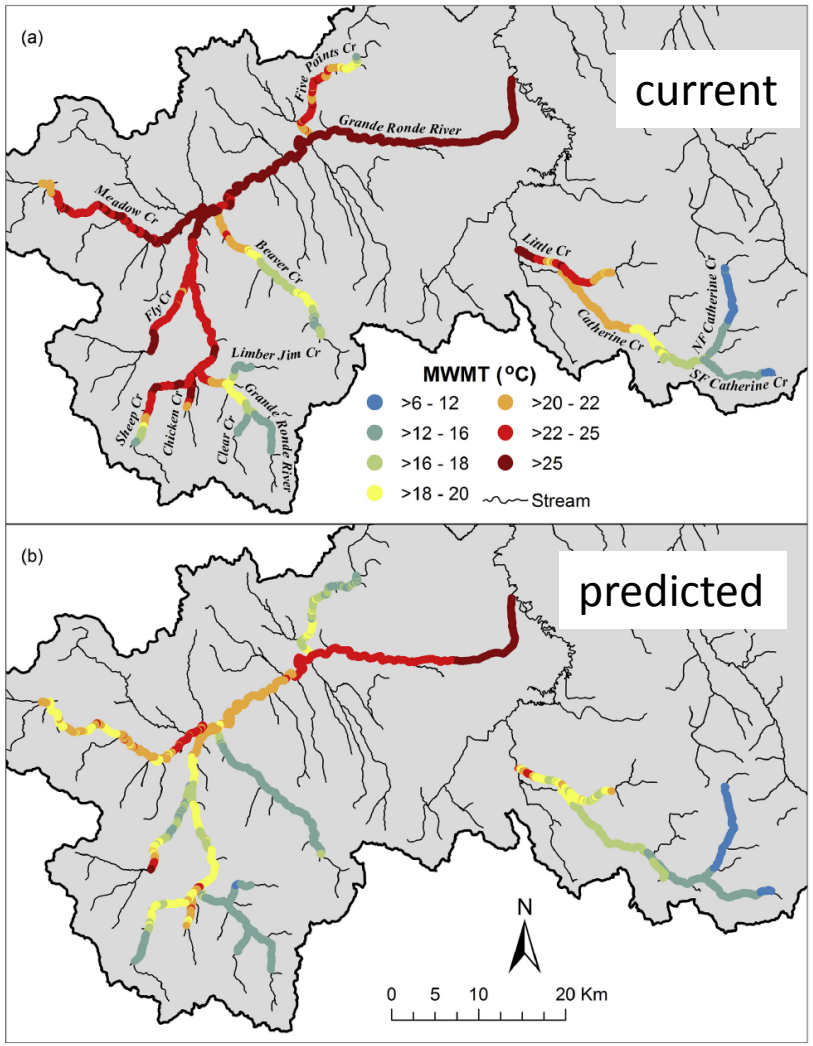
Predicted Effects of Channel Restoration & Riparian Planting

Upper Grande River

- 6.5^{O} C decrease of peak summer temperature
- 590% increase in Chinook parr

Catherine Creek

- 3.0^{O} C decrease of peak summer temperature
- 67% increase in Chinook parr



MWMT = maximum weekly mean temperature

Habitat & Effectiveness of Restoration Actions

CHaMP/ISEMP:

Identification of Limiting Factors, Predicting & Measuring Restoration Effects

Legacy of the CHaMP/ISEMP projects

- Products
  - 54 Monitoring protocols
  - 800 CHaMP sites
  - 3 Intensively Monitored Watersheds
  - 23 tools for restoration assessment
  - 6 life cycle models
  - 10 studies of fish and habitat trends
- Key Assessment Tools
  - Integrated Rehabilitation Assessment (IRA)
    - Uses Quantile Random Forrest (QRF) to estimate carrying capacity by life stage

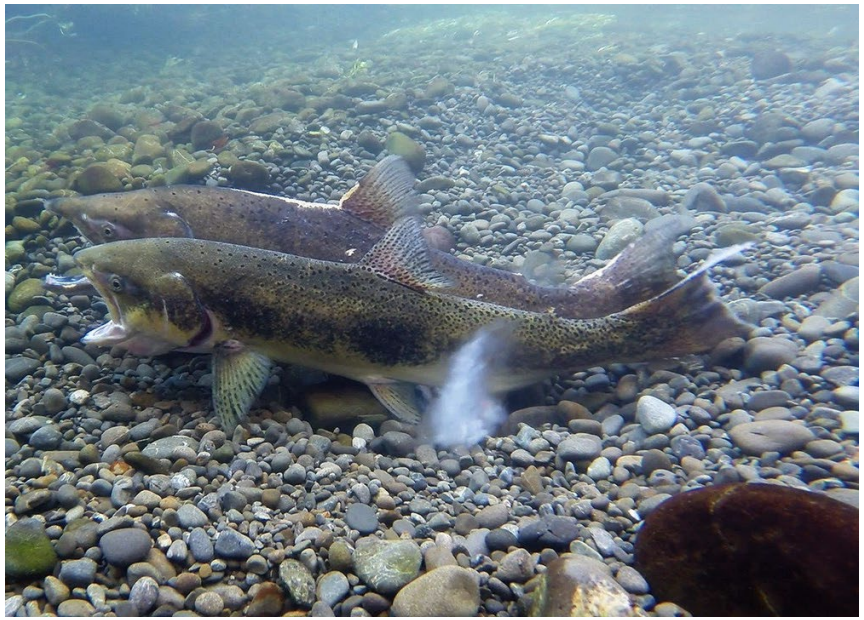
    QRF can:
    - Estimate gains in carrying capacity by a proposed action
    - Assess cumulative effects of projects on carrying capacity at a watershed scale
    - Prioritize prospective projects based on gains in carrying capacity

Fish Propagation

Effectiveness of Hatcheries as Conservation Tools

Relative Reproductive Studies

- 10 Investigations
  - 4 Steelhead
  - 6 Spring Chinook
- General Conclusions
  - Both environmental & genetic factors reduce hatchery-origin reproductive success in nature
  - Hatchery-origin Steelhead generally have lower RRS values than hatchery spring Chinook
  - Estimates of RRS from juveniles & adult progeny are comparable
  - Projects are investigating methods to reduce domestication selection

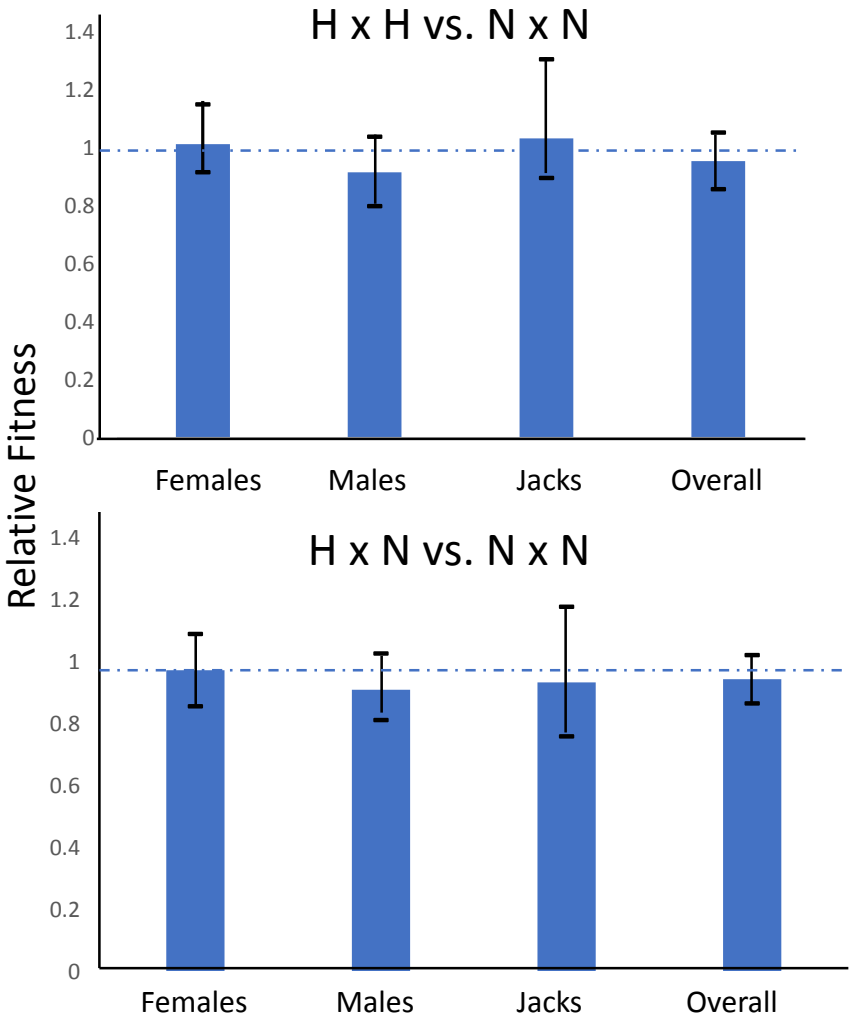


Two Hatchery-Origin Chinook spawning in nature

Photo: Kevin Belcher

Fish Propagation

Effectiveness of Hatcheries as Conservation Tools



RRS Yakima River spring Chinook for 1 BY
100% natural-origin broodstock

Data from Peter Galbreath, CRITFC

Reducing Domestication

Methods Being Tried & Evaluated

- 100% Natural-Origin Broodstock (Steelhead & Chinook)
- Altered rearing environments to reduce genetic selection for surface orientation & aggression (Steelhead)
  - Rearing density
  - Food & feeding methods
  - Flow regime
  - Habitat complexity
- Use of natural growth profiles (Steelhead & Chinook)
  - Rearing and release of age-1 & Age-2 steelhead smolts
  - Reduces precocious maturation in Chinook

Fish Propagation

Improvements to Fish Culture Methods

PROBLEM

Annual Release of Millions of Hatchery Spring Chinook Minijacks

- 7 – 71% of hatchery males mature precociously as Minijacks
- Minijack rates are influenced by:
  - Stock origin
    - Integrated hatcheries >> rates than segregated programs
  - Growth cycles & diet
    - Rapid growth in the Fall promotes early maturation
    - Diets with high lipid or energy content promote early maturation

Minijack Age-2 spring Chinook

Microjack Age-1 spring Chinook

Fish Propagation

Improvements to Fish Culture Methods

PROBLEM CONTINUED:

- Difficult to detect
- Biases SAR, R/S & SAS values
- Reduces anadromous adults
- Compete for resources

Detection

- Best Method: 11-ketotestosterone assay

Solutions

- Use low lipid diets
- Reduce growth in Fall
- Other options are hatchery-specific

Future Work

- Perform surveys of Basin Hatcheries
- Implement & evaluate fish cultural changes

Extra Slides

Fish & Wildlife Populations

Gene Association Studies

CRITFC Hagerman Laboratory

Photo: CRITFC Grande Ronde project

Identification of genomic regions associated with:

- Arrival timing (Chinook & Steelhead)
- Age at maturity (Chinook)
- Resident v. Anadromous (*O. mykiss*)
- Run timing related to maturity (Steelhead)
- Disease resistance (*O. mykiss*)
- Thermal adaptation (*O. mykiss* & Chinook)
- Spawn timing and ocean age (Steelhead)

Habitat & Effectiveness of Restoration Actions

AEM

Measuring Effectiveness at Site/Reach Scales

Photo: Snake River Salmon Recovery Board

Photo: USFWS

Effectiveness of LWD & Barrier Removal

- Completed Extensive Post Treatment Analysis (EPT)
- Multiple-Before-After-Control-Impact (MBACI) analyses are in progress
- Ultimate goal—extrapolate reach/site scale results to watershed or basin scales
- Individual project results can guide on-going restoration