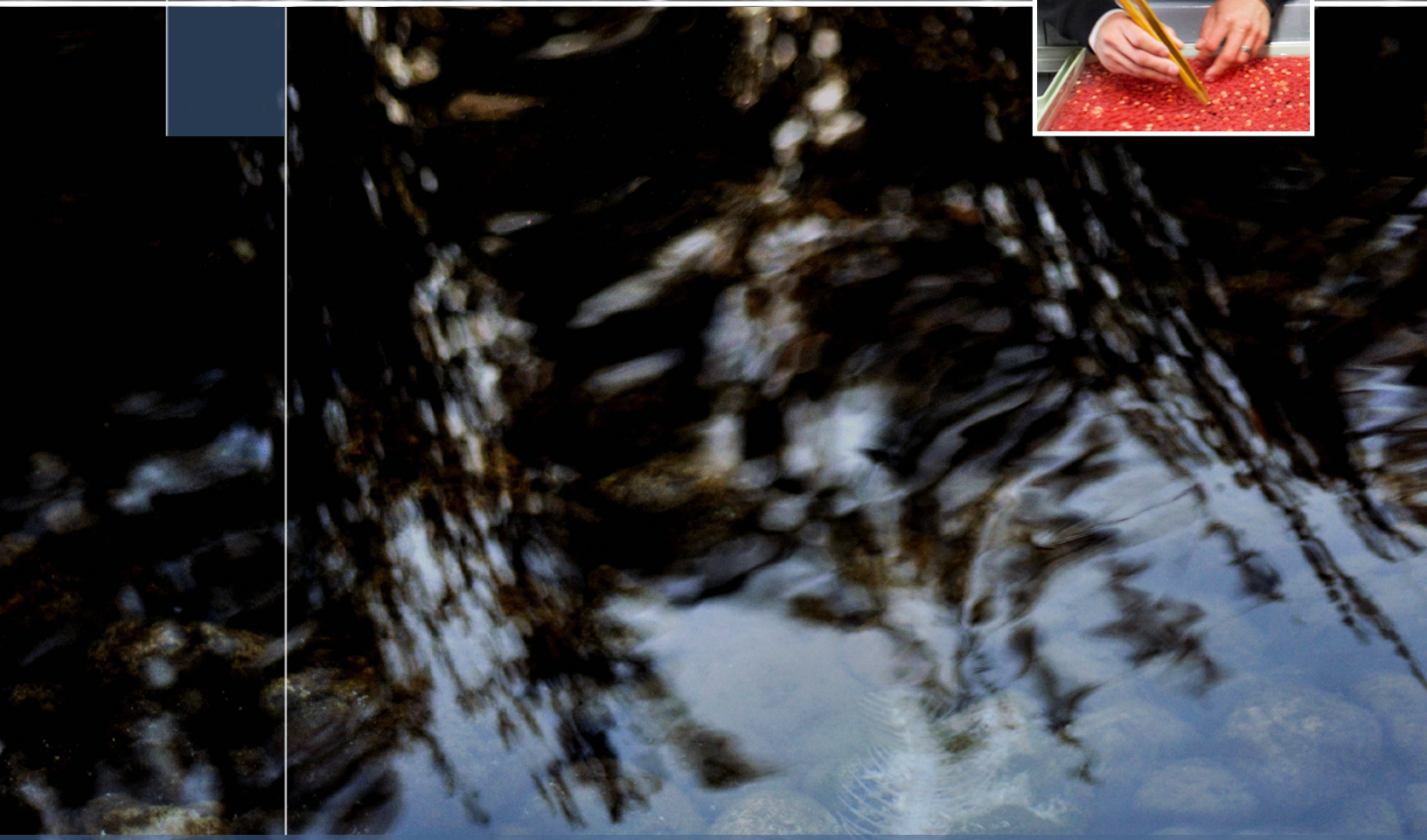
2013

Upper Columbia Science Conference



Salmon Recovery Science in Practice

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The mission of the Upper Columbia Salmon Recovery Board is to restore viable and sustainable populations of salmon, steelhead, and other at-risk species through the collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia region.

11 Spokane Street, Ste. 101, Wenatchee, WA 98801 phone: (509) 662-4707 www.ucsrb.com

October 30, 2013

Upper Columbia Science Conference Participants,

Welcome to the second Upper Columbia Science Conference. The Upper Columbia Salmon Recovery Board (UCSRB) and partners use an Adaptive Management Framework to implement the *Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan*. This conference is an important part of the adaptive approach, allowing scientists, managers and project sponsors to review and discuss knowledge gained from monitoring implemented actions.

As we gain more knowledge about the results of habitat actions, and whether monitoring is capturing the correct data at the appropriate scale and location, we can identify changes to strategies aimed at achieving the *Recovery Plan's* goals. Continuing evaluation and adaptation of *Recovery Plan* implementation can assist funding entities and decision-makers in managing listed species in the Upper Columbia.

For fifteen years, science – physical, biological, and social – has been the foundation of the *Recovery Plan*, and we continue to learn more about how these disciplines converge into a feasible project. While this conference focuses on the physical and biological sciences, we continue to adapt to information in all three science disciplines. Over the next two days, think about opportunities to incorporate this information into your decisions and planning, and to communicate it in meaningful ways to decision-makers, landowners, and the public.

Please help us thank our sponsors, who enabled us to host this free conference. We invite you to engage with others and to make the most of this time together. We appreciate the important work that all of you do to collaboratively contribute to our progress towards recovery.

Sincerely,

Derek Van Marter
UCSRB Executive Director

Ron Walter
UCSRB Chair

ACKNOWLEDGEMENTS

We would like to thank the many individuals who dedicated time and energy to making this Science Conference a success. Planning and organizing this science conference has been a team effort from the start and we could not have done it without our amazing steering and organizing committees. The quality of talks and events at the conference is a reflection of the quality of the people we were privileged to work with. Thank you again to all of you.

STEERING COMMITTEE

Greer Maier, Steering Committee Chair, *Upper Columbia Salmon Recovery Board*

Jennifer Bayer, *U.S. Geological Survey & Pacific Northwest Aquatic Monitoring Partnership*

Jeremy Cram, *Washington Dept. of Fish and Wildlife*

John Crandall, *Methow Restoration Council*

Mike Kane, *Chelan County Natural Resources Department*

Steve Kolk, *Bureau of Reclamation*

Andrew Murdoch, *Washington Dept. of Fish and Wildlife*

Pamela Nelle, *Terraqua, Inc. & Integrated Status and Effectiveness Monitoring Program*

Robes Parrish, *U.S. Fish and Wildlife Service*

Chuck Peven, *UC Regional Technical Team and Peven Consulting, Inc.*

Derek Van Marter, *Upper Columbia Salmon Recovery Board*

ORGANIZING COMMITTEE

Greer Maier, Organizing Committee Chair, *Upper Columbia Salmon Recovery Board*

Barbara Carrillo, *Upper Columbia Salmon Recovery Board*

Maureen Duane, *Top Floor Consulting*

Debbie West, *Upper Columbia Salmon Recovery Board*

James White, *Upper Columbia Salmon Recovery Board*

Derek Van Marter, *Upper Columbia Salmon Recovery Board*

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Incorporating science into salmon management and recovery programs: lessons from a cautionary tale

9:40 - 10:40 **PANEL PRESENTATION AND DISCUSSION**
Perspectives on Science Needs - How is science being used in decision making?

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Andrew Murdoch - Washington Department of Fish and Wildlife

2:30 - 3:00 *Research and Monitoring and Recovery Plan Implementation in the Upper Columbia*
Chuck Peven - Upper Columbia Regional Technical Team

3:00 - 3:15 BREAK

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5:30 - 7:30 CONFERENCE RECEPTION AT CAFFE MELA (17 N. Wenatchee Ave.)

CONFERENCE AT A GLANCE
THURSDAY - NOVEMBER 14, 2013

8:00 - 4:30 **POSTER SESSION IN THE LOBBY**

8:10 - 8:15 **OPENING REMARKS**

8:15 - 9:20 **GENERAL SESSION:** *Restoration Strategies and Practices*

9:20 - 10:30 **GENERAL SESSION:** *Emerging Issues*

10:30-10:45 BREAK

10:45-12:30 **GENERAL SESSION:** *Integrated Modeling and Data Management*

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1:30 - 3:00 **GENERAL SESSION:** *Information on Spring Chinook, Steelhead, and Bull Trout*

3:00 - 3:15 BREAK

3:15 - 4:30 **GENERAL SESSION:** *Monitoring the Effects of Habitat Restoration*

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DETAILED CONFERENCE AGENDA
WEDNESDAY NOVEMBER 13, 2013

8:00 - 9:00 REGISTRATION, MORNING SNACKS AND COFFEE

9:00 - 9:10 OPENING REMARKS

Derek Van Marter, Executive Director, Upper Columbia Salmon Recovery Board

9:10 - 9:40 KEYNOTE ADDRESS

Incorporating science into salmon management and recovery programs: lessons from a cautionary tale

Jim Lichatowich

Abstract: Fishery biologists have been criticized for a poor understanding of the history of their profession. One of the symptoms of this shortcoming is the problem of shifting baselines. There are valuable lessons we can all learn from the past, especially past failures. In the first part of my talk I will give a cautionary tale and point out its lessons regarding the incorporation of science in salmon management and recovery programs. In the second part of the talk, I discuss ways that those lessons can be put into practice.

9:40 - 10:40 PANEL PRESENTATION

Perspectives on Science Needs - How is science being used in decision making?

Time	Organization/Agency	Representative
	Government	
9:40	Bonneville Power Administration	Rosy Mazaika
9:45	National Oceanic and Atmospheric Administration	Lynn Hatcher
9:50	Washington Department of Fish and Wildlife	Erik Neatherlin
	Tribal	
9:55	Yakama Nation	Paul Ward
10:00	Confederated Tribes of the Colville Reservation	Bill Towey
	County	
10:05	Chelan County	Ron Walter
	Public Utility	
10:10	Douglas County Public Utility District	Shane Bickford
	Project Sponsor	
10:15	Chelan Douglas Land Trust	Mickey Flemming
10:20	Discussion and Questions	

10:40 - 11:00 BREAK AND BOOK SIGNING BY JIM LICHATOWICH

PLENARY PRESENTATIONS

11:00 - 11:30 ***Species Status and Factors Affecting Listed Salmon and Steelhead in the UC***

Tom Cooney

NOAA National Marine Fisheries Service, Northwest Fisheries Science Center

Abstract: Upper Columbia Spring Chinook salmon and steelhead runs were listed under the ESA following relatively severe declines in natural origin abundance. NOAA Fisheries conducts five year status reviews for all listed anadromous stocks. In the most recent review, published in 2011, populations within each of the two listed Upper Columbia stocks had shown some improvement in natural origin abundance although average spawning escapements remained well below target levels. Diversity risks have been high for both Upper Columbia River steelhead and Spring Chinook Salmon, largely driven by high hatchery origin proportions in natural spawning. Recent year performance in terms of abundance, productivity, diversity and spatial structure will be described and contrasted against Snake River and Mid-Columbia River listed stocks.

11:30 - 12:00 ***Socio-Ecological Complexity and the Restoration of the Columbia River***

Robert Naiman

Independent Scientific Advisory Board and Independent Scientific Review Panel

Abstract: Understanding socio-ecological characteristics associated with rivers and their catchments, and using that understanding to effectively manage and restore river ecosystems, is an increasingly complex challenge. While great strides have been made in the last half century in understanding rivers as ecological systems, human exploitation of river water and riparian zones have frustrated river management to the point that many native species are imperiled or have become extinct, invasive species are rampant, water and sediment quality are in significant decline, environmental flows are neglected and economic pressures are placing unprecedented demands on remaining resources. At the same time, there are societal expectations that river resources be restored or rehabilitated to functional states, even while climate change, population growth, flow diversion and the proliferation of chemicals impose additional burdens in ways that are not adequately understood. Therein lays one of the great challenges of this century. Can river systems be realistically restored or rehabilitated and, if so, what are the approaches and scales that have a chance of being successful? This presentation addresses these questions through the activities of the Independent Scientific Advisory Board (ISAB) and the Independent Scientific Review Panel (ISRP). Two examples of river restoration (Moreton Bay, Australia and the Columbia River) are contrasted to reveal socio-ecological attributes that have been successful, as well as aspects in need of improvement. In the case of effective habitat restoration in the Columbia, a landscape scale restoration approach is needed that emphasizes social engagement and addresses food webs, toxics, and hatchery and non-native effects on carrying capacity. Guiding principles are offered to enhance resilience and promote adaptive capacity within the Columbia's social-ecological system, a system that continues to evolve.

12:00 - 12:30 ***Designing effective habitat restoration in the Upper Columbia, Pacific Northwest and Beyond***

Phil Roni

NOAA National Marine Fisheries Service, Northwest Fisheries Science Center

Abstract: Millions of dollars are spent annually to restore salmon habitat in the Columbia River Basin every year. Unfortunately, some of these efforts fail to meet their objectives because they ignore watershed processes or do not follow key steps needed to adequately plan, implement and evaluate restoration. In this talk I provide an overview of the key factors needed to plan restoration, assess watershed conditions, identify restoration actions, select and prioritize restoration techniques and evaluate restoration projects. I provide examples of successful methods, analysis or models used to address each of these key steps and design and implement effective habitat restoration.

12:30 - 1:30 LUNCH

PLENARY PRESENTATIONS (continued)

1:30 - 2:00 ***Scenarios of climate change for the Columbia Basin: what do they mean for anadromous fish in the Upper Columbia?***

Alisa Wade

University of Montana

Abstract: There is significant uncertainty in modeled scenarios of future climate change stemming from natural variability, environmental policy, and modeling assumptions. Comparison of scenarios of shifts in temperature and hydrologic regimes in the Upper Columbia illustrate the significant uncertainty. Compounding the uncertainty is the complexity associated with ocean conditions and other habitat interactions, such as non-native species, channel morphology, and fire regimes. Despite the myriad uncertainties, many models are suggesting lower and warmer summer flows and increased winter flooding. Likely impacts to fish from these changes are dependent on life-history characteristics unique to individual species and runs; impacts will be context specific. Therefore, climate change must be considered as a key source of habitat uncertainty in recovery planning specific to each species and each location. Managers can use climate scenarios to bound "best" and "worst" case recovery scenarios that are likely to maximize the potential for phenotypic and evolutionary adaptive responses. Climate scenarios do not dictate singular ideal locations for restoration prioritization, but instead reiterate the need for managing for a complex array of salmon habitat.

2:00 - 2:30 ***Hatchery reform in the Upper Columbia Basin: Why the habitat restoration community should care***

Andrew Murdoch

Washington Department of Fish and Wildlife

Abstract: An overview of hatchery programs for ESA listed populations in the Upper Columbia Basin comparing original hatchery programs to the new programs that will be implemented for at least the next 10 years. A general discussion of the potential risks and benefits of the hatchery programs will be followed by expected fish population responses. New approaches regarding the management of hatchery fish in the Upper Columbia Basin will also be presented.

2:30 - 3:00 ***Research and Monitoring and Recovery Plan Implementation in the Upper Columbia***

Chuck Peven

Upper Columbia Regional Technical Team

Abstract: Between 2002 and 2007, the Upper Columbia Salmon Recovery Board (UCSRB) facilitated the development of the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (Plan). Adopted by NOAA Fisheries in 2007, the Plan laid out a framework for research, monitoring, and evaluation (RM&E) and implementation. This presentation will discuss the development, coordination and implementation of RM&E in deploying the Plan, and will focus on the challenges in executing a robust RM&E program and implementing habitat actions within the Upper Columbia River region.

3:00 - 3:15 BREAK

3:15 - 5:00 GENERAL SESSION: HATCHERIES, HARVEST, AND HYDROPOWER

3:15 ***Relative reproductive success of hatchery and wild steelhead in the Twisp River, Washington***
Ben Goodman (WDFW)

3:30 ***Variation in minijack rate among Columbia River Basin Chinook salmon hatchery populations***
Deborah Harstad (NOAA), Donald Larsen & Brian Beckman

3:45 ***Evaluating survival and residualism of hatchery steelhead during the transition to a locally-sourced broodstock at the Winthrop National Fish Hatchery***
Christopher Tatara (NOAA), Bill Gale, Matt Cooper, Penny Swanson, Don Larsen, Chris Pasley & Barry Berejikian

4:00 ***Strategies to improve homing fidelity and recolonization to targeted spawning locations in Upper Columbia salmon supplementation program***
Andrew Dittman (NOAA), Todd Pearsons, Darran May, Ryan Couture, Joseph O'Neil & David Noakes

4:15 ***The Role of Selective Fisheries in Management of UCR Hatchery Programs***
Mike Tonseth (WDFW)

4:30 ***No net impact for the Priest Rapids Hydroelectric Project - How science, technology, and innovation are contributing to success***
Russell Langshaw (Grant County PUD)

4:45 ***Questions/Discussion***

5:30 - 7:30 CONFERENCE RECEPTION AT CAFFE MELA (17 N. WENATCHEE AVE.)

LIGHT BEVERAGES AND FOOD PROVIDED
MUSIC BY KARL POLIVKA AND THE MICHAEL CARLOS BAND

DETAILED CONFERENCE AGENDA
THURSDAY NOVEMBER 14, 2013

8:10 - 8:15 OPENING REMARKS

Derek Van Marter, Executive Director, Upper Columbia Salmon Recovery Board

8:15 - 9:20 GENERAL SESSION: RESTORATION STRATEGIES AND PRACTICES

8:15 ***New tools and techniques for large wood planning, design and implementation - An applied case study on the Trinity River, CA***
David (DJ) Bandrowski (BOR)

8:35 ***Identifying Habitat Improvement Projects: Middle Entiat River, WA***
Rob Richardson (BOR)

8:50 ***Whole Watershed Restoration: Concepts of Natural Process and Assessing Impairment at Sub-Watershed Scales***
Richard Vacirca (USFS)

9:05 ***Questions/Discussion***

9:20 - 10:30 GENERAL SESSION: EMERGING ISSUES

9:20 ***River restoration for a changing climate: a review of climate effects, restoration options, and planning and design considerations***
Tim Beechie (NOAA), Mathias Collins, Robert Dudley, Faith Fitzpatrick, Glenn Hodgkins, Laura Perry, George Pess, Lindsay Reynolds, Phil Roni & Pat Shafroth

9:40 ***Using Aquatic Food Webs to Evaluate In-Stream Restoration Treatments***
John Jorgensen (YN)

10:00 ***Mechanisms of Prespawn Mortality of Spring Chinook Salmon in the Willamette Basin –Applying Lessons Learned to Upper Columbia Salmon Recovery Under Climate Change***
Adrienne Roumasset (CCNRD)

10:15 ***Questions/Discussion***

10:30 – 10:45 BREAK

10:45 - 12:30 GENERAL SESSION: INTEGRATED MODELING AND DATA MANAGEMENT

10:45 ***Using a model to specify data acquisition requirements***
Michael Newsom (BOR), Alexander Fremier, Steve Rentmeester & Ryan Bellmore

11:00 ***The Trophic Productivity Model: Incorporating Food Webs into Salmon Recovery Science***
Ryan Bellmore (USGS), Michael Newsom, Alexander Fremier, Pat Connolly & John Jorgensen

11:15 ***Developing and extending life cycle models of Upper Columbia River Basin salmon populations***
Jeff Jorgensen (NOAA)

11:30 ***Déjà vu all over again: creating knowledge from data to guide decision making in the Columbia Basin***
Willis (Chip) McConnaha (ICFI), Lars Mobrand & Kevin Malone

11:45 ***Ecosystem Diagnosis and Treatment (EDT) Model – Integration with long-term habitat status and trends monitoring in the Okanogan subbasin***
John Arterburn (OBMEP) & Eric Doyle

12:00 ***Fish Habitat Rehabilitation and Fish Recovery in the Okanogan River Basin***
Keith Kistler (CCT) & John Arterburn

12:15 ***Questions/Discussion***

12:30 - 1:30 LUNCH

1:30 - 3:00 GENERAL SESSION: INFORMATION ON SPRING CHINOOK, STEELHEAD, AND BULL TROUT

1:30 ***Spatial Distribution and Abundance of Adult Steelhead (O. mykiss) in the Methow River Basin***
Ben Truscott (WDFW) & Charles Frady

1:45 ***Juvenile spring Chinook salmon life-history and survival in the Methow River Basin***
Charlie Snow (WDFW)

2:00 ***Subadult to Adult Return Ratio of Migratory Bull Trout in the Entiat River***
Mark Nelson (USFWS) & R.D. Nelle

2:15 ***Riverscape heterogeneity and implications for management actions, monitoring, and restoration***
Jeremy Cram (WDFW)

2:30 ***Fish Population Status and Trend Data Collection, Results, and Lessons Learned in the Wenatchee and Entiat Subbasins***
Keith Van Den Broek (Terraqua), Kevin See, Chris Jordan & Michael Ward

2:45 ***Questions/Discussion***

3:00 - 3:15 BREAK

3:15 - 4:30 GENERAL SESSION: MONITORING THE EFFECTS OF HABITAT RESTORATION

3:15 ***Fish response to restoration efforts in the Methow watershed***
Patrick Connolly (USGS), Kyle Martens & Michael Newsom

3:30 ***Upper Columbia Project Effectiveness Monitoring Program: A programmatic approach to regional data collection and analysis***
Jennifer O'Neal (TetraTech)

3:45 ***Field Notes: Rapid Response Effectiveness Monitoring in the Methow Subbasin***
John Crandall (Methow Restoration Council)

4:00 ***A Case Study: Detecting Changes in Habitat due to Habitat Restoration Actions in the Entiat River IMW***
Stephen Fortney (Terraqua)

4:15 ***Questions/Discussion***

4:30 CLOSING REMARKS

Derek Van Marter, Executive Director, Upper Columbia Salmon Recovery Board

POSTER SESSION

Posters will be on display in the lobby throughout the conference.

Abstracts are available at the end of program.

Field testing of a boat deployed deepwater electroshocking platform to detect larval lampreys without handling

Evan Arntzen (Pacific NW National Lab) & Robert Mueller

Data Management Tools developed for Fish Habitat Data collected by the Colville Confederated Tribes

Rebekka Lindskoog (Summit Environmental)

Side Channels Rock! A First Glimpse of Fish Use of Side Channels in the Entiat River Subbasin

Pamela Nelle (Terraqua), Tom Desgroseillier & R.D. Nelle

Distribution of Pacific lamprey in the main Wenatchee River, WA

R.D. Nelle (USFWS), Andy Johnsen, Mark Nelson & Cal Yonce

Small-scale effectiveness monitoring of in-stream habitat restoration in the Entiat River

Karl Polivka (USFS) & Heather Porter

Development of the Yakama Nation's Accord Status and Trend Reports and Supporting Resources

Michelle Steg-Geltner (YN)

Evaluating Fish Movement, Behavior and species interaction in Large Rivers

Tracey Steig (HTI), Sam Johnston, Colleen Sullivan & Kevin Kumara

Using physiological tools to forecast male life-history types to aid in management of hatchery and wild steelhead (Oncorhynchus mykiss)

Penny Swanson (NOAA), Don Larsen, Mollie Middleton, Jon Dickey, Barry Berejikian, Chris Tatara, Matt Cooper, Bill Gale & Chris Pasley

Alphabetical by first author's last name

Affiliation listed is for first author unless otherwise indicated

Field testing of a boat-deployed deepwater electroshocking platform to detect larval lampreys without handling

Evan Arntzen & Robert Mueller

Pacific Northwest National Laboratory

The deepwater electroshocking platform (DEP) is a submersible sled with the ability to electroshock, detect, and measure the size of larval lampreys (ammocoetes) within deep-water rearing habitats (>1 m). The device was previously tested in a laboratory environment. Here we present results of two field trials, conducted during summer (August 2012) and winter (February 2013), respectively, at a location where ammocoetes are known to rear. The field test was conducted in order to evaluate the efficacy of the device in a natural setting and also to evaluate any seasonal differences in sampling efficiency. During summer, 36 locations were sampled with ammocoetes detected at 61% of the locations. During winter, 34 locations were sampled using a similar spatial sampling distribution, with ammocoetes detected at 50% of locations. In total 74 lampreys were detected during summer and 63 were detected during winter. During both seasons, a majority of the lampreys were found in water depths ranging from 1.5 m to 4.5 m. Lamprey size varied from less than 50 mm up to 150 mm, with size distributions that were very similar during summer and winter. Seasons combined, we found 98 ammocoetes less than 75mm and 39 ammocoetes from 75 mm to 150 mm. More ammocoetes (47%) were found within sediments dominated by organic silt than those dominated by silt/sand mixtures (31%) or well graded sands (21%). Upon the initiation of shocking, lamprey ammocoetes (where present) emerged within approximately 1 minute and were recorded using optical video. The DEP was used to survey aquatic habitat at a rate of approximately 0.55 m2/min, was operated by only two persons, did not require transporting lampreys to the surface, and did not disturb sensitive benthic habitats.

Ecosystem Diagnosis and Treatment Model - Integration with Long-term Habitat Status and Trends Monitoring in the Okanogan Subbasin

John Arterburn & Eric Doyle

Confederated Tribes of the Colville Reservation

Understanding the status and trends of habitat conditions is a core component of salmon and steelhead conservation efforts throughout the Pacific Northwest. A key limitation of many existing monitoring efforts is that habitat conditions are commonly reported using metrics that do not translate directly to population recovery goals, are difficult to apply, and their meaning is difficult to communicate to decision makers and the public. The Ecosystem Diagnosis & Treatment Model (EDT) is particularly well suited to this challenge because it integrates empirical habitat data into estimates of salmonid habitat potential, allowing for direct comparison of habitat scenarios representing past, present, and hypothetical future conditions. Habitat conditions are expressed as fish population performance using Viable Salmonid Population (VSP) parameters, which are easily communicated and directly relevant to recovery goals. The Colville Confederated Tribes (CCT) Okanogan Basin Monitoring and Evaluation Program (OBMEP) is integrating the EDT model with long-term habitat status and trends monitoring to create results that are more useful for reporting trends in habitat conditions, and more relevant to critical decisions such as the prioritization of habitat protection and restoration actions. OBMEP is collecting data on multiple habitat metrics at 300 fixed and rotating panels sites distributed throughout

the subbasin on a four-year monitoring cycle. We have developed procedures for translating these data directly into EDT model inputs, allowing for the creation of unique model habitat scenarios representing each four-year monitoring cycle. We have created customized reporting tools to compare habitat scenario performance, allowing for characterization of observed trends in habitat conditions in terms of the change in habitat potential for ESA-listed Okanogan Chinook salmon and steelhead. OBMEP/EDT integration translates habitat data into useful information for decision making, and provides a consistent platform for tracking improvements in data quality, and identifying additional monitoring needs. This application has broad application to other habitat status and trend monitoring efforts in the Columbia Basin.

New tools and techniques for large wood planning, design and implementation - An applied case study on the Trinity River, CA

David (DJ) Bandrowski

US Bureau of Reclamation - Trinity River Restoration Program - Northern California

Over the past decade, the utilization of large wood in the river restoration projects has evolved quickly and has now become a mainstream technique within the restoration community. This evolution has challenged restoration practitioners to develop new technologies to aid in the planning, design, and implementation of large wood projects that help create habitat for salmonids and other wildlife. Innovative design tools have recently been developed to help model and predict future hydraulic and geomorphic response on proposed large wood elements. These tools are providing robust analyses to help designers and managers make more thorough informed decisions and balance important factors of both benefit and risk. Implementation techniques for large wood have also advanced to allow for more streamlined constructability and more efficient use of project dollars.

The Trinity River Restoration Program (TRRP) has harnessed this evolution in wood use and has dramatically increasing its application on channel rehabilitation projects sites. Scientific reviews and rigorous monitoring efforts have validated increased salmonid utilization in-conjunction with recent wood installations. Constructed log jams are being implemented as geomorphic hard-points to help bifurcate and partition flows into side channels and to help activate new split flow channels on the Trinity's mainstem. Construction methods have had to advance to keep pace with the increased use of wood within the active channel. Large wood construction have forced more effective containment and isolation of turbidity caused by the need to excavate and drive piles below the bed of the river to reach critical foundation depths to counteract scour. Many challenges have had to be overcome to balance the construction of these features while still maintaining river navigation and recreation. Implementation has been focused toward non-traditional construction without cables and artificial anchoring techniques. The structures are not designed for static longevity but rather encourage process-based principles of dynamics and evolution.

The design process on the Trinity has become more structured with the incorporation of detailed goals, objectives, and quantifiable design metrics. Another useful design tool is the Large Wood National Design Manual, currently being developed by a team of experts through support of the Bureau of Reclamation and Corp of Engineers. Design analysis tools with consistent and strategic monitoring efforts are helping design teams carry-out the adaptive management cycle, learn from progress, and ultimately become equipped to better inform future designs.

River restoration for a changing climate: a review of climate effects, restoration options, and planning and design considerations

Tim Beechie, Mathias Collins, Robert Dudley, Faith Fitzpatrick, Glenn Hodgkins, Laura Perry, George Pess, Lindsay Reynolds, Phil Roni & Pat Shafroth

NOAA National Marine Fisheries Service, Seattle, WA

Future climate scenarios suggest that riverine habitats will be significantly altered in coming decades, forcing managers to ask whether and how river restoration activities should be altered to accommodate climate change. In this review we first briefly examine how climate change is expected to alter future stream flow, temperature, and riverine ecosystems. We then review which types of restoration actions are likely to ameliorate specific climate effects or increase habitat diversity and resilience. Finally, we discuss and provide examples of how climate change considerations might influence watershed-scale restoration plans, and how projected climate change effects can be incorporated into project design. Key conclusions are that (1) restoring connectivity (longitudinal, vertical, and lateral) is most likely to ameliorate streamflow or temperature changes and increase ecosystem resilience, (2) a decision support framework for evaluating project selection and restoration priorities shows promise for helping practitioners adapt watershed-scale restoration plans to accommodate climate change, and (3) climate change is logically considered in restoration project design at the key stages of assessing the project context, establishing design criteria, and evaluating design alternatives.

The Trophic Productivity Model: Incorporating Food Webs into Salmon Recovery Science

Ryan Bellmore, Michael Newsom, Alexander Fremier, Pat, Connolly & John Jorgensen

US Geological Survey

We constructed a mechanism-based system dynamics model that links abiotic and biotic compartments of stream ecosystems to explore how salmon restoration strategies impact the flows of energy that fuel freshwater fishes. This model, termed the "Trophic Productivity Model", explicitly links stream food web dynamics to physical habitat and riparian conditions. Here we present the underlying structure of the model, and simulations that demonstrate how fish populations might respond to two distinctly different salmon recovery strategies: (1) direct alternations of the food web, via additions of marine derived nutrients, and (2) reconfiguration of physical habitat, via floodplain reconnection. These simulations demonstrate that our modeling framework can be used to explore how fish populations and ecosystem processes (e.g., primary and secondary productivity) respond to restoration. Finally, we use the model to predict basal level productivity (primary production) at several intensively monitored sites in the Methow River where model calibration and validation field studies are currently being conducted. Our model provides a tractable framework for estimating the potential benefits of alternative salmon recovery scenarios, information which can be used to generate hypotheses, plan field experiments, and ultimately guide salmon recovery efforts.

Fish response to restoration efforts in the Methow watershed

Patrick Connolly, Kyle Martens & Michael Newsom

US Geological Survey; Western Fisheries Research Center; Columbia River Research Laboratory

We have been tracking the fish response to ongoing stream restoration efforts in the Methow watershed. Much of the restoration work has emphasized enhancement of longitudinal and lateral connectivity in unconstrained reaches in the heart of the Methow Valley (river kilometers 66-80 of the Methow River, lower 12 km of the Chewuch River). To assess reach-level effects of the restoration actions, we established a smolt trap site in the Chewuch River near its mouth and a network of PIT tag

detectors. Along with other traps and detectors established by Washington Department of Fish and Wildlife, this network is highly capable of tracking movements, growth, and fate of juvenile salmonids and other fish species. The fish assemblage in the middle reaches of the Methow is diverse, but much dominated by large, mature mountain whitefish and small, ubiquitous sculpin. Steelhead and summer Chinook spawn and rear to various degrees in the middle reaches of the Methow. Spring Chinook are largely natal to more upstream reaches and tributaries, but settle into or migrate through the reaches of the middle Methow. Coho have become more prominent the last few years as a result of a large-scale reintroduction program. Much of our effort has been to understand the degree of retention of parr rearing in the reaches and side channels of the middle Methow and to assess current growth, survival, and smolt age patterns. Most side channels in this section of stream become hydrologically connected with higher flows from snow melt in spring, and lose connection for most of the summer and winter months. When connected, these side channels attract young-of-year steelhead and salmon, and many of these fish remain and survive until reconnection. Within disconnected side channels, juvenile salmonids in deep pools (> 100 cm) had higher survival than those in shallow pools (< 100 cm), but long sections of these side channels often become dry and incapable of supporting fish. For juvenile steelhead, Chinook, and coho in the six disconnected side channels that we monitored during 2008-2012, mean survival during isolation was 54%, 30%, and 46% in deep pools, but reduced to 27%, 26%, and 26% in shallow pools. These characterizations represent the pre-treatment phase of our before-after, control-impact study design. We have completed four years of pre-treatment assessments of treatment and control sites, and now are sliding into the post-treatment phase of this long-term study.

Riverscape heterogeneity and implications for management actions, monitoring, and restoration

Jeremy Cram

Washington Department of Fish and Wildlife

Riverscape survey methods offer an effective means for documenting the relative distribution of fish and aquatic habitat within watersheds. The information gained from riverscape surveys contributes to numerous aspects of fisheries science and management. This presentation will focus on various examples of riverscape research and monitoring, and how such methods would benefit the Upper Columbia. The studies to be discussed were designed to investigate changes in fish distribution after habitat restoration, homing behavior by spring Chinook relative to aquatic habitat, utilization of thermal refugia by salmonids, and distribution of rearing juveniles relative to habitat conditions. The findings of each study emphasize the utility of spatially continuous surveys.

Field Notes: Rapid Response Effectiveness Monitoring in the Methow Subbasin

John Crandall

Methow Restoration Council

Project sponsors of aquatic habitat improvement actions benefit from rapid feedback on the effectiveness of projects they implement. Monitoring information can be used to: 1) assess how a project met its goals and objectives, 2) adaptively manage the project and, 3) inform subsequent project planning efforts. Thus, effectiveness monitoring provides project sponsors with critical feedback to assist them in maximizing the benefits of the projects they, and others, implement.

Several factors may prevent project sponsors from fully realizing the benefits of effectiveness monitoring. First, not all project sponsors possess the capacity to develop effectiveness monitoring programs for the projects they implement. Secondly, funding entities may specifically exclude effectiveness monitoring activities from available implementation funds. Thirdly, the opportunity to incorporate results from large-scale effectiveness monitoring efforts into project planning is missed as

the time it takes to obtain, interpret, and peer review the extensive monitoring results exceeds the time scale on which current projects are planned and implemented. In addition, large-scale effectiveness monitoring efforts are often not geared to the project scale, but are intended to shed light on program level effectiveness in increasing fish production at a subbasin scale.

To remedy these impediments to "effective" effectiveness monitoring, a scientifically credible and low cost project scale effectiveness monitoring program has been established in the Methow Subbasin. The program incorporates quantitative data and qualitative observations to investigate basic biological and physical questions about site specific habitat improvement projects. The data are reported in user friendly briefs, often with accompanying video imagery, to provide project management with relevant and useful information within a meaningful timeframe. The results from this monitoring have enabled local project sponsors to integrate monitoring results into adaptive management of current projects and into planning and design of developing projects. The results are also used for internal and external outreach efforts to strengthen the connection between habitat improvement projects and watershed and community health in the Methow Subbasin. Agency officials find the information useful as examples of the potential benefits of salmon habitat improvement actions that can be easily shared with funders, regulatory agencies, and environmental advocates. It is hoped that this program will serve as a model in the development of regional, low cost effectiveness monitoring that serves projects sponsors, funding entities, stakeholders and the public.

Strategies to improve homing fidelity and recolonization to targeted spawning locations in Upper Columbia salmon supplementation programs

Andrew Dittman, Todd Pearsons, Darran May, Ryan Couture, Joseph O'Neil, David Noakes

Environmental Physiology Program, Northwest Fisheries Science Center, NOAA National Marine Fisheries Service

The need to rear salmon at large centralized hatcheries and then release them offsite to supplement specific populations or fisheries is a practical reality of artificial production. However, this practice can dramatically increase stray rates. Accurate homing of hatchery salmon to ensure spatial segregation of hatchery and wild fish (or for conservation supplementation programs, integration of hatchery and wild fish) is critical for salmon management and conservation efforts. Homing is governed by the olfactory discrimination of home-stream water and exposure to the home stream during appropriate juvenile stages is critical for olfactory imprinting and successful completion of the adult homing migration. In particular, the parr-smolt transformation has been demonstrated as a critical period for olfactory imprinting and most hatchery programs use this as a guiding principal for designing release strategies that will return fish to targeted locations. Smolt acclimation and imprinting facilities have been developed as part of most hatchery supplementation programs and hundreds of millions of dollars have been spent for construction, operation and maintenance of these facilities. However, several recent studies have indicated that physical and logistical constraints on where these facilities must be sited relative to appropriate spawning habitat can result in a large percentage of fish spawning in non-target or inappropriate locations.

In this presentation, we propose a novel, cost-effective, approach for achieving successful imprinting and homing fidelity to target spawning locations without moving fish from their central rearing hatchery prior to release. This new imprinting paradigm is based on the observation that most salmon species imprint to their natal sites during early development and we hypothesize that hatchery-reared adult salmon will seek their earliest detectable olfactory imprint as the appropriate location to terminate their spawning migration. Under this scenario, natural waters would be collected from targeted spawning areas and transported to a central rearing hatchery where embryos would be initially incubated in target waters during critical periods for imprinting. We believe that if successful, this approach could be used to facilitate re-establishment of sustainable natural populations of upper

Columbia River salmon without the need for expensive and logistically challenging acclimation facilities. Here we describe initial experiments demonstrating that salmon embryos can learn and discriminate the olfactory signatures of natural waters and that stream waters can be collected, transported and stored without compromising their olfactory integrity. Finally, we describe potential applications of this imprinting paradigm for several ongoing supplementation programs in the upper Columbia River.

A Case Study: Detecting Changes in Habitat due to Habitat Restoration Actions in the Entiat River IMW

Stephen Fortney

Terraqua, Inc.

The Entiat River watershed is home to populations of ESA-listed spring Chinook and steelhead and has been identified by the Action Agencies and the Expert Panel as a priority in the Upper Columbia for restoration actions. In cooperation with partners in the Upper Columbia, the Integrated Status and Effectiveness Monitoring Program (ISEMP) has implemented an Intensively Monitored Watershed (IMW) approach to habitat restoration action implementation and monitoring in the Entiat River watershed. As part of the monitoring design, ISEMP is implementing the Columbia Habitat Monitoring Program's (CHaMP) protocol to detect changes in fish habitat as a result of instream rehabilitation actions. The CHaMP protocol is a fish-centric habitat monitoring protocol that measures the quantity and quality of, and changes in, stream habitat for salmonid fishes. Here we present a case study highlighting habitat monitoring results from three types of reaches in the mainstem of the Entiat River, one with restoration actions and two where there were no restoration actions. We will show changes in fish habitat using results from a geomorphic change detection analysis e.g., Digital Elevation Models (DEMs) of difference, and will demonstrate the types of metrics and indicators that can be generated from CHaMP data, which can help guide future stream rehabilitation actions.

Relative reproductive success of hatchery and wild steelhead in the Twisp River, Washington

Ben Goodman

Washington Department of Fish and Wildlife

Hatchery production is used as a tool to restore and conserve wild steelhead *Oncorhynchus mykiss* populations in the Columbia River basin. However, the ability of hatchery programs to achieve steelhead recovery goals is uncertain due to hatchery spawning and rearing practices that may result in a decrease in the relative reproductive success (RRS) of hatchery fish spawning in the natural environment. We initiated a study to determine the RRS of hatchery and wild summer steelhead that spawn in the Twisp River, Washington, using a DNA-based pedigree approach. Eventually, we will evaluate RRS at three life stages (i.e., age-1 parr, smolt, and returning adult) and over multiple generations when the study concludes in 2025. Thus far, we have collected 1,257 DNA samples from five broods of adult steelhead (2009–2013) that were passed over a weir on the Twisp River. In addition, we have collected data on run timing, spawn timing, fat content, age composition, length at age, and spawning distribution of adult steelhead to determine whether differences exist between hatchery and wild fish that may explain differences in observed RRS, should they occur. Age-1 and smolt *O. mykiss*, progeny of the 2009–2012 broods, were collected using angling, netting, electrofishing, and a rotary screw trap to determine RRS. Parentage analysis was conducted on 1,453 juveniles sampled in 2010 and 2011 (i.e., progeny of the 2009 and 2010 broods). DNA samples were genotyped at 152 single nucleotide polymorphism loci to complete parentage assignments. Juveniles were assigned a single parent (29.4%), two parents (36.5%), or no parents (30.6%). Of the single-parent assignments, most (71.9%) were assigned a maternal parent. Based on these preliminary results,

hatchery and wild mothers produced similar numbers of age-1 offspring for both the 2009 and 2010 brood years. However, wild males appeared to produce more offspring than hatchery males.

Variation in minijack rate among Columbia River Basin Chinook salmon hatchery populations

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Northwest Fisheries Science Center, NOAA National Marine Fisheries Service

In Columbia River spring and summer Chinook salmon (*Oncorhynchus tshawytscha*), age of maturation ranges from age-1 (microjack), -2 (minijack), -3 (jack), to -4 or -5 (adult) years. The presence of age-2 minijacks has been noted in several experimental studies and documented for a few hatchery programs but a comprehensive survey of their occurrence in hatchery production programs has never been conducted. The objective of this study was to quantify the prevalence of minijacks produced in hatchery programs across the Columbia River Basin. We measured the proportion of minijacks among males released from several spring- and summer-run Chinook salmon hatchery programs throughout the Columbia River Basin for brood years 1999 through 2010, using 11-Ketotestorone levels in males as an index of maturation. The hatcheries surveyed included both segregated (only hatchery-origin broodstock) and integrated (some natural-origin broodstock) programs. Minijacks were found in all programs monitored, and rates varied approximately 10-fold across release groups ranging from 7.9 - 71.4% of males in spring Chinook salmon programs and 4.1 - 40.1% of males in summer Chinook salmon programs. There was a significant positive relationship between size at release and proportion of minijacks released from the integrated, but not the segregated spring Chinook salmon programs. Minijack rates were significantly higher in the integrated spring Chinook salmon programs compared to the segregated programs despite the fact that most of the integrated programs released smaller fish, suggesting that domestication selection for age at maturation has occurred in segregated programs. Findings of this study have implications for hatchery production efficiency and harvest, as well as genetic and ecological consequences for naturally spawning populations.

Using Aquatic Food Webs to Evaluate In-Stream Restoration Treatments

John Jorgensen

Yakama Nation

Dramatic declines in the abundance of anadromous Pacific salmonids have occurred over the last century in the Columbia River basin. Population declines followed harvest, hydrosystem and watershed development, habitat loss and degradation, and reduced survival in freshwater, estuary, and marine environments. These declines are accompanied by greatly reduced levels of natural production due to an array of anthropogenic factors. While physical habitat loss and degradation, loss of marine derived nutrients (MDN), and the deleterious presence of non-native fishes are recognized as three critical limiting factors, natural production in many imperiled populations may be simultaneously co-limited by multiple factors. Thus, successful salmon restoration programs for co-limited populations will likely require multiple restoration treatments, along with a standard, comparable methodology to characterize the complex biological responses to these restoration treatments.

Food webs provide such a methodology, by describing how food and energy are routed through ecosystems, and by providing insight into the complex, multi-species assemblages within which organisms of interest grow, survive, and reproduce. While food webs have traditionally been used to characterize and compare ecological conditions within or between biological systems, they can also provide great benefit as a monitoring tool to evaluate the complex responses to multiple restoration actions for salmonids.

In this study we use trophic basis of production to characterize: (1) the effects of physical habitat degradation, the loss of MDN, and the deleterious presence of non-native fish (brook trout) on natural production; and (2) the individual and additive effects of physical habitat restoration, nutrient addition, and brook trout removal treatments on production of ESA-listed Chinook salmon and steelhead, and on supporting trophic ecology. This study is being conducted in Hancock Springs, a small spring creek in the Methow River Subbasin. The study design includes temporal and spatial controls to evaluate sequential implementation of restoration treatments. Physical habitat restoration (channel and riparian zone reconstruction) occurred during 2011, with annual nutrient addition beginning in 2014 and brook trout removal beginning in 2016. A standardized multi-trophic level biomonitoring program is ongoing to address the separate and additive effects of multiple restoration treatments.

Initial responses to physical habitat restoration included order of magnitude increases in fish abundance, biomass, and production within the treatment reach, with ESA-listed (Chinook and steelhead) and non-native species (brook trout). We use energy flow webs to characterize and discuss responses to individual and additive effects of restoration actions.

Developing and extending life cycle models of Upper Columbia River Basin salmon populations

Jeff Jorgensen

Conservation Biology Division, Northwest Fisheries Science Center, NOAA National Marine Fisheries Service (contracted through Ocean Associates, Inc.)

Life cycle models can be useful tools for understanding the potential impacts of management actions and environmental variability on threatened populations. Taking advantage of several recent life cycle modeling efforts and extensive data collection and monitoring in the basin, a team of researchers is developing and extending a stochastic life cycle model of spring Chinook salmon in the Wenatchee basin. This effort is directed toward capturing aspects outlined in the FCRPS Biological Opinion's Adaptive Management Implementation Plan, and incorporating important biological characteristics of this population. Moving towards a finer spatial resolution, the model includes subbasin biological parameters from major production areas, and we have updated the early ocean survival with more recent abundance and ocean conditions data. Scenarios that demonstrate the model's capabilities included combinations of management actions, such as habitat improvements (increased prespawning and spawner-to-parr survival, as a proxy) and mainstem hydropower operations (increased survival through the dams) and estuary survival (reducing avian predation). Preliminary model results suggest that a combination of management actions such as improvements in freshwater and estuary survival may significantly offset the negative effects of unfavorable ocean conditions, as measured by increased abundance and reduced extinction risk. Current work includes incorporating juvenile life history diversity, hatchery-wild interactions, and freshwater habitat-survival relationships.

Fish Habitat Rehabilitation and Fish Recovery in the Okanogan River Basin

Keith Kistler & John Arterburn

Confederated Tribes of the Colville Reservation

The Okanogan River is the uppermost tributary of the Columbia River which supports anadromous salmonids. The Okanogan River watershed drains nearly 9,000 square miles, of which approximately 70% lies in British Columbia, Canada. The floodplain of the Okanogan River basin averages 1 mile-wide, with broad terrace surfaces that have historically been desirable locations for agricultural development. Consequently, many Okanogan River tributaries have been subject to streamflow withdrawals for irrigation, including complete seasonal dewatering of some reaches. Fish habitat, use and access to upstream habitat were directly impaired by: irrigation water withdrawals reducing stream flow, and increasing geomorphic instability of channels and tributary confluences. Other factors

affecting anadromous fish populations have been: increased sediment delivery sources, reduced riparian areas, straightening of stream channels, impoundments in the headwaters and range and timber management activities. The anadromous salmonids which inhabited these cold water tributaries have suffered and consequently, stream-type Chinook salmon are considered extirpated and Upper Columbia summer steelhead are recognized as "threatened".

The Colville Confederated Tribes have been implementing a range of efforts to rehabilitate fish habitat and to restore fish access within Okanogan River tributaries since the 1990's. Since the inception of the Okanogan Subbasin Habitat Improvement Project (OSHIP) by the Confederated Tribes of the Colville Reservation Anadromous Fisheries Division (CTCRAFD) in 2008 various hydrologic and habitat modeling studies have been undertaken for the benefit of steelhead, Chinook and sockeye spawning, rearing and migrating.

OSHIP is employing a set of sequenced steps to address ecological concerns in the Okanogan Basin which are intended to lead to the recovery of listed salmonid species and enhancement of habitats for non-listed salmonids. This presentation will focus on some of the projects implemented by the CTCRAFD and how modeling has validated the success of the projects or has driven the location and extent of future projects in various sub-basins of the U.S. portion of the Okanogan Basin.

No net impact for the Priest Rapids Hydroelectric Project - How science, technology, and innovation are contributing to success

Russell Langshaw

Grant County Public Utility District

The Priest Rapids Project is uniquely situated with numerous ESA listed salmonid populations upstream, an extremely productive Chinook salmon stock immediately downstream, and important cultural resources throughout the project area. Balancing resource use and protections is the primary objective of the federal operating license that was issued in 2008. The license includes provisions for "all Hs" (i.e., Hatcheries, Habitat, Harvest, and Hydro) and is based on adaptive management. Recent technological advances are providing the opportunity for innovation, particularly in the hydrosystem. I'll provide an overview of what we are learning and how we are using it to inform water management, infrastructure improvements, and passage programs at the dams.

Data Management Tools developed for Fish Habitat Data collected by the Colville Confederated Tribes

Rebekka Lindskoog

Summit Environmental Consultants, Inc.

Background : The Confederated Tribes of the Colville Reservation (CCT) Fish and Wildlife Department has undertaken many projects to monitor and evaluate the status and trends of fish and wildlife populations, habitats, and ranges. Today, they have millions of data records, collected throughout the Okanogan River Basin using rigorous field protocols. Since 2006, the Bonneville Power Administration has funded collaboration between Summit Environmental Consultants Inc. (Summit) and the CCT to collate, manage, evaluate, and report these data.

Summit's Role: Data management support provided by Summit initially included development of repository databases and automated analysis routines, and has recently expanded to include:

•Development of customized software for hand-held data collectors (Trimble Yuma Rugged Tablets) to improve the efficiency and quality of field data;

•Design of a data repository, with sharing and vetting tools for a decade of fish, water quality and habitat data;

•Design of a data storage and analysis tool for use in hatchery operations and subsequent fish monitoring;

•Development of interactive, web-based data sharing and reporting tools; and

•Provision of technical support and training programs.

Fish Habitat Data Management Tools: Sound resource management decisions require a large volume of high quality data and efficient reporting tools. Three of the tools developed by Summit for the CCT specifically for data collection, management and analysis of fish habitat data are:

1. Fish habitat data collection module: software specifically designed to enable intuitive and efficient entry of data on hand-held computers that follow specific data collection protocols in the field, and allow for automatic synchronizing of data to the in-house data system, and ensure the upmost data quality and integrity.

2. Viewer dashboard: desktop software designed for program managers to view and analyze real-time data.

3. Mapbook: Easy-to-read summary of GIS-analysis to support identification and prioritization of fish habitat restoration and conservation opportunities and recommendations.

Déjà vu all over again: creating knowledge from data to guide decision making in the Columbia Basin

Willis (Chip) McConnaha, Lars Mobrand & Kevin Malone

ICF International

Understanding the relationships between freshwater habitat conditions and salmonid population performance is of paramount importance to fishery managers and funding agencies. Useful information about the factors limiting population performance is critical for responsible prioritization of restoration actions and accountable investments. Over the past four decades the Bonneville Power Administration (BPA) and other entities have made substantial investments in habitat restoration under the NW Power Act, the Endangered Species Act and tribal funding agreements. However, significant scientific uncertainties remain about habitat priorities and restoration effectiveness. In recognition, BPA has invested substantially in monitoring programs to track population and habitat status and trends and provide a more robust basis for decision making. These programs have produced a substantial and growing body of data, but the translation of this investment into decision-relevant information remains an ongoing challenge. Persistent scientific and policy uncertainties require that management actions be based on inferences from information available at a point in time. Ecological models have long been used as tools for developing and applying management hypotheses, and several have been applied the Columbia Basin. The regional Subbasin Planning process, for example, used data and models available in the early 2000's, to create what remains the most regionally extensive body of information about salmonid-habitat relationships in the world. This process translated reach-level assessments of habitat conditions and hypotheses regarding their biological importance into estimates of habitat potential, limiting factors, and protection and restoration priorities. Despite limitations in both models and data available at the time, these assessments provided a consistent set of analytical frameworks and results that continue to inform regional priorities and decision making. We conclude that building on the data and habitat-based models that the region has already invested in provides the most efficient and cost-effective means for making practical, decision-relevant use of the growing body

of habitat monitoring data being collected in the basin. Habitat-based models have evolved considerably while retaining the basic data structure and logic framework for organizing emerging scientific knowledge. In combination with complementary models addressing other subjects like population dynamics and physical processes, habitat-based models provide a powerful framework for organizing information, testing hypotheses, and making defensible and accountable decisions. We will review the status of Subbasin Planning species-habitat models and regional data collection efforts and suggest how the constructively integration of these resources can be applied to make the best use of habitat monitoring and restoration investments.

Distribution of Pacific lamprey in the main Wenatchee River, WA.

R.D. Nelle, Andy Johnsen, Mark Nelson, Cal Yonce

Mid-Columbia River Fishery Resource Office, U.S. Fish and Wildlife Service

The Pacific lamprey *Entosphenus tridentatus* is an anadromous fish species native to the Pacific Northwest including the Columbia River and many of its tributaries. In recent decades the numbers of returning adults has declined dramatically across the range in part due to dams, habitat degradation, stream alteration, and predation. This decline has initiated an interest in the current distribution of Pacific lamprey. Within the Wenatchee River, Pacific lampreys were historically observed up to and including Lake Wenatchee. The objective of this study was to determine the current upstream extent of Pacific lamprey presence within the Wenatchee River by electrofishing for rearing juvenile lamprey. From 2010 to 2011 we used an ABP-2 backpack electrofisher to sample 23 sites comprised of Type I and II lamprey habitat in the Wenatchee River. Sampling occurred between river kilometers 40.3 and 87.1 for a total electrofishing time of 8.3 hours. Pacific lampreys were only found at one site located 2 kilometers downstream of Tumwater Dam located at river kilometer 49.5. Expanding on the 2010 and 2011sampling, during 2012 we conducted electrofishing surveys using probability of occurrence methods to sample 50 m long generalized random-tessellation stratified sample sites. In the Wenatchee River, 21 sites were sampled from Lake Wenatchee downstream to Tumwater Dam and 21 sites were sampled from Tumwater Dam to mouth of the Wenatchee River. No juvenile lamprey were collected upstream of Tumwater Dam. Downstream of Tumwater Dam juvenile lamprey were collected at 20 of the 21 sites. Our study documents that Pacific lamprey are not distributed upstream of Tumwater Dam in the Wenatchee River. The fishway on Tumwater Dam was modified in the late 1980's and the modifications, along with the fishway operations schedule, may have impacted the passage of adult Pacific lamprey in the Wenatchee River. Changing the operations schedule or installing a lamprey passage structure (LPS) may allow adults to pass upstream of the dam to spawn and restore distribution to this area historically utilized by Pacific lampreys.

Side Channels Rock! A First Glimpse of Fish Use of Side Channels in the Entiat River Subbasin

Pamela Nelle, Tom Desgroseillier & R.D. Nelle

Terraqua, Inc.

Side channels provide important habitat for juvenile salmonids as they offer a refuge from high flow events that might otherwise wash juveniles downriver before they are ready to migrate. Access to side channel habitat is limited in the Entiat River subbasin and side channel creation or enhancement has been identified as a priority restoration action. The U.S. Fish and Wildlife Service Mid-Columbia Fisheries Resource Office and the Integrated Status and Effectiveness Monitoring Program (ISEMP) are monitoring fish use of six side channels along the Entiat River mainstem as part of action effectiveness monitoring under the Intensively Monitored Watershed (IMW) approach being implemented in the Entiat. Monitoring includes seasonal mark-recapture events and the use of instream PIT tag detection

arrays at the inlet and outlet of the channel if appropriate. Early results suggest that densities are high in side channels and that fish are healthier, as measured by size or condition factor.

Subadult to Adult Return Ratio of Migratory Bull Trout in the Entiat River

Mark Nelson & R.D Nelle

Mid-Columbia River Fishery Resource Office, U.S. Fish and Wildlife Service

Detailed information on all life stages of bull trout (*Salvelinus confluentus*) is needed for the development of management strategies to effectively recover this threatened species. The refinement of passive integrated transponder (PIT) tag technologies provide opportunities to address data gaps such as survival of subadults and their return as spawning adults in migratory populations. The USFWS is currently PIT-tagging out-migrant subadult bull trout at a rotary screw trap in the lower Entiat River and monitoring detections at in-steam antenna arrays throughout the upper Mid-Columbia Basin. From 2007 to 2010, at total of 347 subadults were captured, measured and tagged in the Entiat River. Two migration peaks occurred: in spring during high discharge (May-June) or in fall during low discharge (October-November) and out-migrants were significantly smaller in the spring. Preliminary analysis indicates that, overall, a total of 29 subadults survived and reared for 244 to 1020 days in the Columbia River before returning as adults to spawn in the Entiat River, with significantly fewer returns of spring out-migrants than expected. During the study period, the overall subadult to adult return ratio averaged 8.4% and ranged from 3.3% of the 2007 outmigrants to 15.1% of the 2009 outmigrants. Based on PIT detections in the fish ladders of the Mid-Columbia River dams, approximately equal numbers matured in the Rocky Reach, Rock Island, and Wanapum reservoirs before returning to the Entiat River. Additional PIT tagging and analyses are needed, but the preliminary results suggest that habitats that provide subadult bull trout rearing areas and refuges from high spring discharge may be limiting factors for seasonal survival and subadult to adult return rates in migratory populations. Stream restoration projects that increase or enhance these rearing and refuge habitats should be designed and implemented in the Entiat River.

Using a model to specify data acquisition requirements

Michael Newsom, Alexander Fremier, Steve Rentmeester, & Ryan Bellmore

U.S. Bureau of Reclamation

Natural resource management questions require large volumes of data in order to draw statistically valid conclusions over large spatial and temporal domains. We use a model to clearly define and limit the data collection to the data required to estimate the parameters in the model, thereby reducing the data collection effort. Here we illustrate the use of a model to represent the ecological mechanisms that drive watershed-scale patterns of aquatic trophic productivity in the Methow River, Washington. This presentation describes the model data and the two data management programs used to capture and prepare data for the productivity study. Sitka Technology Group works with large-scale monitoring programs in the Columbia River Basin to develop data management tools that support programs such as the Columbia Habitat Monitoring Program (CHaMP). The Pacific Northwest Aquatic Monitoring Partnership's (PNAMP) MonitoringResources.org website provides online data management services built and hosted by Sitka. The University of Idaho developed an online program called Hatch (DataHatch.org) that identifies and collects data from Methow data generators to demonstrate a method to seamlessly integrate data collection with analysis. By uniting these independent data management programs through the use of a model, the watershed-scale

patterns and processes can be understood while realizing potentially significant savings in the data collection effort.

Upper Columbia Project Effectiveness Monitoring Program: A programmatic approach to regional data collection and analysis

Jennifer O'Neal

Tetra Tech

The Upper Columbia Project Effectiveness Monitoring Program was implemented with the objective of creating a long-term monitoring effort to evaluate habitat and fish responses to restoration actions in the Upper Columbia basin. Two categories of projects are monitored under the program - floodplain enhancement and instream habitat projects. The program uses protocols, data management, and analysis methods that are consistent with other large-scale monitoring efforts across the region (e.g. Columbia Habitat Monitoring Program and Bonneville Power Administration Action Effectiveness Monitoring), allowing data to be shared among programs. This approach increases the sample size and statistical validity for category-level analysis while reducing costs.

The program currently monitors nine sites within the Upper Columbia Region, including sites on the Wenatchee, Okanogan, Chewuch, and White rivers. Five of the projects are floodplain enhancement projects, while four of them are instream habitat projects. All projects in this program are monitored using a Before After Control Impact (BACI) sample design, with post-project monitoring for up to ten years. Baseline monitoring has been conducted at all project sites, and post-implementation monitoring is currently underway.

Habitat metrics include determining changes in pool area and channel complexity, as well quantification of geomorphic change using digital elevation models. Fish surveys focus on project use by juvenile Chinook and steelhead. Of four projects with one year of data (2012 results), three have shown improvement for both habitat and fish metrics, and one has shown inconclusive results. With only one year of post-project data, results are considered very preliminary and conclusions about project effectiveness cannot yet be made.

Data can be combined with statewide monitoring data sets collected as part of the Washington Salmon Recovery Funding Board Project Effectiveness Monitoring Program and are also compatible with the Columbia Basin-wide Action Effectiveness Monitoring Program funded through the Bonneville Power Administration.

Identifying Habitat Improvement Projects: Middle Entiat River, WA

Rob Richardson

U.S. Bureau of Reclamation

Salmon and steelhead habitat mean many different things to many different people. The same can be said regarding river form and function. Identifying the best, most appropriate yet acceptable habitat improvement projects within a river therefore represents a unique challenge.

The Entiat River in central Washington State contains threatened salmon and steelhead for which habitat improvement is a priority under the 2010 Federal Columbia River Power System Biological Opinion (BiOp). In an effort to address BiOp requirements, the US Bureau of Reclamation (Reclamation) has provided technical assistance and worked with local partners to identify and evaluate appropriate habitat improvement actions. Reclamation prepared a Tributary Assessment and Reach Assessments examining watershed- and reach-scale river form and function including documentation of historic, existing, and target conditions, human impacts, and potential improvements.

Reclamation and its partners used this information and other available supporting documentation to identify appropriate and feasible habitat improvement projects. One result of this collaborative process was a set of map books identifying, summarizing and illustrating conceptual habitat improvement actions generally accepted by partnering designers, regulators and funding entities. Conceptual elements were grouped according to physical interdependencies then ranked based on potential geomorphic response and biological benefit. Multiple groupings of elements were combined into project areas based on access, construction efficiencies, and landownership. Each conceptual project can now be streamlined through final concept, design and construction via local project sponsors and individual design teams.

Bridging the gap between the best available science and on-the-ground project implementation can be challenging. The Middle Entiat River project identification process has largely been a success thanks to several years of learning through evolution among a broad group of interdisciplinary collaborators. Presented here is a summary of the product of that evolution including discussion of scientific analysis, the collaborative process and lessons learned.

Mechanisms of Prespawn Mortality of Spring Chinook Salmon in the Willamette Basin –Applying Lessons Learned to Upper Columbia Salmon Recovery Under Climate Change

Adrienne Roumasset

Chelan County Natural Resources Department

Prespawn mortality (PSM) (adult mortality that occurs post migration, within the natal watershed, near spawning grounds and prior to spawning onset) can threaten salmon recovery. PSM has been documented throughout the Pacific Northwest including the Columbia River, the South Fork Salmon River, the Klamath River, the Alagnak River in Alaska, in urban streams of Puget Sound, and in the Willamette basin. By examining a PSM case study, a greater understanding of the nature and mechanisms of this threat can be achieved, subsequently aiding the facilitation of management and restoration actions directed towards reducing PSM in the Upper Columbia.

The study goal was to test the hypothesis that variability (ranging from 1% to 95%) in the PSM rates of spring Chinook salmon in Willamette tributaries can be partially explained by environmental conditions (i.e. percent agriculture, low and high flow, channel topography, geology, 7DAM stream temperature) during adult holding period and population differences regarding fish density and origin. Comparing multiple regression models with data collected from ODFW reports, USGS records, and GIS analysis found consistent significant associations between annual PSM rate and stream temperature, fish density, (positive associations) and percent wild origin (negative). Model results and exploratory within-basin tests suggest that large densities of hatchery fish may produce an ecological hatchery effect especially in areas where habitat is marginal, and increased PSM rates at higher stream temperatures. A separate model of stream temperature found associations with percent agriculture and geology, suggesting hierarchical mechanisms. We conducted further analyses of the stream temperature effect by relating longitudinal temperature profiles to movement data from radio-tagged adults. Results suggest that fish behaviorally thermoregulate to cooler areas when ambient temperatures reach thermal limits (i.e. >18°C), potentially creating a negative feedback loop on PSM.

Our method of thermal profiling (towing a high-resolution data logger through the stream and georeferening with a continuous GPS track) can be used as a significantly cheaper alternative to aerial thermal imagery. The effects of climate change (i.e. lower flows and higher stream temperatures in the summer) are projected to increase, making the identification, protection and restoration of potential thermal refuges for salmonids increasingly important. The CCNRD has started collecting continuous longitudinal data on potential and existing project areas) to inform project development and adaptive management.

Juvenile spring Chinook salmon life-history and survival in the Methow River Basin

Charlie Snow

Washington Department of Fish and Wildlife

Methow River spring Chinook salmon are an ESA-listed population within the upper Columbia River Evolutionarily Significant Unit (ESU). The Methow spring Chinook salmon population is the most upstream population in the Columbia River, and juvenile and adult fish must navigate past nine hydroelectric dams between spawning grounds and the ocean. Despite seemingly adequate and relatively pristine spawning and rearing habitat in much of the Methow River Basin, this population is characterized by low overall abundance of natural origin fish. Factors limiting survival of natural origin fish may act on key life stages, or during specific time periods or locations. I use data from on-going spawning ground survey, smolt trapping, and remote PIT-tagging projects to describe trends in the annual distribution and survival of natural origin spring Chinook salmon in the Methow River and its tributaries.

Development of the Yakama Nation's Accord Status and Trend Reports and Supporting Resources

Michelle Steg-Geltner

Yakama Nation

The 2008 Columbia Basin Fish Accord (Accord) is intended, in part, to implement projects considered necessary to improve the survival of salmon and steelhead listed under the Endangered Species Act (ESA) to the levels anticipated in the National Ocean and Atmospheric Administration's 2008 Biological Opinion for Federal Columbia River Power System Operations. This is an update on the development of the Status and Trend Annual Report (STAR) and Web Resource, which document implementation progress of Accord actions by the Yakama Nation and the status and trend of key species. With information summarized at ESU/DPS, population/subbasin, and assessment unit scales, the STAR project serves as both a high level reporting mechanism for the Yakama Nation Tribal Council, managers, and the general public, and as a resource for practitioners. High level summary status reports cover the Yakama Nation's Accord-funded implementation progress in the areas of habitat restoration and hatchery/supplementation, Accord actions in hydrosystem operation, and status and trends of target species. The purpose of the status reports are to track the: 1) effectiveness of efforts to implement the projects described in the Accord agreement and 2) biological effectiveness of implemented projects by reporting trends in the status of ESA-listed salmon and steelhead populations. The web-based supporting sections of the STAR project will present a searchable hierarchical structure with downloadable summary reports of species status and trend, the Yakama Nation's habitat restoration actions and their targeted benefits, and monitoring information. The region covered is approximately 12 million acres, encompassing habitats used by the treaty-trust natural resources of the Yakama Nation. The foundational structure of the STAR project is still under development, with

functionality to the detailed reports and website being added gradually. The high level summary status reports are expected to be released fall-spring 2013/2014.

Evaluating Fish Movement, Behavior and species interaction in Large Rivers

Tracey Steig, Sam Johnston, Colleen Sullivan & Kevin Kumagai

HTI Hydroacoustic Technology, Inc.

Acoustic telemetry is routinely used at hydropower dams for monitoring fish presence/absence, survival, passage and behavior. The telemetry information is typically combined into a chronology of time-stamped tag detections to measure fish survival, passage timing and other attributes. If tag transmissions are uniformly spaced with a high level of precision, these detection time series are used to monitor fish behavior. In recent years as more data has become available from various species via fine-scale 2D and 3D telemetry, new questions have emerged. As more and larger fish populations are studied using acoustic telemetry methods, increased information is available to relate species-specific tagged fish behavior to attributes such as predator avoidance, schooling/shoaling, predation, and tag defecation. From single receivers, movement toward or away from the hydrophone can determine fish directionality, observed cessation of tag movement can indicate holding behavior and stationary tags observed for extended periods may be interpreted as mortality or tag defecation following predation. In this presentation, we will discuss fish movement, species interaction, and acoustic behavior and as it relates to the Columbia River and recent studies on the Sacramento-San Joaquin Delta.

Using physiological tools to forecast male life-history types to aid in management of hatchery and wild steelhead, *Oncorhynchus mykiss.*

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Northwest Fisheries Science Center, NOAA National Marine Fisheries Service

Steelhead (*Oncorhynchus mykiss*) exhibit a high degree of life history plasticity including variation in age of smoltification and maturation, freshwater residence time, and seasonality of adult upstream migration and spawning. While stock- specific life history patterns have a genetic basis, the proportion of fish expressing various life-history phenotypes in the same stock can vary yearly due to environmental factors (e.g. temperature, food availability) that influence early development rate, emergence timing, growth, and body energy stores. This is most apparent in steelhead reared in hatcheries where rearing environment and feeding rates differ considerably from those in nature. For example, wild steelhead typically remain in fresh water for two to three years before smolting and migrating to sea, while hatchery steelhead are typically released as yearlings. Hatchery steelhead that either fail to reach minimum size thresholds for smolting or exceed size thresholds for maturation fail to migrate and remain resident in fresh water ('residualize') where they may pose genetic and ecological risks to native salmonids. In concert with research to develop hatchery rearing protocols to reduce production of residuals, we developed a suite of physiological indices to quantify reproductive phenotypes of male summer-run steelhead released from the Winthrop National Fish Hatchery, Methow River, WA. Using a combination of gonad histology, plasma hormone levels and gene expression in both the pituitary and testis, we identified several male phenotypes: 1) fish that were immature and showed no signs of initiation of puberty; 2) fish that were mature and expected to spawn soon after release; and 3) fish with testes in early to mid-spermatogenesis with elevated expression of reproductive hormones and would be expected to spawn a year after release. A survey in the Methow River 4-5 months after release confirmed that a high proportion of residuals were males that had matured in the previous spring and those that were initiating maturation for the following year. These physiological indices are now being used to compare the diversity of life history phenotypes of fish

reared on regimes designed to produce one and two-year old smolts, and to estimate proportions that may residualize after release either due to male maturation or failure to complete smoltification. While we have applied this approach to evaluate other stocks of summer- and winter-run hatchery steelhead, these physiological indices can be used to assess impacts of environmental factors on steelhead life history in their native habitat as well.

Evaluating survival and residualism of hatchery steelhead during the transition to a locally-sourced broodstock at the Winthrop National Fish Hatchery

Christopher Tatara, Bill Gale, Matt Cooper, Penny Swanson, Don Larsen, Chris Pasley & Barry Berejikian

NOAA National Marine Fisheries Service, Northwest Fisheries Science Center, Manchester Research Station

Winthrop National Fish Hatchery (WNFH) rears summer steelhead to assist in the recovery of ESA-listed Upper Columbia River steelhead in the Methow River basin. Previously, the hatchery reared yearling steelhead smolts (S1) sourced from co-mingled (Okanogan and Methow Rivers) broodstock collected at Wells Dam. To minimize the genetic and demographic risks inherent in rearing a co-mingled stock, the WNFH is transitioning to locally-sourced broodstock (Methow River). However, the later spawn timing of broodstock returning to the Methow River combined with cold water temperatures at WNFH precludes successful production of yearling smolts, requiring an additional year of hatchery rearing (S2). During the transition, WNFH is producing both S1 and S2 smolts.

We estimated percent survival and calculated travel times of PIT-tagged S1 and S2 smolts as they migrated through the Columbia River, and we tested for size-selective migration in 2011-2013 using forced (2010 & 2011) and volitional (2012 & 2013) release strategies. Survival of S1 steelhead from Winthrop NFH to Rocky Reach Dam was significantly lower than S2 steelhead in 2010 and 2011, equal in 2012 and significantly greater in 2013. Travel times from WNFH to Columbia River dams were significantly greater (i.e., migration was slower) for S1 steelhead than for S2 in 2010-2012. In 2011 and 2012 S1 fish were smaller than S2 fish at the time of release and migrant S1 fish experienced greater size selection than S2 fish. There was no size selection on S1 or S2 fish in 2013.

We sampled index sites for residual steelhead in Spring Creek and in the Methow River near WNFH on two occasions during the summers of 2010 through 2013. A greater percentage of S1 than S2 steelhead residualized in 2010 and 2011. Percentages of S1 and S2 residuals were nearly equal in 2012. Residual S1 and S2 fish were smaller than migrating fish in 2011 and 2012.

We conclude that (1) WNFH can raise S2 steelhead from locally-sourced broodstock with equivalent or better survival than S1 smolts from the co-mingled Wells broodstock, (2) survival of S1 smolts is more variable than that of S2s and is contingent on rearing practices that maximize growth and size at release, (3) the composition and characteristics of residual populations of steelhead can be affected by rearing and release practices, and (4) detections of migrating steelhead are inversely related to residualism.

The Role of Selective Fisheries in Management of UCR Hatchery Programs

Mike Tonseth & Jeff Korth

Washington Department of Fish & Wildlife

Hatchery mitigation levels for programs intended to supplement or recover natural populations often produce significantly more adults than what is needed to meet broodstock and escapement objectives for the target natural populations. Additionally, some UCR hatchery programs are specifically for harvest and are intended to be segregated, however have the potential to negatively affect non-target populations. Selective fisheries are one of several tools being implemented to address management of surplus hatchery adults.

Adult Steelhead Abundance and Distribution in the Upper Columbia River Basin

Ben Truscott , Charles Frady, and Darin Hathaway

Washington Department of Fish and Wildlife

The Washington Department of Fish and Wildlife and the Colville Confederated Tribes began a project in 2010 seeking to improve the accuracy and estimate the precision of adult steelhead run and spawning escapement estimates. The objectives of the project included estimating the abundance of natural and hatchery steelhead for each population, hereafter referred to run escapement, and the abundance that survived to the spawning grounds. In addition, estimate the abundance and distribution of steelhead that spawned outside the current sampling design. Instream PIT tag arrays located at the mouth of major rivers, as well as important spawning tributaries, were utilized to detect PIT tagged adults during their migration to spawning areas. Furthermore, temporary instream PIT tag arrays were placed at upstream limits of current spawning areas, or in reaches that were previously not surveyed. Results of two years of monitoring and future goals are presented.

Whole Watershed Restoration: Concepts of Natural Process and Assessing Impairment at Sub-Watershed Scales

Richard Vacirca

US Forest Service Okanogan-Wenatchee National Forest

In 2010, National Forests throughout the U.S. were mandated to implement the new Watershed Condition Framework (WCF) process. The goal of WCF was to identify current conditions for each 6th hydraulic code sub-watershed and use that assessment to further identify priority watersheds where focused management over a 5-10 year period could change constituent elements that impair watershed function. The result of the watershed assessment portion of WCF demonstrated that the extensive road network across the Oka-Wen NF is the primary driver impairing watershed and aquatic ecosystem function and desired conditions. Given our road network, periodic flood events only serve to further degrade those same floodplains, stream channels, water quality and aquatic habitat.

Fish Population Status and Trend Data Collection, Results, and Lessons Learned in the Wenatchee and Entiat Subbasins

Keith van den Broek, Kevin See, Chris Jordan & Michael Ward

Terraqua, Inc.

One of the many objectives of ISEMP in the Upper Columbia is to estimate summer parr abundance of ESA-listed spring Chinook and steelhead in the Wenatchee and Entiat River subbasins. In this work, we

provide estimates of status and trends at the site, HUC5 assessment unit, and population scale, and evaluate the precision and comparability of these estimates to determine the appropriateness of the data. Status and trends monitoring of Chinook and steelhead in the Wenatchee and Entiat subbasins has been conducted annually since 2004. These data have been collected under a robust generalized random tessellation stratified (GRTS) statistical design, within a strictly delineated sampling frame (land use, gradient) and a wadeable stream protocol. A variety of sampling methods have been used as the program evolved, including snorkel counts, depletion surveys, and mark-recapture experiments. Up to 25 sites are surveyed annually in each subbasin, with a combination of repeat and new sites. Design-based estimates of the annual status of parr abundance at the subbasin and assessment unit scales were compared with data from rotary screw traps and redd surveys. We estimated trends at the subbasin spatial scale for each species, and evaluated whether the data support differing trends at the assessment unit scale. The precision of the parr abundance estimates varies by species, subbasin, and temporal and spatial scale for several potential reasons. Data collected under this design and protocol in the Wenatchee and Entiat provides, as was intended, information at the population scale and for other ISEMP objectives, such as developing fish-habitat relationships.

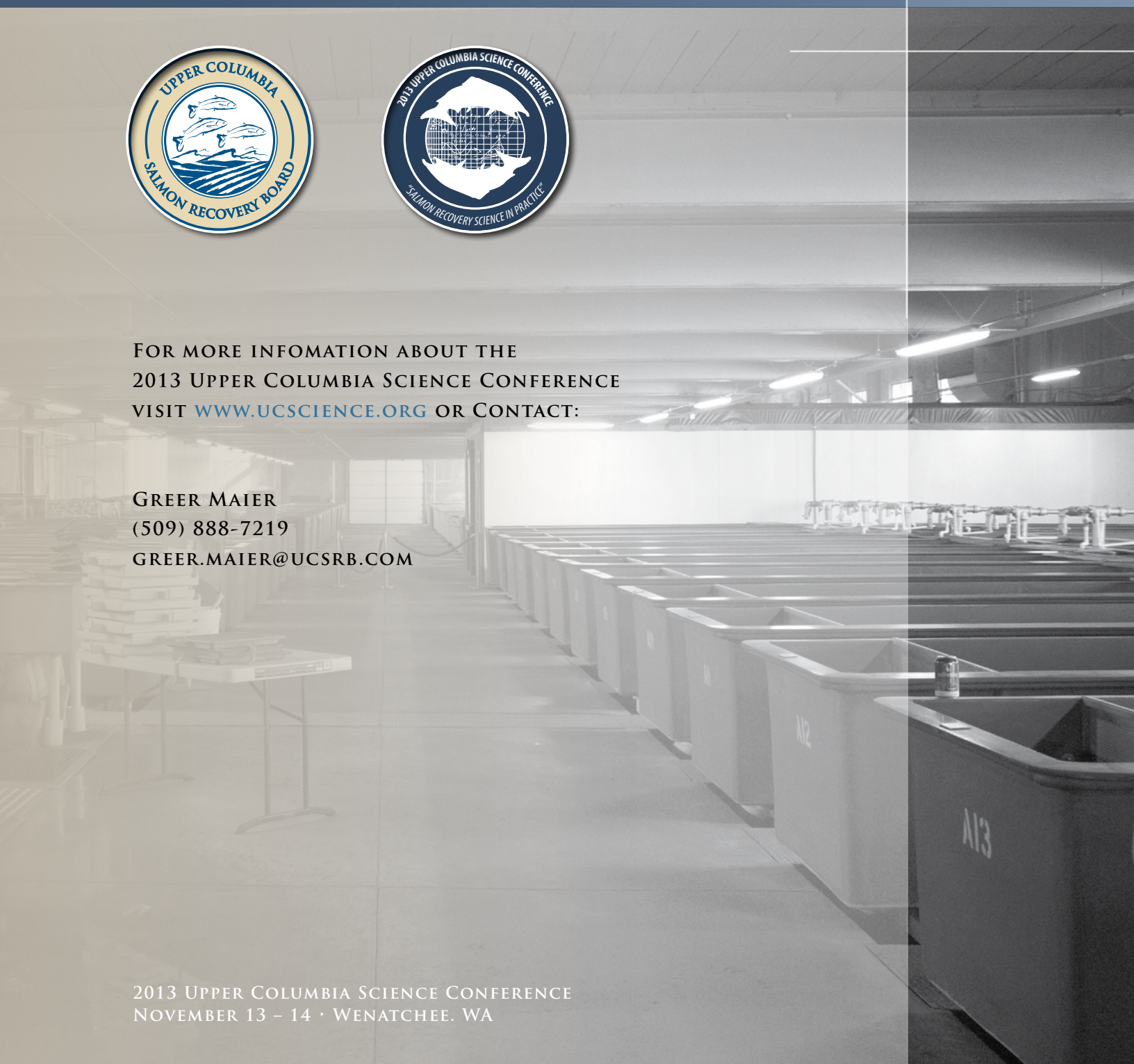
EXHIBITORS

SmithRoot • Oregon RFID

Okanogan Basin Monitoring and Evaluation Program

Upper Columbia Salmon Recovery Board • Washington Water Trust

Hosted By:
Upper Columbia Salmon Recovery Board



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