

Working to restore viable and sustainable populations of salmon, steelhead and other at-risk species through collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia Region.



January 27, 2016

Upper Columbia Science Conference Participants,

Welcome to the third Upper Columbia Science Conference; this year's theme is *Working Together to Create Our Future*. Communicating and understanding current research by project implementers, scientists, managers, and the public is essential for effective implementation and evaluation of our regional recovery efforts. This conference is an opportunity to come together to discuss the state of the science and to collectively learn how to improve the work we do.

You will hear about topics such as salmon and steelhead survival, climate change, hatchery and wild origin fish interactions, and the use of models as a tool for restoration. You will also hear from experts in the field of effective science communication.

Our hope is that this conference provides all attendees with an opportunity to learn and discuss information in a way that leads to more informed recovery projects in the future. You will hear from speakers both within and beyond our region, and we hope to provide the opportunity for ample networking and information sharing. Ultimately we hope this conference supports the development of a strong regional community of scientists, managers, and natural resource professionals.

Please join us in thanking our generous partners and sponsors who make this conference possible. We appreciate all you do to contribute to salmon recovery.

Sincerely,

A handwritten signature in black ink, appearing to read "Derek Van Marter".

Derek Van Marter
UCSRB Executive Director

A handwritten signature in black ink, appearing to read "Paul Ward".

Paul Ward
UCSRB Chair

Acknowledgements

I would like to thank the many individuals who dedicated time and expertise to making this Science Conference a success. Planning and organizing this event has been a team effort from the start and I could not have done it without the support of our amazing board of directors, steering committee and organizing committee. The quality of this event is a reflection of the quality of people we were privileged to work with. Thank you to all of you.

Sincerely,

Greer Maier, Conference Chair & Science Program Manager, UCSRB

Upper Columbia Salmon Recovery Board of Directors

Paul Ward, Chair, Yakama Nation

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Debbie West, Upper Columbia Salmon Recovery Board

Conference Overview

Wednesday, January 27, 2016

7:00 – 5:00	Registration
7:00 – 8:15	Welcome Social - coffee and light breakfast
8:15 – 8:30	Opening Remarks
8:30 – 9:00	Keynote Address – Sara LaBorde, Wild Salmon Center
9:00 – 9:30	Plenary Talk – Tom Cooney, NOAA Fisheries
9:30 – 10:15	Morning Session – Salmon and Steelhead I
10:15 – 10:45	Break and Poster Session– coffee and snacks
10:45 – 12:00	Morning Session – Salmon and Steelhead II
12:00 – 1:00	Lunch – on your own
1:00 – 1:30	Plenary Talk: Jeff Heer, University of Washington
1:30 – 2:00	Afternoon Session – Science Communication
2:00 – 2:30	Break – coffee and snacks
2:30 – 3:00	Plenary Talk – Phil Roni, Cramer Fish Sciences
3:00 – 4:30	Afternoon Session – Restoration
4:30 – 5:30	Afternoon Session – Salmon and Steelhead III
6:00 – 8:00	Evening Social Event at Pybus Market– Drinks and Appetizers

Thursday, January 28, 2016

7:00 – 12:00	Registration
7:00 – 8:00	Welcome Social – coffee and continental breakfast
8:00 – 8:30	Plenary Talk – Dan Isaak, U.S. Forest Service
8:30 – 10:00	Morning Session – Climate Change
10:00 – 10:30	Break and Poster Session – coffee and snacks
10:30 – 11:45	Morning Session – Salmon and Steelhead IV
11:45 – 12:15	Plenary Talk – Jack Stanford, University of Montana
12:15 – 1:15	Lunch – on your own
1:15 – 1:45	Plenary Talk – Gordie Reeves, U.S. Forest Service
1:45 – 2:45	Afternoon Session – Watersheds
2:45 – 4:00	Afternoon Session – Salmon and Steelhead V
4:00 – 4:15	Closing Remarks

Detailed Conference Agenda

Wednesday, January 27, 2016

- 7:00 – 5:00 Registration
- 7:30 – 8:30 Welcome Social - coffee and light breakfast
- 8:15 – 8:30 Opening Remarks
- 8:30 – 9:00 **Keynote Address – Sara LaBorde, Wild Salmon Center**
When will science save the world?

Every night, my Facebook news feed is filled with information – posts, papers, articles, videos – about what we have learned and need to do. More people than ever are “connected” and reading quips and bits. Never before has there been such a combined effort of Federal, Tribal, state, local, private and citizens focusing and investing on specific regions to make a difference. So with all this commitment, when will science save the world?

Morning Session: Salmon and Steelhead I

- 9:00 – 9:30 **Plenary Speaker – Tom Cooney, NOAA Northwest Fisheries Science Center**
Current Status of ESA Listed Upper Columbia River Spring Chinook Salmon and Steelhead

Upper Columbia Spring Chinook and Steelhead were listed under the Endangered Species Act following steep declines in abundance culminating in extremely low escapements into natural spawning areas in the early 1990’s. NOAA Fisheries conducts five year reviews of listed salmonid species, initiated by current stock status summaries compiled by the Northwest Fisheries Science Center relative to salmonid population (VSP) parameters - abundance, productivity, spatial structure and diversity.

Both total and natural origin spawning estimates of Upper Columbia Spring Chinook populations increased sharply from 1999 through 2002, followed by a period of relatively high variability with peak returns around 2001 and 2010. Natural origin escapements remain below minimum viability thresholds. Hatchery proportions in natural spawning areas remain high in the Wenatchee and Methow, reflecting ongoing directed supplementation programs. Straying into the Entiat system has decreased. Although improved, all three extant populations remain at high risk relative to recovery objectives. Efforts to develop information on habitat conditions and fish/habitat relationships are underway through life cycle modeling in the region. Future status assessments could substantially benefit from the innovative approaches being explored through the life cycle modeling initiative.

Upper Columbia Steelhead DPS populations have also increased relative to levels estimated in the years leading up to ESA listing, although three out of the four populations remain well below VSP recovery objectives. High hatchery

proportions of spawners in natural areas remains a concern. The Wenatchee River population has shown the most improvement relative to prior reviews. Initial results from a PIT tag based approach for improved estimates of abundance are promising and will be phased in for future assessments.

Short term (e.g. 5 to 10 year) patterns in abundance are strongly influenced by year to year survival fluctuations contributing to the difficulty of immediately detecting response to recovery actions using adult abundance time series.

9:30 – 9:45

Kevin See, Washington Department of Fish and Wildlife, Benjamin Truscott, Andrew Murdoch
Summary of Biological Data for Four Upper Columbia Wild Steelhead Populations Based on PIT Tag Data

Adult steelhead (*Oncorhynchus mykiss*) have been PIT tagged at Priest Rapids dam since 2011. The wealth of biological data such as sex, age and length that are collected at Priest Rapids can be joined with information about which population each fish escaped to, based on the instream PIT tag detection site escapement model, allowing the examination of biological similarities and differences between wild populations, including sex ratios, age compositions, length and length-at-age for spawn years 2011 – 2015. When broken down by spawn year and population, the percent of males ranged from 22 – 54%, but showed no consistent patterns across populations or time. The Okanogan population typically displayed the highest proportion of fish with stream age of 1 for males and females. Most fish spend two years in freshwater, and the proportion spending one year in the ocean is generally higher than two years for males, but lower for females, with some variation across populations. This dataset provides meaningful insights into life-history differences between Upper Columbia wild steelhead populations, necessary for recovery and management.

9:45 – 10:00

Ben Truscott, Washington Department of Fish and Wildlife, Andrew Murdoch, Kevin See
Novel Methodology to Estimate Population Level Steelhead Spawning Escapement

The Washington Department of Fish and Wildlife initiated research in 2010 seeking to improve the accuracy and precision of adult steelhead run and spawning escapement estimates in the Upper Columbia River Steelhead distinct population segment (DPS). The project seeks to estimate the abundance of natural and hatchery steelhead returning to each population within the DPS, and the abundance that survives to spawning, with known accuracy and precision. An instream PIT tag detection site (IPTDS) based escapement model was developed to estimate spawner escapement in major spawning streams. For stream reaches where the IPTDS model could not be used, a second model was developed to estimate escapement based on redd observer efficiency and accuracy. Spawner escapement estimates for the Wenatchee and Methow populations comprise the summation of the IPTDS and redd based escapement model estimates. In the Wenatchee, an estimated 978 (CV = 0.098) and 545 (CV = 0.178) wild and hatchery steelhead spawned in 2014. Spawner escapement in the Methow comprised 819 (CV = 0.090) and 675 (0.096) wild and hatchery fish in 2014. With the utilization of these two models, escapement estimates

approached or exceeded National Marine Fisheries Service recommendations for monitoring ESA-listed Pacific Northwest salmon and steelhead.

10:00 – 10:15 Questions/Discussion

10:15 – 10:45 Break and Poster Session– coffee and snacks

Morning Session – Salmon and Steelhead II

10:45 – 11:00 **Andrew Murdoch, Washington Department of Fish and Wildlife**, Christopher Johnson, Trenton De Boer, George Pess, Phil Roni
Reach-Scale Environmental Factors Influencing Wenatchee River Basin Spring Chinook Egg-to-Fry Survival

Population level mortality of Chinook salmon and other salmonid species is thought to be greatest during early life stages, when hatching or newly emergent fry are most susceptible to environmental factors such as temperature, flow related scour, redd superimposition, and/or the accumulation of fine sediment. Unfortunately, perhaps in-part due to difficulties associated with sampling, field estimates of survival over large spatial scales are not common for this life-stage. Such estimates however, are necessary for identification of factors most limiting to specific populations when productivity is low, and to inform recovery efforts. A cooperative project between the Washington State Department of Fish and Wildlife and NOAA Fisheries was initiated in 2014, to compare relative survival of spring Chinook salmon (*Oncorhynchus tshawytscha*) among six study reaches of the upper Wenatchee River Watershed; representing 60.2 river kilometers of Wenatchee spring Chinook spawning habitat. A total of 88 artificial redds were constructed over a two-week period at the peak of spawning activity in 2014, and the subsequent data used to compare relative survival among study reaches, while controlling for adult mating and spawn time. Mean survival ranged from 0 to 50.7 percent (mean, 25.3, SD, 20.3), and was detectably different among study reaches ($P < 0.01$). Further, results suggest significant differences in specific environmental mechanisms affecting survival among reaches (e.g. temperature, fine sediment accumulation, and scour). This study serves to expand our understanding of environmental factors affecting survival of upper Wenatchee River spring Chinook salmon. Moreover, it provides an example of applying standardized methods to identify factors limiting survival at a broad spatial scale.

11:00 – 11:15 **Tracy Bowerman, University of Idaho Dept. of Fish and Wildlife Resources**, Matthew Keefer, Chris Caudill, Lisa Crozier
Chinook Salmon Prespawn Mortality Patterns and Process in the Columbia River Basin

Prespawn mortality (PSM) occurs when adult salmon reach natal tributaries but die prior to successful reproduction. Variable, and in some instances, high (>50%) rates of PSM have been noted in spring and summer-run Chinook salmon populations, but rates have not been systematically reported, nor have proximal causes been identified. We surveyed fisheries biologists throughout the Columbia River Basin to gather information on how and where PSM was evaluated and compiled responses to critically evaluate current methods used to assess PSM. Survey results helped us gather and standardize data on PSM rates

from throughout the basin. Based on 20 years of data from 33 spring and summer Chinook populations, we evaluated the relationship between annual prespawn mortality rates and average August stream temperatures in spawning tributaries, as well as other factors, including stream discharge and spawner density.

Biologists from throughout the basin estimated annual rates of female PSM based on data from carcasses collected during the spawning season. However, specifics of data collection and reporting varied considerably among respondents, making it difficult to compare PSM rates across broad geographic areas. Standardization of methodology may be increasingly important to detect regional effects of climate change and management actions on PSM. In particular, systematic monitoring prior to the onset of spawning was identified as an important monitoring gap in many locations. Observed rates of PSM varied considerably among surveyed years and populations, and ranged from less than 1% to more than 90%. Annual PSM rates were positively related to stream water temperatures, and in some locations, PSM may also increase with fish density. Ongoing research includes evaluation of PSM relative to individual covariates (e.g., origin, size), and development of a bioenergetics model to examine how temperature exposure and energetic expenditure during migration and holding may affect PSM under current and predicted climate conditions.

11:15 – 11:30

Lance Campbell, Washington Department of Fish and Wildlife, Jamie Lamperth, Andrew Claiborne, Dan Bottom, Mara Zimmerman, Dan Rawding, Bryce Glaser, Andrew Murdoch

Life History Strategies of Selected Chinook Salmon Spawning Populations in the Columbia River, as Inferred From Otolith Microchemistry

Growing evidence in the Columbia River suggests juvenile Chinook salmon (*Oncorhynchus tshawytscha*), utilize portions of both the natal and non-natal freshwater environments as well as estuarine habitats on their juvenile migration. However a clear link between these varied life history pathways and the success of returning adults is not well understood. To test the hypothesis that non-natal rearing is important for juvenile Chinook, we recovered adult otolith samples on the spawning grounds of upper, middle and lower Columbia River tributaries. Laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) was used to analyze chemical patterns in otoliths. Otolith microchemistry was used to estimate the size and timing of juvenile outmigration for selected adult populations. Furthermore, residency within the freshwater portion of the estuary was estimated based on recoveries of SrCl marked adult otoliths from the Coweeman River.

11:30 – 11:45

Charlie Snow, Washington Department of Fish and Wildlife

Chinook Salmon Spawning Areas in the Columbia River Upstream of Wells Dam, WA

Summer-run Chinook Salmon *Oncorhynchus tshawytscha* utilized spawning habitat in the Columbia River as far upstream as British Columbia, Canada prior to the construction of Grand Coulee and Chief Joseph dams. Since construction, the upstream extent of main-stem Columbia River spawning has been documented immediately downstream of Wells Fish Hatchery in the tailrace of Wells Dam, Washington. Utilizing radio-telemetry and video monitoring equipment between 2011 and 2013, wild summer-run Chinook Salmon were

monitored throughout their migration and spawning period to investigate and document possible spawning activity in the main-stem Columbia River upstream of Wells Dam. Two small spawning areas in the Columbia River immediately downstream of Chief Joseph Dam were used consistently by wild summer-run Chinook in each year of study. A total of 70, 59, and 134 redds were identified in 2011, 2012, and 2013, respectively. Escapement to these spawning areas represented 1.7%, 1.6%, and 2.9% of the estimated total redd counts in all spawning areas upstream of Wells Dam. Redds were located in depths between 3.7 and 7 m, with spawning occurring between mid-October and late-November in each year.

11:45 – 12:00 Questions/Discussion

12:00 – 1:00 Lunch – on your own

Afternoon Session – Science Communication

1:00 – 1:30 **Plenary Speaker – Jeffrey Heer, University of Washington**
Principles of Data Visualization

The world is awash with increasing amounts of data, and we must keep afloat with our relatively constant perceptual and cognitive abilities. Visualization provides one means of combating information overload, as well-designed visual encodings can supplant cognitive calculations with direct perceptual inferences, improving comprehension and decision making. Furthermore, visual representations may help engage more diverse audiences in the process of analytic thinking. In this talk I will share some fundamental concepts for the design of effective visualizations, rooted in perceptual principles. These concepts will help you better create and evaluate visualizations in your own work.

1:30 – 1:45 **Rufus Woods, The Wenatchee World**
Tapping into the Power of Story

There are tremendous challenges but also significant opportunities to tell the story of salmon recovery in ways that build trust, a sense of community and communicate what is possible when we human beings work together.

I'll frame the conversation with a brief discussion about the media landscape that exists today, with the decline of the traditional media and the dated "problem mentality" that drives the news. I'll also talk about the changing social landscape where opinions are too often unsupported by facts and the political landscape that is hyper polarized and driven by fear and the need to find someone to blame.

Then I'll focus on ways you can creatively break through and, in an authentic and meaningful way, tell compelling stories that will encourage people to think differently. It's about bringing possibility thinking into the public space as opposed to problem thinking. Doing so effectively means using the power of story and finding those individuals who have seen the amazing work that is being done and letting them tell their story rather than you telling it for them.

1:45 – 2:00 **Jeff Ostenson, North 40 Productions**
Sharing Your Story: how to engage your audience with the right message

Film Producer, Jeff Ostenson of North 40 Productions shares his insights on how best to distill your story, package it, and to effectively share it with your audience.

2:00 – 2:30 Break – coffee and snacks

Afternoon Session: Restoration

2:30 – 3:00 **Plenary Speaker – Phil Roni, Cramer Fish Sciences**
Does Habitat Restoration Increase Fish Numbers or Simply Concentrate Fish?

Despite more than a billion dollars spent on habitat restoration annually and millions spent on monitoring and evaluation, we still find ourselves asking whether restoration really increases fish numbers. Based on the latest science, I discuss three hotly debated questions related specifically to restoration of salmon habitat including: 1) does restoration simply concentrate fish or lead to increased fish numbers; 2) does restoration lead to increased survival or increased numbers or both; and 3) are larger restoration projects more effective than smaller ones? Whether restoration concentrates fish or leads to increased abundance is a question as old as restoration itself. Despite a few studies on movement that suggest river restoration may concentrate fish, there is little evidence to support this contention in the freshwater environment. Increasing habitat complexity may actually reduce movement distances of salmonids, at least during low flow periods. However, restoration appears to have little effect on broad-scale movements to rearing or spawning habitat that occur seasonally. While there has been a considerable focus in recent years to examine whether restoration increases fish survival, very few have shown increases in survival. Rather most studies showing a positive response of salmonids to restoration have shown increases in fish numbers (capacity). It would seem intuitive that larger restoration projects would be more successful than smaller ones, though recent studies examining both physical and biological response to restoration project size, have found little relationship between restoration project size and biological response. There is evidence that the intensity of restoration (how much the habitat is improved) rather than the length or area restored is an important factor determining localized fish response to restoration. Moreover, the total amount of restoration within a basin is an important factor for producing a population level response for salmon and steelhead.

3:00 – 3:15 **Nicholas Albrecht, U.S. Fish and Wildlife Service, Tom Desgroseillier**
Utilization of Off-Channel Habitats in the Entiat River by Juvenile Salmonids

Flood-plain connectivity and off-channel habitat availability has been greatly reduced over the last century as a result of anthropogenic activities such as stream channelization. This reduction in hydrological connectivity has altered the flow of nutrients between terrestrial and aquatic ecosystems, reduced habitat complexity, and decreased the amount of rearing habitat for juvenile fish. Habitat restoration efforts in the Upper Columbia River have sought to improve and increase the amount of juvenile salmonid rearing habitat in off-channel habitats.

To assess how these habitat improvements impact juvenile salmonids, the U.S. Fish and Wildlife Service has been actively monitoring off-channel habitats within the Entiat River watershed since 2011. The objectives of this study are to examine the abundance, physical condition, survival, and residence time of juvenile salmonids in five off-channel habitats utilizing Passive Integrated Transponder (PIT) tag technology and mark-recapture methods. Results indicate that juvenile Chinook salmon utilize off-channel habitats for longer periods of time in the upper watershed sites than off-channel habitats in the lower river. Survival rates for juvenile Chinook captured in off-channel sites were also greater in the upper watershed than in the lower river. Furthermore, abundance of juvenile Chinook salmon in off-channel habitats was inversely related with seasonal hydrological connectivity of the off-channels habitats with the main stem, with the greatest densities occurring in the summer when the off-channel habitats were fully connected with the main stem and overall fish densities were the greatest. Despite abundances of juvenile Chinook salmon decreasing in the off-channel habitats from summer to winter, densities in off-channel habitats remained higher than main stem locations during all sampling periods. These findings serve to support the need for increasing hydrological connectivity with the floodplain and the creation of new off-channel habitats to help meet recovery objectives.

3:15 – 3:30

Bryon Amerson, Montana State University, Goeff Poole, Mike Lambert, Scott O'Daniel

Meacham Creek Hyporheic Restoration and Monitoring

The Meacham Creek Hyporheic Restoration Monitoring Project in the Umatilla River Basin, Umatilla County, Oregon was designed to evaluate the efficacy of a 2011 channel restoration on hyporheic and surface water hydrology and temperature. In 2011, a 2.6 km reach of Meacham Creek was reconfigured from a straight, steep wall-based channel to a more sinuous, low-gradient channel in an effort to restore its degraded hydrology. Key objectives of the project were to raise the water table, create new and more diverse subsurface flow paths, increase the rate and magnitude of groundwater-surface water exchange (e.g. hyporheic exchange), and initiate increased buffering and lagging of water temperature in the subsurface to mitigate warm surface water temperatures. The primary goal of the project was to address aquatic habitat needs for spring Chinook and summer steelhead, which use Meacham Creek for spawning and rearing. Our work combined hydraulic modeling of the floodplain aquifer with a comprehensive floodplain groundwater temperature data collection campaign. Our modeling allowed us to develop a comprehensive understanding of how hydrology and water temperature were affected by the channel plan form change due to restoration, while the data collection campaign provided empirical constraints to our model. Here we present preliminary results of our monitoring and modeling effort showcasing how water temperature, an important water quality parameter, can also be used as a tracer to track hyporheic water movement and confirm model predictions.

3:30 – 3:45

John Arterburn, Colville Confederated Tribes, Eric Doyle

Seeing the Signals – Application of Okanogan EDT Status and Trends Analysis Results

The Colville Confederated Tribes Okanogan Basin Monitoring and Evaluation Program (OBMEP) has completed the second in a series of habitat status and trends analyses for Chinook salmon and steelhead in the Okanogan River system using the Ecosystem Diagnosis & Treatment Model (EDT) platform. The Okanogan EDT model translates quantitative habitat data collected during each OBMEP 4-year monitoring cycle into useful information that can be used to describe changes in habitat performance over time, identify and prioritize restoration actions, and direct future monitoring efforts. We will review EDT model results for high-priority tributary watersheds in the Okanogan subbasin to demonstrate how this integrated habitat monitoring and modeling platform is successfully detecting and describing habitat trends and validates previously identified restoration priorities.

3:45 – 4:00

John Crandall, Methow Salmon Recovery Foundation

Habitat Restoration for Pacific Lamprey in the Upper Columbia

Pacific lamprey populations in the Upper Columbia are in steep decline. Habitat restoration can be used to improve habitat quality to benefit lamprey, yet due to their unique life history and habitat requirements, special attention must be given when planning projects. Implementation of salmonid-based habitat restoration projects provides a valuable opportunity to improve habitat conditions for Pacific lamprey. The Pacific Lamprey Habitat Restoration Guide was developed to assist managers and habitat restoration practitioners with information that can be used to develop projects that incorporate the habitat needs of lamprey.

4:00 – 4:15

Karl Polivka, PNW Research Station USDA Forest Service, Shannon Claeson

Individual Growth and Habitat Affinity: Robust Response Variables for Evaluating Fish Response to In-Stream Habitat Restoration

Multi-year data from restored segments in two major geomorphic reaches of the Entiat River indicate increased occupancy by fish in pools formed by restoration structures. However, the spatial extent of this increased occupancy by juvenile Steelhead Trout and Chinook Salmon within a given river segment during the summer rearing months is very localized and temporally variable. Average fish density in the unrestored portions of a restored segment declines rapidly to near zero within as few as 10 m away from a structure. Thus, spacing of structures warrants consideration in restoration design. In light of these findings, we sought a more robust indicator of a positive response to restoration. Behavioral habitat affinity might give an indication about the quality of a habitat if individuals are observed to remain in a habitat for more than a single sampling event. Life history traits such as individual growth can indicate the fitness-correlated benefits obtained from remaining in a particular habitat. In multiple years of mark-recapture studies, we have observed higher affinity in both species for pools created by restoration structures, but affinity depended on individual condition of fish. Chinook recaptures were poor in unrestored habitat; thus, we could only compare individual growth across habitats for steelhead, which showed higher growth in restored habitat in 2009-10 and 2013, but not in 2012. This growth benefit was detected even in a year when it did not appear that

structures had increased occupancy. Finally, we present the development of a growth model that can be used to demonstrate the benefit of restoration to growth of Chinook salmon, even when low recapture rates limit comparisons among habitat types. Quantification of a growth benefit provided by restoration can inform life cycle models that incorporate terms such as parr-smolt survivorship, which is strongly correlated with growth.

4:15 – 4:30 Questions/Discussion

Afternoon Session: Salmon and Steelhead III

4:30 – 4:45 **Andrew Murdoch, Washington Department of Fish and Wildlife, Mike Ford**
The Relative Reproductive Success of Hatchery and Natural Steelhead in the Wenatchee Basin

Hatchery steelhead have been released into the Wenatchee Basin for over 100 years. The broodstock origin and life stage at release has varied greatly over time. In 1998, after the Wenatchee population, including hatchery fish was listed under the ESA the broodstock source reverted back to fish returning to the Wenatchee River rather than Wells Dam. The goal of the new hatchery program was to assist in the recovery of the natural population rather than simply providing harvest opportunity. Hatchery programs have been shown to pose both demographic and genetic risks to the natural produced component of the population. Given the extensive and diverse history of steelhead artificial propagation in the Wenatchee Basin, a study was conducted between 2007 and 2011(4 brood years) to compare the contemporary levels of productivity (number of juveniles/spawner) of natural and hatchery steelhead in the Wenatchee Basin. In total, 3,806 hatchery and 2,390 natural adult steelhead were trapped, sampled and released upstream of Tumwater Dam. Genotypes from these potential spawners were used to assign parents to the 7,901 juvenile steelhead that were collected between 2009 and 2013. Juveniles were assigned a single parent (36%), two parents (54%), or no parents (10%). Of the single-parent assignments, most (59%) were only assigned a mother. Based on these assignments, the average number of juveniles produced by naturally spawning hatchery females and males was only 82% and 58% of their wild counterparts, respectively. The origin of the hatchery parents, size, age, and run timing were all found to significantly influence the relative reproductive success of hatchery fish.

4:45 – 5:00 **Ben Goodman, Washington Department of Fish and Wildlife, Todd Seamons, Charlie Snow, Andrew Murdoch**
Relative Reproductive Success of Hatchery and Wild Steelhead in the Twisp River

Hatchery supplementation is used to conserve and restore wild steelhead *Oncorhynchus mykiss* populations in the Columbia River basin; however, the effects of hatchery programs on wild populations are unclear. Recent studies have shown that hatchery spawning and rearing may cause a decrease in the relative reproductive success (RRS) of hatchery fish spawning in the natural environment as compared to wild fish. We initiated a study to determine the RRS of hatchery and wild summer steelhead spawning in the Twisp River, Washington, using a DNA-based pedigree approach. From 2009 to 2015, 1,870 adult steelhead were sampled for DNA at the Twisp River weir; samples were

genotyped at 192 single nucleotide polymorphism loci (SNPs). Run timing, spawn timing, spawning distribution, fat content, age composition, length at age, redd dimensions, and spawning habitat of adult steelhead were estimated to determine whether differences exist between hatchery and wild fish that may explain differences observed in RRS. Steelhead RRS was evaluated to age 1, age 2, and smolt stages captured with angling, netting, electrofishing, and a rotary screw trap from 2010 to 2013. Genotyping and parentage analyses were conducted on 6,242 juveniles in total. Juveniles were assigned a single parent (36%), two parents (35%), or no parents (29%). Of the single-parent assignments, most (81%) were assigned a mother. Based on juvenile assignments, RRS of naturally spawning hatchery mothers and fathers was 63% and 51% that of their wild counterparts, respectively.

5:00 – 5:15

Michael Hughes, Washington Department of Fish and Wildlife, Andrew Murdoch
Discrimination of Spawning Site Selection and Redd Morphology Within and Among Redds Constructed by Hatchery- and Natural-Origin Spring Chinook

Spawning is a critical stage in the life history of salmonids. Relative reproductive success (RRS) among spring Chinook in the Chiwawa River, Washington indicate that hatchery-origin fish have a lower mean fitness than their wild counterparts. Moreover, fish that spawn lower in the watershed (plane-bed channel type) exhibit lower RRS than those spawning higher (pool-riffle channel type). Data was collected from 2004 to 2013 during annual redd surveys. Origin of females associated with redds were determined via instream PIT tag detections. From each redd, a suite of metrics were measured to characterize the spawning location (e.g., velocity, depths, and channel location) and redd morphology (e.g., redd size and relief). An initial series of pairwise descriptive discriminant analyses (DA) were conducted to describe differences in site selection and redd morphology among hatchery- and natural-origin females for each habitat within pool-riffle channel type. No comparisons among origins were made for within plane-bed channels due to sample size limitations. A second series of DA's were conducted to examine differences between redds constructed by hatchery-origin females within pool-riffle and plane-bed channel types by habitat types. Results indicated that redds created by hatchery- and natural-origin females in pool riffle channels were constructed similarly with the exception of redds in glide habitats. Conversely, the DA results indicated greater ability to discriminate between hatchery-origin redds in pool-riffle and plane-bed channel types for both site selection and redd morphology variables. The differences observed among redd characteristics, specifically, among redds constructed by hatchery-origin females between channel types, provides additional explanations toward reduced reproductive fitness, specifically, those differences associated with spawning location.

5:15 – 5:30

Questions/Discussion

6:00 – 8:00

Evening Social Event – Complimentary Drinks and Appetizers

Pybus Public Market, 3 N Worthen St, Wenatchee

Thursday, January 28, 2016

7:00 – 12:00 Registration

7:00 – 8:00 Welcome Social – coffee and light breakfast

Morning Session: Climate Change

8:00 – 8:30 **Plenary Speaker – Dan Isaak, U.S. Forest Service**

Identifying, Protecting, and Enhancing Climate Refugia for Salmonids as a Means of Strategic Conservation Planning

Climate change in the PNW has been gradually warming rivers and reducing snowpacks and runoff for several decades. Those trends are likely to continue for the next several decades and maybe longer depending on the evolution of human energy economies and future greenhouse gas emissions. Climate cycles associated with the Pacific Decadal Oscillation and El Niño will periodically dampen or exacerbate environmental trends, but populations of salmon and trout that require cold water to survive will be subject to increasing amounts of thermal stress for the foreseeable future. Many populations of resident salmonid species like bull trout or cutthroat trout that live in steep, cold headwater streams can persist simply by shifting their distributions towards higher elevation refuge habitats. But adaptation is more challenging for populations of anadromous fish that migrate through large rivers during warm periods. Warming trends of those rivers are difficult or impossible to stop so shifts in migration timing by natural and hatchery selection are needed. Near spawning grounds, habitat restoration strategies that maximize riparian vegetation shade or instream flows may be beneficial. Facilitating access of anadromous fish to cooler river habitats that are blocked by dams or natural barriers could also be a viable option in a few instances. High-resolution stream temperature and flow scenarios are available to predict where the most resilient habitats are likely to persist, which could provide a strategic basis for long-term conservation investing but uncertainties about the amount of future climate change will loom for decades. Biocomplexity and environmental heterogeneity in the PNW ensure that many salmonid species will continue to persist in the region's rivers and streams but some populations of some species are likely to experience long-term declines. Continuing and enhancing the culture of adaptive management and collaborative spirit that permeates the region's fisheries community will be needed to navigate the challenges ahead.

8:30 – 8:45 **Ingrid Tohver, University of Washington Climate Impacts Group, Nathan Mantua, Alan Hamlet**
Impacts of Climate Change to the Columbia Basin and Implications for Recovery Efforts of Aquatic Habitats

The hydrologic responses of the Columbia Basin to climate change have implications for recovery efforts of aquatic habitat. Models indicate that the Basin and its tributaries will undergo increases in water temperatures as the climate warms and changes in peak and low flow regimes. These shifts will have negative effects on salmon habitat in the Basin and should be incorporated in recovery efforts to maintain suitable aquatic conditions for salmon survival.

8:45 – 9:00

Lisa Crozier, NWFSC – NOAA Fisheries, Benjamin Sandford, Elene Dorfmeier
Impacts of Climate Change on Upper Columbia River Chinook Salmon

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages. I will review the current state of knowledge on life stage-specific impacts for Columbia River spring Chinook salmon. I will present preliminary qualitative results from NOAA's West Coast Salmon Climate Vulnerability Assessment and quantitative results from recent life cycle modeling and upstream migration analyses. Finally, I will discuss how anthropogenic factors, i.e., habitat modification/restoration, hatcheries, and fisheries interact with climate drivers to shape cumulative population responses to climate change.

9:00 – 9:15

Jonathan Armstrong, Oregon State University
Beyond Refugia: Fish and Wildlife Exploit Thermal Heterogeneity Not Only to Survive, but Also to Thrive

At the southern extent of their range, salmonids and other fishes often rely on coldwater refugia—patches of habitat that remain physiologically suitable during periods of warm weather or low flows. Much less is known about the ecological significance of thermal heterogeneity at higher latitudes, where species are less likely to experience heat stress and more likely to be limited by the physiological constraints of cold water. Here I review a series of recent case studies that demonstrate how salmonids in Alaska actively exploit thermal heterogeneity and strongly benefit from the complementary effects of warm and cold habitats, via a variety of ecological mechanisms. Further, I show how the shifting habitat mosaic of intact floodplains can buffer the growth potential of fish from strong inter-annual variation in temperature and precipitation. While many studies attempt to predict the biological responses of fishes to climate change, more work is needed to understand how habitat features mediate this response and contribute to the resilience of freshwater ecosystems

9:15 – 9:30

Treva Coe, Nooksack Tribe
Nooksack Climate Adaption

The South Fork Nooksack River Climate Change Project in the South Fork Nooksack River, Whatcom County, Washington, was developed as a pilot project to consider how projected climate change impacts could be incorporated into the South Fork Temperature Total Maximum Daily Load (TMDL) Program and inform adaptation of the WRIA 1 (Nooksack) Salmon Recovery Plan. Past and ongoing land uses have severely degraded habitat conditions in the South Fork Nooksack River, which lacks large wood and deep pools and is 303(d)-listed for low instream flows and temperature. Effective salmon recovery into the future must consider the cumulative impacts of both land use and climate change. Two components comprised the South Fork Climate Change pilot project: (1) a quantitative assessment that modeled stream temperatures under various future climate and restoration scenarios; and (2) a qualitative assessment that evaluated potential impacts of climate change in the South Fork to Chinook, steelhead, bull trout and other salmonid populations and identified and prioritized restoration actions to address those impacts. QUAL2Kw temperature modeling indicates that maximum daily temperatures in the South Fork during critical conditions (7Q10 flows, 90% percentile air temperature) could increase by

3.4-6 °C by 2080, depending on future emissions scenarios, but that restoration of natural channel and riparian conditions could mitigate that increase. We present results of our scenario modeling and recommendations for salmon recovery adaptation, as well as lessons learned and potential applicability to the Upper Columbia basin.

9:30 – 9:45

Ruth Howell, NOAA Northwest Fisheries Science Center

Keep the Returns Coming: Communicating about Salmon When it Has All Been Said

Salmon touch thousands of communities in their distribution from Japan to California, from white caps to snow caps, and from time immemorial to modern day. They have complex and diverse life histories and bestow valuable, and sometimes conflicting, benefits to equally diverse societal groups. Add to this the increasingly sophisticated and specialized scientific techniques and management strategies, and it's easy to see how communicating salmon recovery management and science is about as hard as swimming 900 miles upstream. NOAA's Northwest Fisheries Science Center has studied and communicated information about salmon populations for over 40 years. Recent collaborations between Center scientists, NOAA communicators, and community partners have resulted in new and creative methods to impart emerging ideas and knowledge surrounding salmon recovery to targeted audiences, and designed to achieve specific communication goals. This presentation will demonstrate practical science communications tools and techniques through examples of salmon recovery communications products and campaigns delivered by NOAA Fisheries West Coast and its partners.

9:45 – 10:00

Questions/Discussion

10:00 – 10:30

Break and Poster Session– coffee and snacks

Morning Session: Salmon and Steelhead IV

10:30 – 10:45

James White, Upper Columbia Salmon Recovery Board, Derek Van Marter

Parameterizing Your Policy Decision Maker

Communication of scientific information in general, but communication to policy makers specifically, has been a focus across all the fields of science in recent years. Policy decision makers have a number of tools available to help them make the best possible decisions, even when reliable scientific information is not available. These tools are most useful, and science is most successful, when information is provided in the appropriate context and format compatible with the tools of public policy available to decision makers. In this way, providing information for consumption in a policy decision making context is very similar to providing information to be consumed by models – there are specific formats, contexts, and characterizations that will be more successful than others, and there are some ways to express information that will not work for either model or decision maker. In this talk, we will describe the policy decision making process and several of the most important tools available to decision makers, as well as the types and format of information that is most useful. We will also offer tips and recommendations for ways to display scientific information so that it can most easily be acted on by an educated, but not expert, audience.

10:45 – 11:00

Catherine Willard, Chelan County Public Utility District, Alene Underwood, Greg Mackey, Tom Kahler, Peter Graf, Todd N. Pearsons
Chelan, Douglas and Grant County Public Utility Districts' Hatchery Compensation Programs in the Upper Columbia Basin and Their Role in Supporting Recovery of ESA Listed Fish

Chelan, Douglas, and Grant County Public Utility Districts implement hatchery compensation programs as part of licensing agreements related to the operation of their hydropower projects located in the Upper Columbia Basin. For ESA listed fish, the goal of the hatchery programs are to “Support the recovery of ESA-listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.” Ongoing efforts to achieve this goal have included operating the hatcheries to improve survival, improve homing, and decrease undesirable genetic and ecological effects. This has been accomplished through hatchery facility improvements, early implementation of Hatchery Scientific Review Group (HSRG) recommendations in 2009 as well as new hatchery operating permits that attempt to manage for these influences. Additionally, fisheries co-managers recently began implementing adult management activities to achieve proportion of natural influence (PNI) targets set forth in hatchery permits. Extensive monitoring and evaluation of the hatchery programs and target populations provide critical status-and-trend data to the recovery community at large, and have allowed the program managers to adaptively manage these programs to support the recovery of ESA-listed species.

11:00 – 11:15

Christopher Tatara, NOAA Fisheries, Northwest Fisheries Science Center, Matt Cooper, Bill Gale, Chris Pasley, Penny Swanson, Don Larsen, Jon Dickey, Mollie Middleton, Barry Berejikian
A Two-year Smolt Program for Steelhead Enables Transition to Using Locally-derived Natural Broodstock

Steelhead hatcheries in areas with threatened or endangered natural populations are starting to use locally-sourced broodstock to minimize potential negative genetic effects of artificial propagation and to assist in recovery efforts. However, the combination of natural broodstock spawn timing and cold hatchery water temperatures precludes production of yearling smolts for some steelhead supplementation programs. We compared the performance (survival, migration, maturation, and residualism) of yearling smolts (S1) from non-local broodstock, and two-year smolts (S2) from local broodstock released from the Winthrop National Fish Hatchery over six release years. Apparent survival of S2 smolts was greater or equal to S1 survival in all 6 years and related to body size. Outmigration travel times were faster for S2 steelhead in all years. The majority (75-97%) of S1 and S2 males were immature; however, in two release years there was a significantly higher proportion of S2 males that either matured or initiated maturation. Residualism was similar in both programs and related to average body size at release. Fifteen years of hatchery records show S1 steelhead are smaller and more variable in size than S2 steelhead at release, suggesting an S1 program produces smaller smolts with lower survival, slower travel times, and higher residualism than an S2 program. The S2 program may reduce some genetic and ecological risks compared to S1 smolt rearing using non-local broodstock.

11:15 – 11:30

Charles Frady, Washington Department of Fish and Wildlife, McLain S. Johnson, Michael A. Humling, Nathan B. Dietrich
Regulated Escapement: Adult Management Activities in the Methow and Wenatchee Rivers

Hatchery mitigation programs seek to maximize production and adult returns while incorporating hatchery reform recommendations. Since the implementation of hatchery mitigation programs in the Methow and Wenatchee River Sub-basins, many anadromous salmonids that return to spawn are of hatchery-origin (>80% in most years). In an adaptive management framework, efforts to reduce the proportion of hatchery-origin spawners (pHOS) have been implemented for steelhead *Oncorhynchus mykiss* and spring Chinook Salmon *Oncorhynchus tshawytscha*. Using multiple trapping facilities in the Methow Sub-basin and the Tumwater Dam fish ladder in the Wenatchee Sub-basin as capture tools, adult steelhead and spring Chinook Salmon have been removed in accordance with escapement goals developed by co-managers and the ESA permitting process. In the Methow Sub-basin, hatchery-origin spring Chinook Salmon were collected primarily at the Winthrop NFH hatchery ladder while hatchery-origin steelhead were removed at the Twisp River weir. Since 2010, an average of 3,119 spring Chinook Salmon and 89 steelhead were removed annually at these locations. Since 2010, between 218 and 1,236 adult hatchery-origin steelhead were removed annually at Tumwater Dam. A total of 296 and 1,146 adult hatchery-origin spring Chinook Salmon were removed at Tumwater Dam in 2013 and 2014, respectively. These activities have lowered pHOS for spring Chinook Salmon in the Methow Sub-basin and steelhead above Tumwater Dam by 50% or more in some years. Adult management activities in the Methow and Wenatchee Sub-basins are providing valuable insight towards understanding the ecological effects (e.g. density dependence) and genetic impacts (e.g. reproductive success) of excess hatchery-origin fish on the spawning grounds.

11:30 – 11:45

Questions/Discussion

11:45 – 12:15

Plenary Speaker – Jack Stanford, University of Montana
The Shifting Habitat Mosaic of River Ecosystems: Fundamental Process for Salmon Recovery

In this presentation I will examine river ecosystems in a trophic-dynamic habitat context and as governed by the laws of thermodynamics and evolution. I will present a general typology of floodplain structures or elements as a basis for habitat delineation. I argue that while the elements that define riverine habitats tend to persist in natural river systems (and are constrained or eliminated by human alteration), the distribution of the habitat patches (mosaics) changes spatially over time due to primary drivers, particularly flooding, channel avulsion, cut and fill alluviation (erosion and deposition of fine and coarse sediments), deposition of wood recruitment and regeneration of riparian vegetation. I and others refer to this phenomenon the shifting habitat mosaic (SHM) and I argue that it is a fundamental process attribute of river ecosystems. I will review an array of contemporary theories about river ecosystem structure and function are substantially unified by thinking of river ecosystems as a continuum of 3-dimensional shifting habitat mosaics from headwaters to the ocean. I will provide a number of examples of how the SHM plays out in salmon rivers from different biomes. I focus on the Flathead River in northwestern Montana where the biophysical interactions of the SHM were originally observed and documented. I

will compare and contrast the Flathead with a wide array of studies by my group on the Kol and Utkholok Rivers in Kamchatka, the Kwithluk River in Alaska and the Skeena River in British Columbia in context of a robust conceptual foundation for protection and restoration of Pacific Rim salmon rivers.

12:15 – 1:15 Lunch – on your own

General Session: Watersheds

1:15 – 1:45 **Plenary Speaker – Gordie Reeves, PNW Research Station U.S. Forest Service**
Thinking Local to Meet the Challenges of the Future

Native fish in the Pacific Northwest face an uncertain future because of challenges from the continuing pressure of a suite of stressors and the increasing potential implications of climate change. The effects of these factors will vary wildly within a stream network, and on the ecological processes that influence the suitability and productivity of the aquatic ecosystem. This local variation and consequences to ecological processes are seldom recognized in the development and implementation of restoration, conservation, and management plans and have likely limited the success of these efforts. Moving forward, we need to examine and adjust fundamental assumptions we have about aquatic ecosystems and how they operate in space and time to use new analytical tools to understand local variation of the effects of existing and future stressors to develop restoration and conservation actions. Doing these now is critical to successfully manage, restore and conserve the ecosystems and populations of these fish and other aquatic and riparian-dependent organisms as we move into a likely novel future.

1:45 – 2:00 **Robert Warren, Bonneville Environmental Foundation, Todd Reeve**
Building Resilient Locally-Driven Watershed Stewardship Initiatives – a Funder’s Perspective on the Future

Since 2003, the Bonneville Environmental Foundation’s Model Watershed Program has partnered with a diverse array of watershed restoration initiatives in the Pacific Northwest and Northern Rocky Mountain regions. Most of these partnerships were formalized with 10-year agreements to provide funding and technical support. The 10-year approach was designed to overcome shortcomings of the prevailing project-focused funding model by integrating science into restoration planning and implementation, encouraging meaningful community engagement, and providing a framework for evaluation, adaptation, and accountability.

Our experience has underscored the reality that, even under ideal circumstances (high organizational capacity and sustained funding) it will take 50-100 years to implement actions necessary to achieve stated restoration goals. This persistent issue raises three critical questions: How can the capacity of an initiative be sustained over multiple decades? What is the nature and degree of change expected in social and ecological systems over 50-100 year timescales? What implications does expected change have on the validity of restoration goals? While most watershed restoration initiatives conceptually recognize the multi-decade nature of the work, few integrate that realization into their goals and strategies.

Given this and other challenges, we conclude that our focus should be on creating the following conditions: 1) Resilient and adaptable watershed-scale partnerships with skills to collaboratively plan, implement, and evaluate watershed restoration strategies; 2) a broader set of goals that reflect the diversity of social values to ensure the work is relevant to a sufficiently representative cross-section of society; 3) the integration of projected future conditions of ecological and social systems into the process of defining long-term goals and strategies; and 4) an exploration and openness to the potential values that novel or hybrid ecosystems can offer society – and integrating strategies to steward them in concert with strategies focused on protecting or restoring natural or historic conditions.

2:00 – 2:15

Mark Wigmosta, Pacific Northwest National Laboratory/University of Washington,
Zhuoran Duan, Andre Coleman, Richard Skaggs

Potential Impacts of Forest Restoration on Snowmelt and Streamflow in the North-Central Cascades

Management of forest lands in the Upper Columbia River basin is necessary to ensure the sustainability of natural ecosystems and enhance protection and recovery of fish and wildlife populations. By 2030, summertime surface water demand is expected to significantly exceed supply in most years in many Upper Columbia tributaries; in some years, a portion of these tributaries will exceed supply even outside the summer months. Forest restoration (i.e., timber harvest, prescribed burning, thinning), designed to provide resilience to catastrophic fire, and achieve ecological objectives has been shown to subsequently increase snow accumulation and total runoff volume. Targeted forest restoration actions have the potential to help increase late season flows, while possibly reducing peak flows during the fall and winter to better meet salmonid habitat requirements.

We used the Distributed Hydrology Soil Vegetation Model (DHSVM) to predict with high spatial detail (90 m) the hydrologic changes associated with realistic forest restoration scenarios prescribed within snow-dominated watersheds of the Wenatchee, Entiat, Methow, and Okanogan subbasins under current and future climate conditions. Model results suggest 1) forest restoration will increase peak snow water equivalent and annual water yield under both current and future climate conditions, consistent with published paired watershed studies; 2) the impact of forest restoration on the timing of snowmelt and streamflow varies from year to year and is highly dependent on local meteorological conditions and particular forest restoration scenarios; 3) future climate conditions will generally increase late fall and winter flows and decrease flow during the summer and early fall relative to current climate conditions; and 4) some forest restoration scenarios reduced the impact of future climate conditions on streamflow.

2:15 – 2:30

Michael Young, Forest Service Rocky Mountain Research Station

The Rapid, Range-Wide Inventory of Bull Trout: a Crowd-Sourced, eDNA-Based Approach with Application to Many Aquatic Species

Cold-water salmonids in the northwestern U.S. have declined in many locations from an array of factors, including climate change. To address the need for reliable information about habitats that are suitable now and might be in the future, we developed the Climate Shield model that makes accurate (78–85%) and spatially explicit predictions about natal habitat for bull trout and cutthroat

trout and identifies likely future habitats. This model identified over 5,000 potential natal habitats for bull trout, but thousands of these have rarely or never been sampled. To address this information gap, we developed an environmental DNA (eDNA) sampling method that provides precise, robust information about the presence of bull trout (and other species) that can be collected quickly and at low cost across a species' range. The method has better detection efficiency than electrofishing, costs less, and takes less time; a single person can inventory an entire 6th-code watershed in one day. Initial studies were aimed at precisely delineating the distribution of bull trout within select watersheds, as well as confirming their absence from potential habitats and discovering previously unknown populations. We are now using eDNA surveys to inventory occupied bull trout habitat throughout 4th-code river basins across the interior Columbia River basin. Those inventories will include basins in Oregon and Washington beginning in 2016.

2:30 – 2:45 Questions/Discussion

General Session: Salmon and Steelhead V

2:45 – 3:00 **Tracy Hillman, BioAnalysts, Inc.**
Carrying Capacity: What Is It and Why Is It Important?

Understanding carrying capacity and density dependence are important for managing fish populations. Carrying capacity is generally defined as the number or biomass of individuals the resources of a given area can support through the most unfavorable period of the year. Populations that are regulated by compensatory density dependence show negative relationships between population size and population growth rates. As population size approaches its carrying capacity, population growth rates decline. Measuring or estimating carrying capacity for a given population can be challenging. Fortunately, there are several different methods that can be used to estimate carrying capacity. Commonly used methods include time series modeling, stock-recruitment modeling, and habitat modeling. In this study, I examine the use of stock-recruitment modeling and habitat modeling to estimate carrying capacities for juvenile spring Chinook salmon within the Chiwawa River basin, a tributary to the Wenatchee River, Washington. Based on 23 years of spawning escapement and juvenile abundance data, stock-recruitment functions were successfully fit to both parr abundance and smolt abundance data. Interestingly, the hockey stick model best explained the relationship between spawning escapement and parr abundance, while the Ricker model best explained the relationship between spawning escapement and smolt abundance. Parr results were then compared to capacity estimates generated by an independent research team using quantile regression forest models. The habitat model, which was developed and parameterized using data collected throughout the Columbia River basin, provided nearly identical results to those generated using stock-recruitment models. It is encouraging that both the density paradigm and the mechanistic paradigm provide complementary results. These results can be used by managers to set escapement and harvest levels, inform supplementation programs, guide restoration actions, and populate and parameterize life-cycle models that predict effects of different recovery and climate change scenarios.

3:00 – 3:15

Michael Beakes, NOAA Fisheries

A Geomorphic Approach to Quantifying Salmon Habitat Capacity: How this Works in the Wenatchee River

The conservation and restoration of freshwater habitat is essential for effective management of Pacific salmon. Improving our understanding of fish-habitat relationships will facilitate the identification of valuable and degraded freshwater habitats. Here we used a habitat classification scheme grounded in fluvial geomorphology to quantify salmon habitat capacity in the Wenatchee River watershed. We coupled this classification scheme with historical and contemporary datasets to estimate the potential and current availability of salmon habitat throughout the watershed. We linked habitat availability to observed juvenile salmon habitat use, which allowed us to directly translate habitat area into fish abundance. Our aim was to locate where habitat loss has occurred in the watershed and translate habitat loss, and potential restoration actions, into changes in juvenile salmon production capacity. We found capacity estimates derived from our habitat classification scheme and a classic Beverton-Holt stock recruit model differed by less than 8%, which was statistically insignificant and suggested that our approach for estimating salmon capacity was fairly accurate. We found the difference in current and potential salmon habitat capacity throughout the Wenatchee watershed was spatially variable. For example, we estimated that juvenile Chinook production capacity in Wenatchee River tributaries has been reduced by approximately 10% due to lost pool habitat, and reduced by approximately 15% in the Wenatchee River main stem primarily due to lost side-channel habitat. In contrast, some areas of the Wenatchee watershed like the Chiwawa River remain fairly intact. Our results indicate that restoration actions focused on reconnecting habitats (e.g., reconnecting floodplains, barrier removal) have a proportionally greater impact on improving juvenile salmon production capacity compared to restoration actions focused on habitat transformations (e.g., pool manufacturing). In total, this study expands a framework for identifying mechanistic linkages of habitat loss while providing robust estimates of habitat availability and salmon production capacity at spatial scales relevant to salmon populations and fisheries management.

3:15 – 3:30

Jeremy Cram, Washington Department of Fish and Wildlife, Andrew Murdoch
Overwinter Distribution and Habitat Utilization of Downstream Rearing Spring Chinook Salmon in the Wenatchee River

Juvenile spring Chinook salmon are known to migrate from their natal tributaries into mainstem rivers before their first winter. The proportion of total migrants that exhibit this life history strategy, as opposed to overwintering in their natal tributaries, varies among streams and escapement levels. The implications of overwinter survival within the freshwater environment are important to understand as recovery and restoration practitioners working with ESA-listed species. We mapped edge habitat throughout the mainstem Wenatchee River and conducted mobile PIT-detection surveys to gather spatially explicit information of fish distribution and habitat associations in late fall and late winter. This presentation will summarize an ongoing project intended to identify the overwinter habitat preferences of PIT-tagged spring Chinook salmon in the Wenatchee River.

3:30 – 3:45 **Shubha Pandit, Terraqua Inc.**, Tom Desgroseillier, Stephen Fortney, Keith van den Broek, Pamela Nelle, Michael Ward
Outmigration Patterns of Spring Chinook in the Entiat River, Columbia River Basin: Are they Driven by Habitat?

Outmigration patterns of anadromous salmonids vary by location and species. Little is known about the factors governing migration patterns; here we hypothesize that the probability of a fish moving is affected by the habitat quality in the river segment in which they were initially PIT tagged. We tested this hypothesis using 4 years of data (2010-2013) from PIT-tagged spring Chinook salmon in the Entiat River, Washington, in a multistate capture-recapture model. We estimated outmigration probabilities across three geomorphically distinct valley segments within the lower mainstem of the Entiat River and the lower Mad River (tributary to the Entiat River). Spring Chinook outmigrate from late summer through the following spring, and outmigration patterns vary by tagging location. Here we present results showing the relative influence of habitat quality on observed patterns of spring Chinook outmigration.

3:45 – 4:00 Questions/Discussion

4:00 – 4:15 Closing Remarks

Poster Session

Posters will be on display in the lobby throughout the conference and poster sessions will be held during the morning breaks. Posters are listed alphabetically by first author's last name.

Matthew Fuller – The Evergreen State College

Light on the Corridor: Coal Dust Deposition in Aquatic Environments along a Proposed Coal Transport Route in Washington.

Though plans for several proposed coal export facilities in Washington State have fallen through, the state has still seen an increase in the amount of coal being transported along our railways over the last several years. If constructed, the proposed Cherry Point coal terminal in Whatcom County would be the largest coal export facility in North America and, by industry estimates, add nine coal trains a day traveling throughout the state along many rivers and protected waterways. Each of these trains would have an estimated 125-150 cars and, according to research from BNSF, each fully-loaded car could lose between 500lbs to 1 ton of fugitive coal along a route that starts in the Powder River Basin of Montana and Wyoming and follows the Columbia River to Western Washington before turning North through the Puget Sound to the terminal in Whatcom County.

In addition to carbon, unburnt coal contains a variety of inorganic materials that affect its behavior in and around water. It can be a significant source of acidity, salinity, trace metals, polycyclic aromatic hydrocarbons (PAHs) and radionuclides and have a variety of impacts on affected ecosystems. Many of these effects on aquatic and marine plants and fauna are well-documented and can fall into categories of being biological or chemical, though research also shows mutagenic and cellular effects, as well. This presentation will take a look at the potential and researched effects that fugitive coal dust could have on such plants and species in the aquatic and marine waters along the proposed coal transport route here in Washington.

Sarah Heerhartz – Hood Canal Salmon Enhancement Group, Joseph Anderson, Mendy Harlow

Habitat Restoration in the Hood Canal Intensively Monitored Watersheds: Linking Monitoring, Research and Planning

Hood Canal Intensively Monitored Watersheds (IMW), Stavis, Seabeck, Little Anderson, and Big Beef creeks, support coho, summer and fall chum, steelhead and cutthroat trout. Major threats to salmon habitat in these watersheds include failing culverts, lack of off-channel and pool habitats, coarsening of streambed sediments, and lack of floodplain connectivity. To date, habitat restoration in these watersheds has included addition of large woody debris (LWD), riparian planting, and culvert repair. Scheduled work over the next three years includes additional LWD supplementation in Seabeck, Little Anderson, and Big Beef creeks, and fill removal and lowering an artificial stream bank in Big Beef creek. The goal of these restoration projects is to increase productivity of salmon in the watersheds by improving spawning and rearing success. Based on previous work, we know that LWD supplementation leads to increased channel complexity, formation of pool habitats, and sediment retention, all of which improve stream resilience and are important features of salmon habitat. However, careful analyses are needed to determine whether any of this past or future restoration work is achieving the hypothesized response in salmon populations. Data collected for the IMW program are being used to evaluate restoration actions and plan future projects, keeping in mind the broader goal of enhancing Hood Canal salmon populations.

Shawn Higgins – Natural Systems Design, Inc., Tim Abbe, John Soden

Hydrologic Response to Future Climate Changes in the Wenatchee and Entiat River Watershed

Model projections of future climate scenarios indicate a shift in the seasonal timing of runoff for the Upper Columbia region with a greater proportion of winter precipitation occurring as rain versus snow. Such changes have important implications for development and evaluation of habitat protection and restoration strategies in the region. The objectives of this study are to: (1) develop summary statistics that characterize sub-watershed variability of temperature, precipitation, and runoff from the Wenatchee and Entiat River watersheds; and (2) present a case study application that evaluates variability of the hydrologic response to climate change at the sub-watershed scale. Historically, mean temperature for the core winter months December through February averaged 29 degrees Fahrenheit (F) over the study area and ranged from 23 degrees F in headwater areas to 32 degrees F in lower mainstem valleys. Hypsometric analysis of watershed elevation shows the relative proportions of sub-watershed areas in three hydrologic zones: snow-dominated, rain-dominated, and mixed snow-and-rain. Projected increases in temperature over future decades will shift the rain-snow transition toward higher elevations and decrease the relative watershed area in the snow-dominated zone. Data from anomalously warm conditions in WY 2015 illustrate the sensitivity of seasonal runoff patterns to variations in temperature as maximum snow water equivalent at Stevens Pass was just 34% of normal despite precipitation totals that were 93% of normal for the period October through April. Simulation of the A1B emissions scenario completed by the University of Washington Climate Impacts Group projects a more than twofold increase in winter runoff from both the Wenatchee and Entiat River watersheds by the end of the 21st century with concurrent decreases in runoff during summer. Associated impacts to hydrologic processes will likely include an increase in winter flow variability and more extreme values in both peak and base flows.

Keith Kistler – Confederated Tribes of the Colville Reservation

Working with Landowners and Cooperators to Restore Fish Passage and Stream Flow in Antoine Creek of the Okanogan Basin

Antoine Creek is a perennial stream that flows into the Okanogan River. Through EDT Analysis it was determined to have substantial potential to be good habitat for federally listed steelhead. In 2004 restoration of the stream started with a stream inventory assessment which identified fish passage and flow issues within the basin. The Colville Tribe led an effort to work with landowners and cooperators to remove fish passage barriers and to restore stream flow. The effort has been over 10 years in the making and the results are beginning to show promise. The series of steps taken and the effort to implement those steps will demonstrate how a vision for restoration of a watershed is possible through patience, perseverance and cooperation.

Hayley Potter – U.S. Fish and Wildlife Service, Travis Collier, Christopher Foster, Matt Cooper, Sonia Mumford

Dealing with Drought: A Case Study at Leavenworth National Fish Hatcher.

In 2015 many hatcheries in the Pacific Northwest experienced one of the worst droughts to hit the region in almost a century. This left many facilities without the water resources necessary to successfully rear fish. Leavenworth National Fish Hatchery was no exception to this situation. Here we present how the utilization of cool water reservoir storage, the ability to reduce raceway densities, and the implementation of a novel well recharge system essentially saved the facility from

catastrophic loss. Additionally, we suggest how proper contingency planning is essential for providing the tools and options necessary to guard against future loss if drought conditions continue.

Benjamin Sandford

Implications of management and dynamic climatic conditions for the recovery of Snake River sockeye

North America's southernmost sockeye salmon population from Idaho's Salmon River basin has partially recovered from near extinction in the 1990s due to a captive broodstock and hatchery supplementation program, improved natal habitat, and improved riverine and ocean conditions. Significant challenges remain in completing this recovery for both juveniles and adults as dramatically demonstrated this past summer. While record returns were realized for this population to the Columbia River, very low river flows and high water temperatures substantially impacted further migration and survival to spawning.

We utilized passive integrated transponder (PIT)-tag technology to individually follow sockeye salmon and examine overall migration and survival as well as cohort differences in rearing strategies, release protocols, and barge transport vs in-river migration. With recent adult return increases, we have also estimated adult upstream migration timing and survival and compared population-cohorts in the common migration reach from Bonneville Dam (BON) to McNary Dam (MCN).

Results showed interesting patterns using migration years 2008-2013 data: 1) Smolt-to-Adult return percentage (SAR) from Lower Granite Dam (LGR) to BON was annually variable (0.2 to 3.7%); 2) Sawtooth Hatchery had 75% lower SAR than Oxbow Hatchery presumably related to smaller release size; 3) juvenile transportation had 75% higher LGR-BON SAR than in-river migration; 4) BON-LGR adult survival was highly variable (4-75%) averaging 23% and 43% for juvenile-transported and in-river fish, respectively (2013 at only 4 and 16% due to extreme conditions this summer) and often seasonally decreasing; 5) therefore, juvenile transportation had 17% lower LGR-LGR SAR than in-river migration; 6) omitting transported fish, Salmon River adult fish had lower BON-MCN survival than upper Columbia fish (averaged 10% but was 35% this summer).

These results indicate this sockeye salmon population can respond positively to recovery efforts but is quite sensitive to anthropomorphic and climate effects.

Rebecca Scully – USGS-PNAMP, Jen Bayer

PNAMP's Map Viewer, Who is Monitoring What, Where, When and How?

Making management decisions over a large spatial scale requires a comprehensive understanding of conditions. Given shrinking budgets, extensive spatial scales, complex life histories of anadromous fish, and the patchwork of land ownership in the Columbia River Basin, a single monitoring project or program cannot tell the full story. The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) has facilitated the development of a suite of online tools to map the locations where monitoring has occurred. Monitoring Explorer is an online map viewer designed to allow users to see multiple state and federal monitoring program's sample locations. The sharing of location data is achieved using a data exchange standard and web resources. Each sample location is linked to PNAMP's online data documentation tools, allowing users to link locations to associated metadata such as protocols and methods. Viewing locations of monitoring sites from multiple programs can

create efficiencies, allowing for collaborations and opportunities to find data and complete analysis across large spatial and temporal scales.

Torre Stockard – Methow Beaver Project, Katie Weber, Richard Woodsmith, Izzie Tween, Kent Woodruff

Monitoring Beaver Movement and Beaver-Dam-Induced Stream Changes in the Methow River Watershed

For eight years the Methow Beaver Project has returned beavers to streams in the Methow sub-basin of the Upper Columbia River. For five years we have pursued quantifying the effects beaver dams have on stream temperature and stream discharge. These investigations have been challenging. A variety of stochastic events has intervened over the course of this investigation to complicate the eventual analysis. Using a Before-After / Control-Impact design, 38 monitoring stations were created where we subsequently released beavers to established beaver dams and retained controls for the purpose of documenting the beaver induced changes. To date we have completed the pre-treatment data collection and the ‘treatment’ phases of the study. Information presented documents the study design; our preliminary temperature results at ‘treatment’ sites; some water storage data gathered in 2015; and some movement data for beavers within the watershed, where we have employed an innovative marking technique that uses in-stream readers and PIT tags in beaver tails. We present the local effect of beaver dams on stream temperature, document the millions of gallons of water stored above ground behind beaver dams, and present the first results from our long-term beaver movement inquiry, with some individuals traveling for multiple years and in some cases more than 100 kilometers from their release site.