Abstracts

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Improvements in Juvenile Salmonid Passage at North Fork Dam on the Clackamas River

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Traditional oral presentation (20 minutes)

The Clackamas River is an important salmon and steelhead producing basin in the Willamette River and Lower Columbia River ESUs. From 2013 through 2015 Portland General Electric made improvements to downstream migrant collection facilities at North Fork Dam, part of the Clackamas River Hydroelectric Project. Most notably, PGE added a 1,000 cfs Floating Surface Collector (FSC) in the North Fork Dam forebay, and a net to reduce spillway entrainment. Our objective was to assess the collection efficiency of juvenile Chinook and coho salmon and steelhead following passage improvements. Releases of PIT tagged fish into the forebay of North Fork Dam were used to assess fish guidance efficiency (FGE) across a range of flows, seasons, and operations. Median FGE estimates range from 85% for Chinook to 94% for steelhead. Collectively the downstream passage improvements have lead to significant increases in downstream migrants passing through the bypass system. This presentation will review design features of the FSC and spillway net, summarize the evaluation to assess the effectiveness of downstream passage at North Fork Dam, and review trends in counts of juveniles through the bypass system.

Social Dimensions in Delisting under the Federal Endangered Species Act

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Traditional oral presentation (20 minutes)

There is widespread belief that the Endangered Species Act (Act) is not successful given the relatively few downlistings and delistings that have occurred since the Act was established in 1973. This is compounded by the fact the pace of adding species to the list of those protected under the Act far exceeds the pace of removing them. The perception that the Act is not successful has led to divergent political views and declining public support for a law that once had overwhelming bipartisan approval.

Interestingly, while a more relevant measure of the Act's success is preventing extinction and supporting recovery - for which the Act has been quite successful - public opinion and procedural trust in the agencies administering the Act appear to be more greatly influenced by the annual and cumulative tally of species being added and removed from the Act's protections. This begs the question that if the Act is successful at preventing extinction and many species are recovering, why have the two federal agencies who administer the Act not been more successful at removing species from the Act's protections? This presentation will explore social factors, both internal and external to the federal agencies who administer the Act, that contribute to a reluctance to remove federal protections from threatened and endangered species.

A Look at Walleye Consumption of Salmonids and Lamprey in the Columbia River

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Traditional oral presentation (20 minutes)

The Northern Pikeminnow Management Program is an interagency program that, since 1990, has applied targeted removal fisheries for Northern Pikeminnow (*Ptychocheilus oregonensis*) with the goal of restructuring populations in the Columbia and lower Snake rivers to reduce predation on out-migrating juvenile Pacific salmon and steelhead (*Oncorhynchus spp*.). Initial modeling simulations suggested that a removal of 10-20% predator-sized Northern Pikeminnow could reduce their predation on juvenile salmonids by as much as 40%. However, this reduction in predation could be offset by potential compensatory responses from other piscivorous predators, such as Walleye (*Sander vitreus*) and Smallmouth Bass (*Micropterus dolomieu*). To investigate whether or not compensatory responses are present, the Oregon Department of Fish and Wildlife collected diet and other biological data from Northern Pikeminnow, Walleye, and Smallmouth Bass at sites in the Columbia River. Recently, there has been concern that Walleye may be more impactful predators on Pacific salmonids and lamprey (*Petromyzontidae*) than was previously thought. In 2018, Walleye had higher abundance indices than Northern Pikeminnow in most areas of The Dalles and John Day reservoirs. Additionally, juvenile salmonids were present in a greater proportion of diet samples collected from Walleye than Northern Pikeminnow in both The Dalles and John Day reservoirs and lamprey were present in a greater proportion of diet samples collected from Walleye than Northern Pikeminnow in John Day Reservoir. The objective of this talk is to look more closely at Walleye predation on species of concern, such as Pacific salmonids and lamprey.

Seasonally Varying Flows: Conditioning a water storage right to protect winter flows

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Traditional oral presentation (20 minutes)

In 2013, the Oregon Legislature passed Senate Bill 839 which established a Water Supply Development account that provides competitive grants and loans for water resources projects. For select water storage projects that are awarded funding, the bill requires that Oregon Water Resources Department (OWRD) establish a Seasonally Varying Flow (SVF). Per statute, "Seasonally Varying Flows" means the magnitude, duration, timing, and frequency of flows, identified for the purpose of determining conditions for a new or expanded storage project, that must remain in-stream outside of the official irrigation season in order to protect and maintain the biological, ecological and physical functions of the watershed downstream of the point of diversion, with due regard given to the need for balancing the functions against the need to store water. SVF assessments are then used to help shape the conditions of the right to store water, effectively limiting operations of the storage system. In 2016, OWRD awarded funds to Farmer's Irrigation District (FID) for the expansion of an existing storage project which diverts streamflow from the Green Point Creek watershed. OWRD utilized available hydrologic data and principles to identify characteristics of the natural flow regime of Green Point Creek and its tributaries. Other available data, including previously developed flow-habitat relationships of local fish species were incorporated to balance species needs with the hydrologic reality and the need to store water. In this presentation, we discuss the methods and processes used to identify the instream needs of a relatively undeveloped watershed and develop a flow prescription which attempts to meet the needs of the instream and out-of-stream water users. In addition, we identified scientific gaps that stakeholders must address to ensure technically sound analysis for flow protection.

Vulnerability of lamprey species to projected environmental change

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Traditional oral presentation (20 minutes)

Projected changes in precipitation and temperature as a result of climate change suggest fundamental shifts in water availability and thermal regimes. To more effectively manage the needs of native fish species given these projected changes, the Oregon Department of Fish and Wildlife (ODFW) is developing a more quantitative, transparent, and adaptive modeling approach to research and monitoring. The new approach uses knowledge of the limiting factors, threats, and the magnitude of their effect on species persistence to categorize habitat for protection, develop new research and monitoring, or provide restoration guidance. Historic and contemporary data are being used to model vulnerability to environmental change as a function of climate sensitivity and exposure to threats. Vulnerability was evaluated for Pacific Lamprey in Western Oregon. Using occurrence datasets and environmental covariates, occurrence probabilities were estimated for stream reaches throughout Western Oregon given contemporary species occurrence. Hypothesized effects to species occurrence and extent were then evaluated based on future climatic projections. Knowledge about the effects of

climate change on species and their habitats will help ODFW better manage and conserve species and develop tools to better respond to habitat mitigation needs at the appropriate spatial and temporal scales.

Thermal regimes and species thermal tolerance in a changing climate

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Traditional oral presentation (20 minutes)

Water temperature is one the most crucial instream habitat features influencing a wide range of biological responses from species phenology (e.g. emergence, migration) and growth, to community composition. Water temperature is also extremely dynamic, varying both spatially and temporally at multiple scales. Monitoring water temperature and evaluating components of the thermal regime (e.g. magnitude, timing, rate of change) are necessary to understand current conditions and identify fundamental shifts. However, without complementary information relating these data to species needs, we will be limited in our ability to make decisions about how best to manage and protect species in general, and more specifically those species at most risk. The most effective conservation and management of fish in a changing climate will then depend on knowledge about both the rate and magnitude of change in the aquatic environment and the effects those changes will have on fish physiology. The physiological response of fish to a changing climate provides a mechanistic explanation for population responses such as altered phenology, range shifts, and biotic interactions. The Oregon Department of Fish and Wildlife is developing a strategy to a) collect stream temperature data at relevant spatial and temporal scales, b) evaluate the thermal tolerances of native fish species, and c) use the combination of those data to make more informed decisions not just about the current status of our fish species but also their potential vulnerability to future conditions.

Going with the flow: Transport and retention of eDNA in flowing waters

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Traditional oral presentation (20 minutes)

Environmental DNA (eDNA) has been the focus of significant research attention given its potential to provide an efficient and cost-effective means for gathering information about the presence or distribution of target species. However, broad integration of eDNA methods into fish monitoring programs is challenging given uncertainties about the fate and transport of eDNA and the resultant spatiotemporal linkage between source organisms and their eDNA signatures. The presence of eDNA in a given sample of water is influenced the balance of processes regulating DNA production with those

regulating DNA transport and retention. Production of eDNA may be largely a function of target organism abundance and shedding rates, but transport and retention of eDNA is likely to be governed by a more complex mix of both physical and biological processes. This presentation couples what we know about eDNA decay and fine particle transport to refine a range of eDNA retention rates for a broad range of flowing waters. I also discuss where additional work is needed to resolve the linkage between source organisms and their eDNA signatures to scales relevant to management and monitoring design.

A Decision Support Model Approach to Identify High Priority Tide Gates for Fish Passage and Habitat Restoration

Greg Apke
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Traditional oral presentation (20 minutes)

Oregon's estuaries are the most complex, intricate, species rich and biodiverse habitats in the state. Nearly two centuries of human intervention continues to compromise ecological function and value of these critical landscapes. Tide gates are structures commonly used to control waters in tidally influenced areas along Oregon's coast and the lower portions of the Columbia River Basin. A recent inventory of tide gates along the state's coastal lowlands identifies approximately 3000 tide gate structures. Decision support tools are being developed to identify areas of high probability for ecological uplift associated with future tide gate repairs and replacements and the estuarine habitats adjacent to and upstream of tide gates. Oregon Department of Fish and Wildlife (ODFW) and other partners are developing a decision support modeled approach to characterize the physical attributes of these important habitats proximal to and affected by tide gates. The goals of this new approach are to provide a more transparent, defensible and more efficient method(s) to assist with the prioritization of future tide gate repair and replacement projects.

This presentation will frame up the scope of the state's problem associated with tide gates as it particularly relates to fish passage and will describe the decision support model, the structure built into the physical attributes associated with model, and the future application of the model.

Shrinking body size of top-predators in headwaters under climate change

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Traditional oral presentation (20 minutes)

Climate change has negative effects on aquatic biota, yet the ability of detect such changes is overlooked due to the lack of long-term ecological datasets. Here, we present evidence from continuous annual surveys of Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii*) and Coastal Giant Salamander (*Dicamptodon tenebrosus*) populations from the Coast (since 1962) and Cascades (1987) mountain ranges of Oregon. We found strong evidence that the size of both trout and salamanders have consistently decreased over time across sites. Our results provide insights about the importance of long-term monitoring of aquatic vertebrates to understand effects of the recent warming climates on freshwater animals.

Seasonality, movement, and carry-over effects: potential blind spots for climate change adaptation

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Traditional oral presentation (20 minutes)

The dominant framework for climate change adaptation is to identify risks to natural resources based on climate forecasts (i.e., vulnerability assessments) and to develop management actions that mitigate these risks (i.e., climate-smart planning). A key difficulty for this framework is that the processes by which climate affects species are complex and must be greatly simplified to inform decision making. Adaptation efforts often consider space at the expense of time, relying on downscaled maps that retain complex spatial heterogeneity while eschewing temporal heterogeneity. While this approach may be appropriate when applied to human infrastructure or sedentary organisms, it likely fails to capture the conservation threats and opportunities for wide-ranging species, particularly those whose life-histories have evolved to exploit seasonal variation. We developed an individual-based simulation to explore the potential risks of prioritizing conservation based solely on summer thermal conditions, without regards to seasonal variation and fish movement. We tracked the growth of coldwater fish in catchments that exhibit spatial and temporal variation in water temperature and include habitats that are both perennially cool (e.g., tributaries) and seasonally warm (e.g., mainstem rivers). We varied fish mobility and the relationship between water temperature and food abundance. We found that under many plausible scenarios, seasonally warm habitats could contribute disproportionately to the annual growth of fish. Our model revealed carry-effects, in which the quality of seasonally warm habitats that fish used during spring mediated their ability to survive on thermal refuges during summer. Though typically devalued by climate-smart planning, our results suggest seasonally warm habitats can complement perennially cool habitats to increase fish production. A key challenge for future research is to understand the degree to which seasonally warm habitats contribute to actual fish production in the wild and whether restoration activities can increase this contribution.

Mate choice of hatchery and wild coho salmon

Heather Auld

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Traditional oral presentation (20 minutes)

Because individuals are limited in their ability to produce offspring, it is important to not mate randomly, but select high quality and/or genetically compatible partners. Mate choice can be important for conservation or population recovery efforts since individuals who choose mates often have greater mating success than those who do not. However, even when given the opportunity to choose mates, reduced reproductive success has been observed in hatchery fish relative to their wild counterparts, suggesting a reduced ability of hatchery fish to select appropriate mates which could be the result of the parental generation of hatchery fish not being able to select their own mates and thus producing less sexually competitive offspring or another selection pressure in the hatchery environment. Using genotyping-by-sequencing, we identify single nucleotide polymorphisms (SNPs) associated with variation in both individual reproductive success and mate pairings in hatchery and wild coho salmon (*Oncorhynchus kisutch*). Our results indicate that reproductive success differences previously observed between fish of either hatchery or wild origin may correlate with differences in mate choice patterns we infer from their pedigree.

Fish Passage Mitigation Banking Pilot Project

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Traditional oral presentation (20 minutes)

The Oregon Department of Fish and Wildlife Fish Passage Program has developed a plan to test an approach to Fish Passage Mitigation Banking in Oregon's North Coast. In 2012, with support from ODFW staff, the Oregon Department of Transportation, Willamette Partnership and The Nature Conservancy began work on a package of tools that would support a pilot fish passage banking program. Fish passage banking will allow ODFW to steer mitigation from multiple waivers towards passage banks - locations where high priority barriers are removed and significant benefits for fish are created. This talk will provide an update in the progress of this pilot program.

Waterbird Predation of Juvenile Suckers in the Upper Klamath Basin

Nathan Banet
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Traditional oral presentation (20 minutes)

In the Klamath Basin, a recruitment bottleneck in populations of Lost River and shortnose suckers has put focus on understanding potential causes of juvenile mortality, including the role of waterbird predation. From 2009 to 2018, 14 nesting colonies of American white pelicans, double-crested cormorants, and Caspian terns in the Upper Klamath Basin were searched for fish tags in the fall after birds departed. Previous results showed that waterbirds could consume a substantial proportion of wild juvenile sucker cohorts, but sample sizes were small (< 220 suckers) and sufficient for estimation in only two years. In 2018, U.S. Fish and Wildlife Service released 3,100 juvenile suckers from their Sucker Assisted Rearing Program. Searches of waterbird colonies in fall of 2018 yielded PIT tags from released suckers on 5 of 11 colonies searched. We detected 2% of the PIT tags from released fish on waterbird colonies and tags were found on colonies up to 80 km from their release location. PIT tags or radio transmitters from 9 of 184 suckers (5%) released with radio transmitters were found on nesting colonies. Waterbird consumption was not limited by the size of juvenile suckers released in 2018 (< 222 mm FL), although releases of larger fish may limit predation by Caspian terns. Results of this study will be used to manage releases of reared suckers to minimize waterbird predation.

Recovery of Juvenile Fish Tags on Bird Nesting Colonies in the Upper Klamath Basin

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Traditional oral presentation (20 minutes)

From 2009 to 2018, 14 nesting colonies of American white pelicans, double-crested cormorants, and Caspian terns in the Upper Klamath Basin were searched for fish tags in the fall after birds departed. Detections of PIT tags show that birds brought tags, primarily those implanted into juvenile salmonids in the Columbia River Basin (ID, OR, and WA), into the Klamath Basin from a variety of locations up to 700 km away. In the Klamath Basin, a recruitment bottleneck in populations of Lost River and shortnose suckers has put focus on understanding potential causes of juvenile mortality, including the role of waterbird predation. Previous results showed that waterbirds could consume a substantial proportion of wild juvenile sucker cohorts, but sample sizes were small (< 220 suckers) and sufficient for estimation in only two years. In 2018, U.S. Fish and Wildlife Service released 3,100 juvenile suckers from their Sucker Assisted Rearing Program. Searches of waterbird colonies in fall of 2018 yielded PIT tags from released suckers on 5 of 11 colonies searched. We detected 2% of the PIT tags from released fish on waterbird colonies and tags were found on colonies up to 80 km from their release location. PIT tags or radio transmitters from 9 of 184 suckers (5%) released with radio transmitters were found on nesting colonies. Waterbird consumption was not limited by the size of juvenile suckers released in 2018 (< 222 mm FL), although releases of larger fish may limit predation by Caspian terns. Results of this study will be used to manage releases of reared suckers to minimize waterbird predation.

The Power of Partnerships

Brian Bangs

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Traditional oral presentation (20 minutes)

Between federal and state agencies, universities, landowners, non-governmental organizations, and other groups with which we work with in the fisheries field, cooperation is not always a foregone conclusion. Each partner can bring a variety of ethics, needs, policies, approaches, and desired outcomes to projects or programs. These hurdles are often shadowed, however, by the authority, experience, skills, and abilities of partners that can often enable successful completion of projects and to overcome barriers. In this presentation, I will describe lessons learned from my own experiences working towards the conservation of at-risk species and detail benefits and problems of working with diverse sets of partners, my approaches with private landowners, and describe the tools I have used to build positive relationships.

Bacterial Kidney Disease in John Day River Salmonids: Are Warmer Waters Increasing the Threat?

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Traditional oral presentation (20 minutes)

While the presence of *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (BKD) in salmonids, is common throughout the Pacific Northwest, elevated sea surface temperatures and more frequent drought conditions may be increasing the affect BKD has on fish survival. To better understand such an effect on populations in the John Day River, we analyzed kidney samples collected from incidental mortalities of juvenile and adult Chinook and steelhead encountered throughout the basin during spawning ground surveys and juvenile abundance monitoring (rotary screw traps and electrofishing). From 2005 through 2018, sample sizes per year ranged from 7 to 181 for adults on spawning ground surveys and 1 to 72 for juveniles. We used enzyme-linked immunosorbent assay (ELISA) to obtain optical density (OD) values and determine infection level. By comparing returning adult OD values with those from juveniles, we examined the potential vertical and horizontal transmission of the bacterium within the John Day population and the effect of changing environmental conditions on the prevalence and intensity of the infection. Additionally, we were able to look at the transference of the bacterium between species, and how this perpetuates the bacterial population within the John Day. Our results indicate a positive relationship exists between antigen presence in returning adults and juveniles that is influenced by a variety of parameters.

Larval Lamprey Use of Mainstem Columbia River Habitats and Impounded Areas

Judith Barkstedt

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Traditional oral presentation (20 minutes)

Rivers with extensively developed hydroelectric systems, like the Columbia River, have highly altered hydrologic regimes. The Columbia River is central in the range of anadromous Pacific Lamprey whose abundance and distribution has become significantly reduced. Pacific Lamprey have a multi-phase life history in which larvae burrow in river sediments for multiple years before transforming and migrating to the ocean. Only recently has the use of large river habitats by larval Pacific Lamprey become well documented. However, the full extent to which larval lamprey use mainstem habitats for rearing and the impact of the altered hydrologic regime to the population is unknown. The goals of this study are to understand if and where larval lampreys may occupy large rivers, characterize the habitat in those areas, and identify where fluctuating reservoir levels may pose a threat due to dewatering. Our specific objectives were to: 1) evaluate the extent to which the Columbia River was occupied with larval lamprey in specific strata including i) impounded reservoirs, ii) reservoir shallow-water margins, iii) impounded river mouths at major tributary confluences, and iv) areas downstream of dams; 2) examine potential differences in occupancy rates among strata; 3) describe and relate habitat variables to occurrence of larvae, 4) describe the species and length distribution; and 5) assess the threat of fluctuating reservoir levels to larval lamprey. We described larval lamprey occupancy and habitat use in four reservoirs of the Columbia River including: Bonneville, The Dalles, John Day, and McNary reservoirs, as well as a free-flowing reach downstream of Bonneville Dam. We also examined occupancy in shallow-water and impounded river mouth strata nested within respective reservoirs, as these areas may be particularly vulnerable to changing water conditions due to river management. Overall, information from this study can increase our knowledge of lamprey ecology and inform how reservoir and tailwater levels might be regulated to minimize negative impacts to Pacific Lamprey. Understanding if and how larval Pacific Lamprey use mainstem habitats is essential to the conservation of the species.

Where Should We Eat? Comparing Salmonid Predation by Northern Pikeminnow at Columbia River Dams and within Reservoirs

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Coauthors: Andrea Carpenter, Eric Anderson
Traditional oral presentation (20 minutes)

Since 1990, the Northern Pikminnow Management Program has applied targeted removal fisheries of Northern Pikeminnow (*Ptychocheilus oregonensis)* to reduce predation on out-migrating juvenile salmon and steelhead from the Columbia and lower Snake Rivers. In addition to a sport reward fishery, the program has administered a dam angling fishery from The Dalles and John Day dams since 2006 and 2007, respectively. There has been recent interest in expanding this part of the program to other Columbia and lower Snake River dams. Our objective was to explore how the diet of Northern

Pikeminnow varies in space and time so as to help inform this management decision. We analyzed diet content and rates of salmonid consumption from Northern Pikeminnow captured via electrofishing from three areas of The Dalles Reservoir as well as fish obtained via hook and line from the dam angling fishery at the tailrace of John Day dam. Preliminary analyses of 2018 data indicate that the proportion of Northern Pikeminnow that contained fish, as a general prey category, was similar regardless of capture method or location. However, the proportion of Northern Pikeminow that contained salmonid prey items was greater in the dam angling fishery than those captured throughout the reservoir via electrofishing. This ongoing investigation will be updated with additional data and analyses.

Seasonal movements and energy budgets of coastal cutthroat trout in the Willamette River

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Traditional oral presentation (20 minutes)

This project explores how a coldwater fish interacts with spatial and temporal heterogeneity in water temperature. In the mainstem Willamette River water temperatures exceed 20C during summer, generating stressful conditions for coastal cutthroat trout. Floodplain alcoves fed by subsurface flows provide cooler temperatures, and prior work found that cutthroat trout aggregate in a subset of these thermal refugia. A remaining challenge is to understand how fish exploit these refuges, what physical features determine whether thermal refuges function to support fish, and how perennially cool habitats combine with seasonally warm habitats to support fish. We are embarking on research to address these key uncertainties and will present preliminary results characterizing (1) the timing of fish movements to refuges, (2) the foraging ecology of fish using refuges, and (3) how fish balance trade-offs between dissolved oxygen and temperature at micro-habitat scales.

Agricultural conversion and restoration in the Columbia River estuary: a case study on Kerry Island and the Westport Unit

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Traditional oral presentation (20 minutes)

A long history of floodplain conversion to agricultural uses exists in the Columbia River basin, including in the Columbia River Estuary. Recent research has highlighted the importance of the estuary and tidal floodplains to aquatic species, including endangered salmon and trout. This critical tidal interaction was restored to two neighboring project sites in the freshwater tidal zone of the Columbia River estuary near Clatskanie, Oregon. This talk will compare the Kerry Island and Westport Unit projects, discussing the feasibility of passive restoration vs. a more active restoration approach which was dictated by

specific site history, hydrology, and biological conditions. The Kerry Island and Westport Unit projects were both historically tidal forested wetlands often called "high marsh" that were converted to agricultural uses in the mid-1900s. Though the Westport Unit was logged and infrastructure was constructed on portions of the site, it remained connected to the tidal influence of the Columbia River via a trestle bridge, largely retaining many of the characteristics of a forested tidal wetland. In contrast, Kerry Island was heavily impacted by agriculture and development, and had exterior levees and drainage ditches that limited regular tidal inundation. Therefore, Kerry Island had been degraded enough to necessitate a more intensive restoration approach that would arrest and eventually reverse the declining site trajectory. Alternatively, the site trajectory at the Westport Unit were such that a relatively passive approach to restoration was feasible. Despite their different approaches, these projects both enhanced marsh ecosystem function and rearing habitat for numerous salmonid species by restoring hydrologic connectivity to the floodplain and addressing habitat and food web limiting factors for salmonids in the Columbia River estuary.

Changing Predation in a changing environment

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Traditional oral presentation (20 minutes)

Environmental conditions mediate predator-prey interactions by influencing spatial-temporal overlap, encounters, capture rates, and consumption capacity. Climate variability, dams and their operations create dramatic changes in the aquatic environment; therefore, it behooves resource managers to understand how predators and prey will likely respond to natural and human-induced changes in flow, temperature, and turbidity. Changing climate and water operations at dams alter thermal stratification patterns and interact with species-specific thermal tolerances to heighten or diminish the duration and magnitude of predator prey interactions. Dams create effective sediment traps and alter the natural cycles in flow and turbidity that created important seasonal refuges for migrating salmonid smolts. An improved understanding for how incremental changes in temperature, turbidity, and other environmental conditions can elicit significant shifts in predator prey interactions will become increasingly important as land development and demands for water increase.

Improving estimates of angler-effort and catch with a time-series creel survey model

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Traditional oral presentation (20 minutes)

The overarching mission of many fish and wildlife agencies is to preserve, protect and perpetuate fish, wildlife, and ecosystems while providing sustainable recreational opportunities. Balancing these dual, and sometimes conflicting, objectives becomes ever more challenging as natural resources become scarcer. Thus, providing natural resource managers with robust estimates of abundance, exploitation, and user participation is of paramount importance. For sport fisheries, creel surveys have become an established method to estimate angler-effort and catch. Despite advancements in analytical techniques throughout the field of fisheries over the past few decades, creel survey data are still commonly analyzed using methods that were developed over 40 years ago. Therefore, our goal was to develop a contemporary creel survey model using update methodologies that would ultimately improve the accuracy and precision of creel derived estimates. Unlike existing creel survey models, which are based on deterministic maximum likelihood estimators, we developed a probabilistic, Bayesian state-space time-series model that takes advantage of the underlying characteristics of creel data and overcomes some of the main limitations of traditional analytical methodologies. During our talk, we will discuss the details of our time-series model, share results from both simulated and empirical data sets, and outline some of the limitations to implementing our updated model to all creel survey datasets.

Hatchery rearing duration effects on reproductive behavior and breeding success of summer-run steelhead

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Traditional oral presentation (20 minutes)

Recent studies of Methow River steelhead have suggested that altering rearing strategies by raising fish to a more natural age at smoltification (age-2) may alleviate some of the size-selective mortality after release and potentially reduce domestication selection on correlated traits. The present study estimates the effects of rearing steelhead smolts for one year in the hatchery (S1, traditional approach) or two years in the hatchery (S2, experimental approach) on breeding behavior and fry production under experimental conditions. Two spawning channels at the US Fish and Wildlife Service Winthrop National Fish Hatchery were stocked with S1 and S2 adult steelhead for each of three consecutive years (2015-2017), creating six independent breeding groups, each containing 11-13 females, 11-13 anadromous males, and 6 precocious male parr (all age-2). Behavioral observations were conducted from dawn until dusk throughout each spawning season, and random subsample of 700 emergent fry from each breeding group (4,200 total fry) were genotyped and assigned to single-pair matings. The following results should be considered preliminary.

Individual female breeding success did not depend on freshwater rearing history (S1 vs S2; $P = 0.730$) and was significantly, although weakly, correlated with body mass ($r2 = 0.07$, $P = 0.023$). Individual S1 males sired an average of 10.1% of the sampled fry (range: 8.6% to 11.9%), S2 males sired an average 3.5% (range: 1.2% to 5.2%), and precocious parr sired an average of 1.5% (range: 0.7% to 2.6%). Analysis of covariance for just the S1 and S2 males indicated significantly greater breeding success for

S1 than for S2 males (P = 0.03) and a positive, but non-significant (P = 0.322) correlation between body mass and breeding success.

Body mass was significantly and positively correlated with positions in male hierarchies (r2 = 0.387, P < 0.01), and the relationships (all positive) were significant for four of the six individual breeding groups. The number of observed spawning participations as the first male to enter the nest during spawning was the strongest proximate factor influencing breeding success (r2 = 0.81, P < 0.001) and was significantly correlated with body size (r2 = 0.18, P < 0.01).

Overall, prolonged hatchery rearing (S2) in males appears to have a negative effect on breeding success, likely caused by differing environmental conditions in S1 and S2 environments that may have influenced the development of competitive behaviors. Effects were not likely caused by heritable influences because all smolts were produced a common genetic stock returning to the Methow River Basin. While body size was important in structuring male dominance hierarchies, and the most dominant individuals tended to have greater breeding success, sneak spawning opportunities were apparently sufficient to allow for subdominant males (including S2 parr) to have measurable and consistent breeding success.

How do missing and related parents affect accuracy of parentage-based tagging? Sauger conservation in the Wind River, Wyoming

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Traditional oral presentation (20 minutes)

Released hatchery-origin fish must survive and reproduce for supplementation to recover collapsed native populations, yet monitoring fitness is challenging, because physical tags are not passed from parent to offspring. Parentage-based tagging (PBT) is a method in which all captive-bred parents are genotyped (i.e., given a molecular tag), and their wild-caught hatchery offspring are identified via genetic pedigree analysis. The sauger (*Sander canadensis*) is a highly migratory, freshwater percid (perch species), native to central and eastern North America. In the Wind River basin, Wyoming the species' abundance has declined considerably since 2002, and in 2013 stakeholders initiated a hatchery program to recover the population. We estimated the statistical sensitivity and accuracy of PBT using 17 microsatellites to identify hatchery-origin saugers captured in the wild. We completed in vitro and in silico experiments that demonstrated 98% sensitivity and 99% accuracy of PBT in distinguishing hatchery- and natural-origin saugers. Moreover, our experiments showed that accuracy is robust to factors expected to decrease assignment accuracy, including highly related parents (i.e., full siblings) and differing proportions of true parents included in the analysis. This research highlights that our ability to assign parentage and estimate fitness is high, and that PBT is an effective way to monitor recovery of saugers in the Wind River basin, Wyoming.

Falkland Islands and South Georgia Landcover Classification Using Combined Satellite and Drone Imagery

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Traditional oral presentation (20 minutes)

Researchers at Oregon State University (OSU) and the South Atlantic Environmental Research Institute (SAERI) have worked in close conjunction to create two map series, the first of which being a set of island-wide landcover classification maps for the Falkland and South Georgia islands, the other being a sequence of site-specific mapping projects currently undergoing development. The first map series has yielded pixel-based landcover classification maps implemented through Google Earth Engine's cloud-based platform that cohesively assimilate the terrestrial, intertidal, and subtidal zones for both the Falklands and South Georgia, with medium-resolution Sentinel 1 and 2 data serving as the primary input of island-wide satellite imagery. The second series of landcover maps, which is currently under construction using Python's scikit-learn library for object-based classification and greatly draws upon high resolution drone survey and Worldview 2 and 3 imagery, is intended to address the mapping- and research-related questions agreed upon in local stakeholder workshops held during the summer of 2018.

Onshore groundtruthing for both the Falklands and South Georgia have, to date, been collected principally through traditional fieldwork, such as local site descriptions and diving surveys, with a minor, although meaningful, subset of inputs collected through remote survey (Worldview 2 and 3 imagery, drone work, and sidescan profiles). Future groundtruthing for both map series is slated to far more heavily unite drone and Worldview-based input within the mapping process. Of special interest to our group is the parameterization of the most effective uses of drone vs. satellite-based imagery as model inputs in order to better constrain the conditions under which one data source may be preferable to the other, and for what reasons. Additional groundtruthing collected in service of the series 2 maps will in turn better inform the groundtruthing dataset currently associated with our series one maps, which may benefit from an influx of additional groundtruthing input as we more fully investigate the most effective means of mapping the combined terrestrial, intertidal, and subtidal environments at our island sites.

Passage and Survival of Chinook Salmon at Lookout Point Dam, Fall 2017 and Spring 2018

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Traditional oral presentation (20 minutes)

Hydroelectric projects throughout the Pacific Northwest present passage challenges to anadromous salmonids, including the Endangered Species Act-listed Upper Willamette River spring Chinook Salmon *Oncorhynchus tshawytscha*. Of particular concern is restricted emigration of juvenile fishes. The purpose of this study was to describe the behavior, distribution, and downstream passage of juvenile Chinook Salmon from Lookout Point Reservoir through the tailwaters below Dexter Dam on the Middle Fork Willamette River, Oregon. Using acoustic telemetry, we addressed two life-history patterns for spring Chinook Salmon: reservoir-rearing with outmigration past Lookout Point Dam in the fall (subyearling Chinook Salmon) and natal-stream rearing with outmigration during the spring (yearling Chinook Salmon). Fish were tagged and released at the head of reservoir in October and December of 2017 (n = 1,507) during fall outmigration and again in February and April 2018 (n = 1,527) during spring outmigration. Juvenile Chinook Salmon dispersed through Lookout Point Reservoir and as the seasons progressed, increasing numbers "disappeared" and were classified as lost. Long residence times and low passage efficiencies suggest that fish migrating through the reservoir spent extended periods of time searching for passage routes at Lookout Point Dam. Fish that passed the dam did so mainly at night through the turbine units. Survival through the turbine units was moderate (~80%) across all study periods except fish released in April where survival was 65%. The spillway was operated for a short period during April and 59% of spring released fish passed this route, with an estimated survival probability of 99%. Results from this study will inform management decisions on long-term structural and operational alternatives at Lookout Point Dam to aid in rebuilding populations of Upper Willamette River spring Chinook Salmon in the Willamette Basin.

Seasonal abundance and habitat associations of steelhead trout and Chinook salmon in a highly managed river basin

Tara Blackman
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Traditional oral presentation (20 minutes)

Water management activities in rivers can influence juvenile salmonids by altering hydrological conditions and stream ecology. In some segments of the Crooked River, Oregon, water management activities reduce flow in the winter and increase flow in the summer, essentially reversing the natural flow regime. Reduced winter flows likely reduce the habitat area available for rearing fish, potentially influencing overwinter survival. Thus, while some salmonid populations in central Oregon are naturally limited by summer low-flows, flow management in the Crooked River may create a habitat bottleneck during the winter. In this study, we investigate juvenile fish density in the Upper Crooked River, at the reach scale, across four broad land use types, and at the mesohabitat scale during both warm and cold-water seasons.

Hatchery Influence on Juvenile Chinook Salmon Stock Composition, Abundance, and Life History in the Columbia River Estuary

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Traditional oral presentation (20 minutes)

For more than a century, Columbia River hatcheries have produced salmon for recreational and commercial harvest and to mitigate for productivity declines caused by dam construction and freshwater habitat losses. Recent federal biological opinions also have mandated restoration of rearing habitats in the lower river and estuary to mitigate for salmon mortalities associated with Federal Columbia River Power System operations. We compared stock composition, distribution, abundance, and length frequencies of marked and unmarked juvenile Chinook Salmon during a 2010-12 beach seining survey to evaluate potential interactions between hatchery origin (HO) and naturally produced (NP) juveniles in shallow-water habitats between the river mouth and Bonneville Dam. Cumulative releases from all hatcheries drove estuary stock composition, abundance, and life histories, particularly during the spring-summer migration peak. NP stocks from the Lower Columbia River ESU, including many fry migrants, were most abundant in nearshore habitats but larger HO juveniles also occupied these sites such that their biomass often equaled or exceeded that of NP fish. Large hatchery releases of Spring Creek Group fall Chinook stock in April and May created sharp pulses in the estuary entry of fingerlings and dominated salmon abundance and stock composition at some shallow-water sites. Moreover, successive releases from scores of upriver hatcheries throughout spring and summer ensured a persistent presence of HO salmon at nearshore sites, regardless of the habitat-specific residence times of individual fish. The larger mean size of HO salmon in shallow estuarine habitats raises concerns about their potential competitive advantage and whether hatcheries could undermine the effectiveness of estuary restoration projects on behalf of NP populations. We conclude that historical replacement of diverse wild populations with fewer hatchery stocks of a narrow size range has homogenized juvenile life histories in the estuary and could undermine resilience of Columbia River Chinook Salmon to changing environmental conditions.

Life in the Hot Zone: Effects of a Sage-Steppe Wildfire on Juvenile Steelhead in Thirtymile Creek, Oregon

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Traditional oral presentation (20 minutes)

During August 2018, a lightning-strike wildfire burned through patches of Thirtymile Creek, a tributary to the Lower John Day River hosting spawning adult and rearing juvenile steelhead. The fire created an unplanned Before-After-Control-Impact comparison among burned and un-burned sampling reaches

with pre-existing juvenile steelhead abundance, survival and growth monitoring. We will compare June-October survival, growth and condition factor of juvenile steelhead among a burned impact reach and un-burned control reaches during both 2017 and 2018. We will also compare end-of-summer production of Age-0 juvenile steelhead per adult spawner by control and impact reach for the pre and post-fire years. Juvenile steelhead response to the wildfire will be placed into the context of sage-steppe wildfire severity with post-fire aerial imagery of the riparian zone and tree mortality.

Delays, domoic acid, and dollars: adaptive management in the Dungeness crab fishery

Troy Buell
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Traditional oral presentation (20 minutes)

Dungeness crab is Oregon's most valuable commercial fishery species and supports a popular and easy to access recreational fishery. The Dungeness crab population off Oregon is highly dynamic with considerable inter- and intra-annual variation in exploitable biomass, molt timing (affecting quality), and biotoxin accumulation. This population variability appears to be increasing with changing ocean conditions such as water temperature and acidification. To maintain a successful fishery into the future, fishery managers and participants must be adaptive and responsive to environmental changes in close to real-time. I will briefly review the regulatory mechanisms used by state agencies to implement adaptive management in Oregon's sport and commercial marine fisheries and which fisheries it is most commonly applied to. I will describe how Oregon's management agencies are responding to present and anticipated challenges in Dungeness crab fisheries by increasing and improving monitoring, and modifying or creating management plans and practices to mitigate negative outcomes.

Oregon State University ORAFS Student Subunit

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Poster presentation

The purpose of the Oregon State University ORAFS Student Subunit is to foster interactions between students, faculty, natural resource professionals, and the community. The subunit focuses on providing students with informational speakers, educational activities, professional development opportunities, and interactions pertaining to the fields of fisheries, wildlife, and other natural resources sciences. We will be presenting photos and information about the subunit's past events along with plans and ideas for the future.

Appropriate treatment of prior data in the evaluation of regulatory compliance

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Traditional oral presentation (20 minutes)

Regulatory fish passage criteria include threshold proportional metrics (e.g., percentage of fish successfully passed) expressed as target values. Appropriate evaluation of success at meeting these targets includes experiments designed around a hypothesis of inequality (Pi < Po), employing a statistically defensible sample size that confers sufficient power to rigorously test such a hypothesis. Such projects frequently occur across multiple years, providing a compelling rationale to include previous data in iterative evaluations. Here, we discuss results from one such study, evaluating upstream adult passage efficiency associated with a fish trap operated at a hydroelectric dam in SW Washington. For each of four years, a sample set of fish have been captured, tagged, and released, then tracked through a telemetry array, in order to develop a suite of regulatory passage metrics. Each fish thus represents a Bernoulli trial; when aggregated, results from the sample of fish are used to infer the binomial proportion of success among the parent population. Frequentist methods for evaluating one-sample proportions against target values can adequately develop estimates of moment and precision but cannot incorporate prior results within a statistically defensible framework. Basic Bayesian proportion tests adequately develop intuitive estimates of precision, defensibly include prior information, and are increasingly simple to execute using freely available R packages. However, appropriate treatment and weighting of prior data justifiably remains a contentious topic. Optimal and appropriate utilization of prior information includes an honest assessment of the relative weight those data warrant, often conceptualized by the "equivalent sample size" metric. Here, we discuss our approach to evaluating the influence of various treatments of prior data on posterior distributions of an exemplary regulatory metric of successful passage. We explored multiple prior treatments, including both "uninformative" priors (e.g., Bayes-Laplace, Jeffreys, Haldane) and conjugate distributions for binomially distributed proportional data. Informative treatments of prior data included (A) identical weighting of all (previous and current) data, (B) weighting combined data from previous years similarly to current year data, and (C) weighting combined data from previous years less than current year data. Our analyses support development and widespread adoption of best practices for inclusion of prior information, in order to obviate understandable concerns of subjective or otherwise biased results when conducting Bayesian analyses in general.

Larval Pacific Lamprey's Response to Chronic Temperature Stress

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Traditional oral presentation (20 minutes)

Freshwater habitats in the Pacific Northwest are becoming warmer due to climate change. The effects of higher temperatures on fish performance can vary tremendously among species and is poorly quantified for many native fishes in Oregon. The Pacific Lamprey (*Entosphenus tridentatus*) rears in streams throughout Western Oregon and many populations are in decline. The goal of this study is to determine how long term exposure to increased temperature affects the physiology of larval lamprey. Juveniles were collected from Mary's River in Western Oregon and acclimated for 30 days to laboratory conditions. The larva were then split among one of five temperature treatments (13, 15, 20, 22.5, & 25°C) for 90 days. Following the chronic exposure to these temperatures we recorded growth, standard metabolic rate (SMR), and molecular stress indicators. SMR was determined using a closed respirometry system. Stress indicators include glucose, lactate, and heat shock protein 70 (HSP70). The results of this study could help managers develop water quality criteria for lamprey and better understand how lamprey will be likely to respond to future climate conditions.

Consumption junction: Can a study that monitors salmonid consumption function for lamprey too?

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Traditional oral presentation (20 minutes)

Since 1990, the Oregon Department of Fish & Wildlife (ODFW) has collected stomach contents from Northern Pikeminnow (*Ptychocheilus oregonensis*), Smallmouth Bass (*Micropterus dolomieu*), and Walleye (*Sander vitreus*) via boat electrofishing to monitor consumption of juvenile salmon (*Oncorhynchus spp*.). In addition, ODFW has sampled Northern Pikeminnow removed via hook-and-line at The Dalles and John Day dams annually (since 2006 and 2007, respectively) for similar purposes of evaluation. Through the analysis of piscivorous fish diets, we discovered that lamprey (*Petromyzontidae spp*.) were frequent diet items. We wanted to explore the data to characterize consumption of lamprey among species and between projects for Northern Pikeminnow, and trends over time when possible. We analyzed data from our time series to characterize diets of Northern Pikeminnow in relation to prey availability. We also used our laboratory methods to ground truth detectability of lamprey life stages within our study. Though these data may be limited in their scope, it may provide additional understanding of predation pressure on lamprey in the Columbia River basin.

Angling catchability of hatchery and natural-origin salmon and steelhead: are wild fish really better biters?

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Traditional oral presentation (20 minutes)

Salmon and steelhead sport fisheries in the Columbia Basin where Endangered Species Act (ESA) listed stocks are impacted by angling are often strictly regulated. In most cases, ESA-listed wild stocks are hooked and released by anglers targeting hatchery salmon and steelhead. Angling impacts associated with these fisheries are typically calculated using an estimate of the number of wild salmon or steelhead captured combined with simple assumptions about hooking mortality. Typically, regulatory agencies assume that wild and hatchery fish are caught at the same rate by sport anglers. However, some empirical evidence exists that suggests wild fish are caught at higher rates than hatchery fish. Additionally, the idea that wild fish are more aggressive biters than hatchery fish and are thus caught at higher frequencies is widely argued by anglers, conservationists, and biologist alike. If fisheries managers and regulators assume wild fish are being caught at higher rates than their hatchery brethren, then stricter regulations could ultimately be imposed on sport fisheries to reduce potential catch and release mortality of wild fish. However, much of the data available to inform these regulations are locally specific, likely biased due to limitations in study design, and may inaccurately suggest higher rates of catchability for wild fish. Between June 2017 and December 2018, 1,268 wild and hatchery salmon and steelhead have been caught and released as part of a three-year angling evaluation in the Lower Columbia River Basin. This dataset provides unbiased empirical insight into the propensity of wild and hatchery salmon and steelhead to be caught by sport anglers. Further, this data provides insights into differences in catchability based on gear types (bait, lures, bait/lure, jigs, or flies), angling methods (bobber, gear, fly, back troll, etc.), and environmental conditions.

Contribution of estuarine rearing in a bar-built estuary to recruitment of Chinook salmon using a hierarchical life cycle model

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Traditional oral presentation (20 minutes)

Estuaries are commonly touted as important habitats to juvenile salmonids, yet the broad range of characteristics of estuaries results in varying effects on salmonid recruitment. In bar-built estuaries, periods of low flow result in sand-bar formation at the mouth of rivers, closing access to the ocean. Remaining outmigrants become trapped and are unable to exit into the ocean, regardless of estuary conditions. How might this phenomenon affect the efficacy of these estuaries as juvenile rearing habitat?

We evaluated the prevalence, survival, and growth of Chinook salmon (*Oncorhynchus tshawytscha*) in Redwood Creek and compared estuarine juveniles to their ocean rearing counterparts. We marked and recaptured juvenile outmigrants in the estuary to assess estuary conditions. Scales and otoliths from spawner carcasses were evaluated to determine their juvenile life history. To assess the contribution of different life histories to population recruitment, we integrated these and additional life cycle monitoring data into a stage-structured life cycle model in the Bayesian framework. The results of our

study provide insight into the efficacy of bar-built estuaries, an estuary type that may become more prevalent with the rise in frequency of drought conditions in the state.

Quantifying $^{87}Sr/^{86}Sr$ temporal stability and spatial heterogeneity for use in tracking fish movement

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Traditional oral presentation (20 minutes)

Over the last decade techniques for analyzing environmental chemical and isotopic signatures in otoliths have transformed the way researchers are able to infer fish movement. The specificity and accuracy of inferred fish origin and movement relies on describing the spatial heterogeneity and temporal stability of surface water environmental signatures. But the cost and logistics of sample collection often precludes the complete quantification of environmental signature temporal stability and spatial heterogeneity. We used repeated sampling to quantify $^{87}Sr/^{86}Sr$ temporal stability and developed a novel, cost effective approach, Bayesian Ridge Regression (BRR), to quantify and predict the spatial heterogeneity of $^{87}Sr/^{86}Sr$ across a stream network. We explained 86% of observed variation in $^{87}Sr/^{86}Sr$ using a BRR model and estimated continuous $^{87}Sr/^{86}Sr$ across a stream network with high accuracy (±0.00106). We then assessed the specificity and discuss the accuracy of inferring movement using three scenarios of described spatial heterogeneity. Our results indicate reliable inference of fish movement requires comprehensive quantification of spatial heterogeneity and temporal variation in environmental signatures.

Collaboration and preservation: Using MonitoringResources.org as a documentation and sharing tool for long-term monitoring

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Traditional oral presentation (20 minutes)

There is a necessity to preserve long-term monitoring efforts and a critical opportunity to share long-term monitoring sampling with a variety of other existing monitoring programs to further science and address societal concerns. The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) facilitates collaboration and coordination of diverse ecological monitoring programs to work across boundaries and promote scientific understanding necessary for the management of the Nation's natural resources. To support partners, PNAMP developed a suite of integrated web tools and resources, MonitoringResources.org, that supports the documentation of how, when, where, and why data are

collected and analyzed. With the standardization of documentation, practitioners can document details once, easily update annually, and share their work many times over. Within MonitoringResources.org, one can document methods and protocols, divulge study design information, and display sample design location information that can then be shared with colleagues and other researchers across the nation. Additionally, the associated documentation will be publicly accessible with a persistent Uniform Resource Identifier (URI). MonitoringResources.org provides a platform to document and share essential information produced from long-term monitoring data collection and analysis and provides a record of effort that can be built upon for future monitoring investigations.

Aquatic and riparian ecosystem recovery following two debris flows in Western Washington

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Traditional oral presentation (20 minutes)

In steep, headwater streams of the Pacific Northwest, storms and flooding often trigger landslides and subsequent debris flows. These primary agents of change dramatically affect aquatic and riparian habitats and associated biological communities. An intense rain-on-snow storm struck southwestern Washington in December 2007 causing large debris flows (2-2.6 km long, 30-50 m wide) in 2 streams near Olympia, WA. The impacted streams had several years of pre-storm data providing a rare opportunity to examine the recovery of aquatic organisms, vegetation and stream temperature. Cutthroat trout were observed a few months after the debris flows. Initially, most trout were young-of-the-year fish, but after 4 years, trout age class resembled pre-impact and a nearby reference stream. After the debris flow, trout occupied habitats further upstream than previously due to the removal of barriers. Tailed-frog tadpole densities decreased after the debris flows and recovery rates were different between impacted streams. Sculpin re-occupied habitats in about 4 years. Crayfish did not recover after 5 years of post-impact monitoring, and western brook lamprey found before the debris flows were not detected afterwards. Benthic insect communities in both streams were relatively low in density and taxa richness the first summer after the debris flows, but increased over the next 4 years, a reflection of changing habitat conditions over time. The streams showed large increases in summer daily maximum and diel temperatures compared to pre-impact years and the adjacent reference stream. Riparian vegetation community colonization patterns were quite similar between the two impacted streams. Red alder was by far the most the most dominate colonizing plant species with over 50% cover after 4 years. We found that recovery rates after the debris flows differed among taxa, was site-specific and related to physical conditions, available habitats and source populations.

Programmatic evaluation of river restoration: lessons learned from a large effectiveness monitoring program

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Traditional oral presentation (20 minutes)

The Washington State Salmon Recovery Board (SRFB) in collaboration with the Oregon Watershed Enhancement Program initiated one of the largest programmatic restoration effectiveness monitoring programs in the country in 2004. The SRFB Project Effectiveness Monitoring (PE) Program originally included monitoring of more than 100 restoration projects spread across multiple project types including: fish passage, instream habitat, gravel addition, riparian planting, livestock exclusion, floodplain, diversion screening, and habitat protection. By 2016, fish passage, riparian planting, gravel addition, diversion screening, and habitat protection categories were discontinued or completed. In 2016, Cramer Fish Sciences was contracted to complete the remaining two years of data collection for livestock exclusion, instream habitat, and floodplain projects and provide a comprehensive review of the SRFB PE Program, including recommendations for future effectiveness monitoring. Results for livestock exclusion projects showed reduced bank erosion and improve riparian structure, despite some issues with control site selection and monitoring protocols. Instream habitat projects showed moderate improvements in mean residual profile, but no significant improvements in fish densities or other physical characteristics. Floodplain projects showed improvements in mean vertical pool profile, mean residual depth, and juvenile Coho salmon *Oncorhynchus kisutch* densities in some years, but no changes for other physical habitat metrics or fish species. While it is tempting to interpret the lack of results, particularly for instream and floodplain projects, as evidence the restoration efforts were not fully successful, the lack of more conclusive results is most likely because of issues with implementation of the monitoring (e.g., selection of treatments and controls, data collection, timing of sampling), which added additional variability and resulted in several sites having to be excluded from the analysis. Future effectiveness monitoring should consider stratifying projects by ecoregion, seasonal fish sampling (summer and winter), more rigorous selection of treatment and controls, improved habitat survey methods (protocols), and using a more efficient post-treatment design that does not require collection of pre-project data.

Lampreys of Oregon: opportunities and challenges

Benjamin Clemens
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Traditional oral presentation (20 minutes)

The goal of this presentation is to increase awareness of opportunities (and challenges) in lamprey research and management. I divide this aim into two objectives: 1) Pacific Lamprey, and 2) all other lampreys in Oregon. Forty-one to 44 known lamprey species exist world-wide. The state of Oregon is rich with lamprey species: 10 occur here. Of these, Pacific Lamprey is the most culturally-important and wide-spread, and it has been the focus of research and management. Opportunities and challenges exist for understanding within-species diversity, behavior, marine biology, and predicting abundance of Pacific Lamprey (as a few examples). The other nine species of lampreys in Oregon have received much

less research and management attention and opportunities for them are nearly boundless. However compared with Pacific Lamprey, the challenges for these nine other lampreys may be higher. Challenges include (but are not limited to) increasing awareness, convincing people of their importance, distinguishing among species, determining feasible monitoring units in time and space, and building productive collaborations to conduct the work and share the information.

Tick tock: what will it take to keep water in streams before the clock runs out?

Shaun Clements
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Coauthor: Anna Pakenham Stevenson
Speed oral presentation (7 minutes)

This talk will wrap up the session by discussing how the community of policy makers, restoration practitioners, advocates for fish, wildlife, and water; and scientists can work together to best represent the needs of fish as we swim into a water limited future.

An Integrated Approach to Fisheries Resource Management

Kelly Coates
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Traditional oral presentation (20 minutes)

Interdisciplinary approaches to management can create conflicts between resource specialists. This approach focuses on outcomes for specific disciplines as opposed to shared goals, objectives, and outcomes. The Cow Creek Band of Umpqua Tribe of Indians uses an integrated approach to resource management which interweaves the social/cultural, ecological, and economic values of the Tribe into all resource management decisions. Under an integrated approach all natural resources are considered cultural resources, the two are not approached with separate management strategies or desired outcomes. Instead, the Cow Creek team works collaboratively across disciplines to manage for a common outcome under common goals and objectives. This outlook is reflected in the Tribe's Fisheries Management Program and serves as the foundation for interactions with partners when considering co-management opportunities within the Tribe's Ancestral Territory. The applications of this integrated management approach are limitless, as any State, Federal, Tribal, or private organization can leverage the process of integrating multiple values, goals, and objectives into specific decision making processes.

The effects of rearing environment on social behavior in juvenile Chinook Salmon

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Traditional oral presentation (20 minutes)

Wild and hatchery salmonids experience significantly different environments during juvenile development. Typically, hatchery fish are reared at high density, in a physical environment very different from the wild, and on high lipid diet often fed to produce maximal growth rates compared to natural-origin (wild) conspecifics. These early rearing differences are likely responsible for the subsequent phenotypic differences observed between hatchery and wild juveniles. Hatcheries release thousands of juvenile salmon into rivers each year with the expectation that many will survive and swim downstream to the ocean. It is conceivable that these rearing differences may lead to differences in social behavior and survival of the fish. Here, we tested whether natural-origin and hatchery juvenile Chinook Salmon differed in their motivation to be near conspecifics. Additionally, we tested a third group of juvenile Chinook Salmon raised using altered rearing protocols to produce wild-like phenotypes, called "wild fish surrogates". We predicted that hatchery fish would be most motivated to be near conspecifics compared to natural-origin and wild fish surrogates when individually tested. We tested fish in an arena with unfamiliar conspecifics in a compartment at the opposite end of a start box or with the compartment empty as a control. For each fish, we evaluated the time it took to exit the start box into an aversive zone, the time it took to traverse the aversive zone, and the time spent in the preference zone. Our results show that wild fish surrogates are more similar to natural-origin fish and different from hatchery fish in their social and exploration behaviors. Understanding the social and motivational differences between hatchery and natural-origin fish may help guide conservation hatcheries and other programs.

Implementation and Evaluation of Efforts to Reduce Avian Predation on ESA-listed Salmonids in the Columbia Plateau Region

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Coauthors: Ken Collis, Brad Cramer, Allen Evans, Daniel Roby, David Trachtenbarg
Traditional oral presentation (20 minutes)

During 2014-2018, the U.S. Army Corps of Engineers (Corps) and Bureau of Reclamation implemented the Inland Avian Predation Management Plan (IAPMP). The goal of the plan was to reduce predation by Caspian terns on ESA-listed juvenile salmonids in the Columbia Plateau region by dissuading terns from nesting on Goose Island in Potholes Reservoir and Crescent Island on the mid-Columbia River, formerly the two largest Caspian tern colonies in the region. As part of this and a separate Caspian tern management plan implemented in the Columbia River estuary, the Corps has constructed alternative nesting habitat for Caspian terns at various locations outside the Columbia Basin in Oregon and California and have attempted to attract Caspian terns displaced from managed colonies inside the Basin to nest at those sites. Passive and active nest dissuasion measures implemented as part of the IAPMP were successful in preventing tern nesting on both Goose Island and Crescent Island during

2016-2018. Following management at Goose and Crescent islands, total numbers of Caspian terns breeding at colonies in the Columbia Plateau region gradually declined by 44% from the pre-management average of 874 breeding pairs (during 2005-2013) to 491 breeding pairs in 2018, suggesting that terns are gradually dispersing outside the region to nest. Based on the movements of Caspian terns that were either satellite-tagged or color-banded, some terns have relocated from Goose and Crescent islands to colonies in the Columbia River estuary and outside the Columbia Basin, including Corps-constructed tern islands. These marked terns also provide evidence that some terns from Goose and Crescent islands have strong fidelity to the Columbia Plateau region, with some terns still attempting to nest on Goose Island and others relocating to nest at unmanaged colony sites in the region, most notably the Blalock Islands on the mid-Columbia River, where colony size increased 5-fold following management (313 breeding pairs in 2018). Implementation of the IAPMP has achieved its primary objective of dissuading terns from nesting at Goose and Crescent Islands and as a result reduced predation on some ESA-listed salmonid stocks, specifically Upper Columbia River steelhead. Further salmonid smolt survival benefits would be realized if the Caspian tern colony at the Blalock Islands is reduced from its current size and there are no commensurate increases at other Columbia Plateau colonies in the future.

Nongame Fish in the Lower Willamette River Basin: Our Search for Oregon Chub and Evaluation of Fish Assemblage and Distribution

Matthew Collver
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Coauthors: Brian Bangs, Mike Meeuwig
Traditional oral presentation (20 minutes)

In a publication from 1908, John Snyder provided the first account for Oregon chub (Oregonichthys crameri), with a holotype collected from the lower Willamette River near Oregon City. Oregon chub were found in several other locations on the Clackamas River, a tributary of the lower Willamette, however the last observation was made in 1953. In recent decades, Oregon chub populations declined and were extirpated from much of their original range in the mainstem Willamette River, leading to listing under the Endangered Species Act in 1993. The species was delisted due to recovery in 2015. The Oregon Chub Investigations Project has discovered numerous populations throughout the Willamette basin, including tributaries where the species had not been observed previously. However, no extant populations have been observed in the lower Willamette River basin. Given the separation of these fish from populations upriver by Willamette Falls, locating a population in this reach has been a research goal for many years. In 2018, we had an opportunity for focused surveys in preferred habitats (i.e., slow moving channels and off-channel habitats) in the lower Willamette River basin. We sampled 50 habitats in the Clackamas River and its tributaries, and three adjacent watersheds: Johnson Creek, Kellogg Creek, and Abernethy Creek. We used baited minnow traps to capture, identify, and enumerate fish species present, and described habitat conditions. Although we were unable to locate an extant population of Oregon chub, we did collect information that may help to characterize the fish assemblage in the lower Willamette River basin. This information may be beneficial for researchers and

managers working in the basin, or as reference for future work. In this presentation, we will describe the history of Oregon chub in the lower Willamette River basin and previous surveys, the methods used in 2018, and summarize our most recent findings.

ODFW Snorkel Surveys Get Some Mussels

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Coauthors: Shelly Miller
Traditional oral presentation (20 minutes)

As part of the Oregon Plan for Salmon and Watersheds, the Oregon Department of Fish and Wildlife has monitored juvenile salmonids in Western Oregon streams since 1998. Monitoring has been accomplished by snorkel surveys in sites selected by a random, spatially-balanced process. Data from these surveys has been used to track juvenile salmonid distribution and abundance trends and support ESA viability evaluations. This effort, known as the Western Oregon Rearing Project (WORP), is scheduled to have a long duration and stable funding. In 2010, at the suggestion of biologists with the Pacific Northwest Native Freshwater Mussel Work-group (NFMW), WORP began to collect data on freshwater mussels (hereafter "mussels"). Mussels are ecologically and culturally valuable and mussel abundance and species diversity has been declining in North America and the Pacific Northwest. The partnership between WOPR and NFMW is an example of what often is referred to as "piggy-backing", where the resources of an existing monitoring program are used to collect ancillary information on a species that lacks adequate funding for monitoring. In order to collect mussel data minor changes were made to WORP's procedures. Surveyor training time was increased by ~1%, a rating of mussel abundance was added to the field protocol for each survey, and empty shells were collected for identification by NFMW. This data was gathered over the past 9 years at no additional cost and negligible increases in survey time to WORP. For many WORP surveyors this was their initial exposure to mussel ecology and conservation. Collection of this data resulted in contributions to the Pacific Northwest mussel database (maintained by NFMW members with the Xerces Society in Portland, OR). WOPR contributed new mussel distribution data, verifying the presence of mussels in four 4th field HUCs in Western Oregon where the status was previously unknown. Though limited to larger spatial scales, WORP's survey design may aid the monitoring of mussels over time in Western Oregon. Refinements could produce data on mussel reproduction and mussel distributions in higher order streams. Data from this project can also be illustrative of the benefits and limitations of "piggy-backing".

Compensatory Survival of Coho Salmon in Western Oregon

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Traditional oral presentation (20 minutes)

The Oregon Department of Fish and Wildlife has monitored Coho Salmon (*Oncorhynchus kisutch*) parr and adults in the Oregon Coast Coho Evolutionarily Significant Unit (OCC) for 21 years and in the Lower Columbia River Evolutionarily Significant Unit (LCR) for 13 years. A primary objective of this monitoring has been to inform conservation and recovery evaluations related to Coho Salmon by providing estimates of distribution and abundance at these life stages. This objective is achieved by using snorkel surveys to count parr at base flows and spawning ground surveys to count both live and dead adults during the spawning period. These abundance estimates were additionally utilized to create female spawner:parr recruit plots using Beverton-Holt models in R version 3.4.0. In the OCC the plots suggested parr production began to asymptote near current spawner abundances, indicating a density dependent effect on rearing capacity at this early life stage. Abundance estimate data suggest rearing capacity may be slightly higher in the Mid South Coast stratum, relative to other strata in the OCC. The number of parr produced per female increased when female spawner abundance decreased and, conversely, decreased when spawner abundance increased, suggesting a compensatory effect. The number of parr per female averaged 64 and ranged from 14, when female spawner abundance was highest, to 221, when female spawner abundance was second lowest. Unlike the OCC, plots of female spawners:parr recruits in the LCR did not suggest an asymptote in parr production at current spawner abundances. The number of parr produced per female in the LCR appeared to be less influenced by female spawner abundance and averaged 54% lower than in the OCC. Parr per female ranged from 7, when female spawner abundance was highest to 66, when female spawner abundance was second lowest, but any compensatory effects seemed weaker in the LCR than in the OCC. Data suggest current freshwater habitat conditions may contribute to limitations in Coho Salmon recovery.

Migration Timing and Movements of Radio Tagged Pacific Lamprey in the Middle Klamath River

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Traditional oral presentation (20 minutes)

In 2015 the Karuk Tribe Fisheries Program joined in collaboration with the Yurok Tribe and the Hoopa Valley Tribes to document migration timing and in-river movements of Pacific Lamprey Entosphenus tridentatus in the Klamath River and tributaries. Karuk Fisheries staff captured migrating Pacific Lamprey at four locations in the Middle Klamath River between RKm 82.25 and RKm 170.00 using traps based on traditional "eel baskets". Radio tags were surgically implanted in fish to determine migration rates, characterize movement patterns, and identify spawning areas. 20 fish were tagged in 2015, 48 fish were tagged in 2016, and 38 fish were tagged in 2017. Tagged lampreys were tracked manually at least once per week until tags were recovered or the battery life ended. Tagged fish were tracked to areas where spawning was observed. Some fish entered tributaries to spawn, however most spawning activity was observed in the mainstem Klamath River. No tagged fish were observed migrating upriver of the Scott River confluence (RKm 233.00). Movement patterns indicate wide variations in rates of upstream migration and time spent holding before spawning.

Use of Barbless Hooks as a Salmon and Steelhead Conservation Measure

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Coauthors: Thomas Buehrens, Forrest Carpenter, Ben Briscoe, Sean Gibbs
Traditional oral presentation (20 minutes)

The use of barbless hooks is a widely applied regulation for Columbia Basin salmon and steelhead hook-and-line fisheries, intended to improve survival of caught and released fish by reducing handling times and lowering injury rates. This may be prudent in cases where ESA-listed fish are present. We examined the available literature and developed a mark-recapture study to determine whether the practice of using barbless hooks is an effective conservation measure for natural-origin salmon and steelhead. We angled and marked over 1,000 salmon and steelhead, and found barbless hook regulations may provide a small survival benefit, but this benefit is potentially offset by lower landing rates in cases where hatchery fish harvest is allowed. Lower landing rates may lead to additional angling time and more frequent encounters between anglers and natural-origin fish. Angler experience level can also impact landing rates and fish handling time, which managers should consider when deciding whether barbless hook regulations are appropriate.

Trends in length at maturity of Oregon's hatchery Chinook

Alex Cuda
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Coauthor: Matthew Falcy
Traditional oral presentation (20 minutes)

Decreasing size and age at maturity of Oregon’s hatchery Chinook salmon are well documented. We used data from 237601 coded wire tag fish collected between 1990 and 2017 to explore the role of several potential causative factors. We treated each individual's age as an ordered factor response, and constructed several competing proportional odds logistic regression models. The models contained different ensembles of explanatory variables, which include length, run year, sex, release month, hatchery of origin, and release group average weight and density. Our best model indicates that size is decreasing annually for fish of age 4, 5, and 6 in both sexes. In addition to length and sex, hatchery of origin also had a large effect in predicting age. Interestingly, each respective release month showcased a significant effect within our models as well. January and July releases are suggestive to produce the smallest sized fish at any age, while May and August releases produce the largest fish. Potential applications of our model include finding optimal release scenarios and length criteria for any desired age composition of hatchery broodstock.

Mud in your eye? The potential of Unmanned Aerial Systems as a tool to conduct resource and habitat surveys in Oregon estuaries

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Traditional oral presentation (20 minutes)

Recent technological advances have made Unmanned Aircraft Systems (UAS) increasingly efficient and cost-effective tools for coastal mapping and inventory of natural resources. Present methods employed by the Oregon Department of Fish & Wildlife (ODFW)'s Shellfish and Estuarine Assessment of Coastal Oregon (SEACOR) project to assess shellfish populations and their habitats in Oregon's estuaries involve extensive field surveys that take more than one year to complete and are evaluated on a decadal scale. Combining these field surveys with UAS mounted with digital camera systems has the potential to improve the resolution of resource and habitat distribution maps, and increase the capacity of the agency to conduct more frequent resource monitoring. The initial efforts of SEACOR to use UAS imagery to survey fine scale (cm to sub-cm scales) features will be discussed including lessons learned, recommendations to avoid common pitfalls, and limitations of the technology. The results will highlight the recent collaboration between ODFW and the Career Tech Charter High School (Lincoln City) Coastal Drone Academy utilizing UAS to map the distribution of eelgrass beds in Netarts Bay, Oregon, as an example of how data from UAS surveys can be applied to monitoring and management.

Machine vision scanning in fisheries management

Steve Dearden
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Traditional oral presentation (20 minutes)

Machine Vision Scanning Observation of migrating fish provides critical data required for recovery and management actions. Considerable resource is expended to count, speciate and sort migrating fish at purpose-built viewing facilities within dams and other man-made barriers. Manual operators observe and record the data in real time or post analyze video recordings. However, the data gathered, and decisions made are inherently prone to human error, operator fatigue and fish directional behavior. Turbidity can also exacerbate accuracy - the main reason that prior automation attempts have been largely unproductive. Recent development of machine vision technology used in manufacturing and fruit harvesting operations provides the potential for dramatically improving and simplifying fisheries data collection. In this session we describe an adaptation by Whooshh Innovations of the current state of the art to fisheries management. Using a simple false weir configuration, the fish are dewatered, singulated and descend a short, wetted slide. Controlled lighting and high-speed imagery from radially arranged cameras provide multiple photographs of consistent quality for real time processing. Using combinations of machine learning, image recognition and triangulation, the control system computers are able to simultaneously synthesize the needed data and provide signals for sorting actions in less than 2 seconds, with an extremely high degree of accuracy. Fish counts, and individual fork length and girth measurements can already be reliably captured. Currently under development are algorithms that

include fin clip detection (for separation of wild and hatchery fish), and some speciation applications - primarily focused on exclusion of invasive species.

The automated nature of the system facilitates 24-hour operation with real-time decisions and remote access to image data. Volitional fish passage is not interrupted, fish are not physically handled, spend minimal time dewatered and are efficiently classified allowing for selective passage.

Advocating for Oregon's Fresh and Cold Water Habitat in a Climate Changed World

John DeVoe
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Traditional oral presentation (20 minutes)

John DeVoe, Executive Director of WaterWatch of Oregon, will present on the topic of advocacy as it relates to climate change and the effects of climate change on cold water and freshwater habitat in Oregon. Specifically, John will offer WaterWatch's perspectives and experience on the critical role of advocacy in adapting to climate change and as a tool for protecting and restoring freshwater habitat, by addressing the following questions:

What are the high level challenges to protecting and restoring streamflows and other freshwater/cold water habitat in Oregon and across the West in a climate changed world?

How can science help?

What is the role of advocacy in policymaking and where are we collectively falling short in protecting and restoring freshwater/cold water habitat in response to climate change?

What are some of the advocacy and related strategies and tactics that have been or can be successful in protecting and restoring freshwater/cold water habitat in response to climate change?

Coupling Airborne Thermal Infrared and Topo-Bathymetric Lidar Data: Potential Advances to Stream Temperature Modeling

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Traditional oral presentation (20 minutes)

Over the past 15 years the science of stream temperature modeling has been advanced by coupling thermal infrared imagery (TIR) and topographic LiDAR. TIR has been used to identify groundwater and

point source inputs for deterministic models as well as providing spatially explicit identification of in-stream thermal refugia. Topographic LiDAR and its derived products have provided high resolution structural information about riparian vegetation, terrain, and the associated parameters for solar loading and shading. While topographic LiDAR effectively maps terrestrial structural characteristics, it does not provide information on in-stream channel morphology since it utilizes a NIR wavelength which does not penetrate water. Traditionally, in-stream channel morphology for use in temperature modeling has been collected by on-the-ground efforts using sonar or total station surveys. Such field efforts are typically conducted as transect surveys, which are time consuming, costly, and require interpolation between physical measurements, yielding relatively low-resolution detail within the stream channel as compared to topographic detail provided from LiDAR. Recently, the development of Topo-Bathymetric lidar technology, which uses a configuration of the NIR and a green wavelength laser to penetrate water, has made it possible to generate high-resolution map of submerged in-stream structure. By reducing or eliminating the interpolation of channel morphology, deterministic models results of in-stream temperature under various flow conditions and channel alterations should be both more detailed and more accurate. Additionally, these informational advances may provide opportunities for associated analytic advances yielding an improved understanding of the processes dictating in-stream conditions.

An adaptive management strategy for Chinook salmon in California's Central Valley

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Coauthor: James Peterson
Traditional oral presentation (20 minutes)

Adaptive management is a special case of structured decision making where management decisions reoccur over space or time and there is a desire to reduce uncertainty associated with system dynamics. It requires information on the current system state, a set of models that represent alternative hypotheses on how the system operates, and the feedback of monitoring data to update our belief in the alternative models (hypotheses) following the implementation of a management action. We discuss the utility of merging integrated population models and coarse-resolution decision-support models to develop a set of optimal state-dependent management policies that collectively form a management strategy for Chinook Salmon (Oncorhynchus tshawytscha) as part of the Central Valley Project Improvement Act Anadromous Fish Restoration Program. We also discuss how monitoring data can be used to refine our belief in alternative models and improve future management decision making. The results of our study revealed a management strategy that can be applied at a broad scale and may be applied to systems with similar constraints.

Climate and streamflow permanence in the Pacific Northwest

Jason Dunham
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Traditional oral presentation (20 minutes)

Flow permanence in headwater streams of the Pacific Northwest are poorly understood. Recent efforts to use existing data on wet or dry stream channel observations have been assembled to produce a regional model of flow permanence. This model - PRediction Of Streamflow PERmanence - or PROSPER represents the results of a collaboration among multiple USGS science centers and thousands of datapoints collected by tribal, state, federal, and other organizations across the region. Although PROSPER provides robust predictions of streamflow permanence at a broad extent, there are some regions of the Pacific Northwest where model predictions do not perform well, and places where more local detail regarding the timing, duration, and frequency of stream drying is of interest. To address these information needs, networks of hundreds of temperature loggers and new tools for mapping wet/dry conditions are being developed and applied. A summary of these methods is provided and future products expected from this work are outlined. New tools for monitoring flow permanence offer many opportunities for collaboration across multiple partners and the key to better understanding how streamflow permanence responds to changing climatic conditions.

Oregon on the Cutting Edge: Creating the Foundation for 21st Century Molecular Monitoring

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Traditional oral presentation (20 minutes)

Rapid technological advancements and declining DNA processing and sequencing costs have led to a genomics revolution enabling the development of molecular applications to monitor biodiversity and assess management policies. Methods using environmental DNA (eDNA) "extraorganismal DNA found in the environment" are currently being applied to monitor a variety of species in freshwater environments. Thus far, these methods have generally been developed as needed for species-specific applications. Although progress is being made to develop multispecies eDNA detection tools, efforts to simultaneously detect multiple species and quantify relative abundance using eDNA have only been partially successful. A necessary foundation for any eDNA-based monitoring tool is a comprehensive reference sequence database of full mitochondrial genomic data for all target and sympatric species. The Oregon Biodiversity Genome Project is currently working with ODFW, OSU, and the USFS to develop a reference sequence database and multispecies detection tools for freshwater vertebrate species within the state of Oregon. At present, we have collected georeferenced, vouchered tissue samples of over 80% of Oregon's freshwater vertebrates, and assembled the mitogenomes of 137 specimens representing 57 species. A unique feature of our collection is that whole-organism vouchers, tissue samples, and genomic data will be linked and publicly accessible via the Oregon State Ichthyology Collection. The field to lab pipeline we have developed for this project will serve as a template to facilitate the development of localized eDNA monitoring programs in other states and regions. Ultimately, the monitoring tools we develop will make Oregon a leader in molecular

monitoring science and give us the 21st century management capabilities we need during the current period of unprecedented biodiversity loss.

A Framework for Assessing "Sufficiency" of Cold-Water Refuges and Climate Refugia for Cold-Water Fishes

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Traditional oral presentation (20 minutes)

Populations of cold-water fishes are increasingly faced with warm river temperatures. Cold water refuges (CWR) "areas of cold water in which thermally-stressed individuals may seek temporary shelter" are increasingly invoked as a potentially mitigating feature within warming river systems. Many studies have documented extensive use of CWR by cold-water fish species, and CWR use is often assumed to confer benefits to thermoregulating fishes by providing temporary (hours to weeks) shelter from adverse thermal conditions. But CWR use and associated behavioral thermoregulation is not without costs. Increased risk of predation, lost opportunity for foraging, and increased isolation within thermally-fragmented river systems may offset potential benefits of CWR use. While patterns of timing of CWR use are relatively well known, less well understood are the relative costs and benefits of CWR use, and net effects on individual fish physiological status, reproductive success, and dynamics of populations. To provide a framework for assessing the relative costs and benefits of CWR, we illustrate a conceptual model of CWR costs/benefits that recognizes that CWR provisioning ability is influenced by the suitabilities, capacities and characteristics of individual refuges, as well as the spatial and temporal context of the surrounding matrix and the suite of potentially connected neighboring refuges. Networks of CWR and their context in relation to extensive areas of cold water serving as core areas can also be understood to function as important elements of larger-scale climate refugia for highly-migratory species like salmon. This framework is intended to be useful as state and federal regulatory agencies continue to incorporate concepts of CWR into water temperature standards and TMDLs.

Over 40 years of restoration of a coastal estuarine ecosystem

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Traditional oral presentation (20 minutes)

The Salmon River watershed is located on the north-central Oregon Coast, USA. The watershed is 195 km2 in size, with an 800 hectare estuary that extends to river kilometer (rkm) 6.5. The basin has a diverse ownership and management: United Nations Biosphere Reserve, US Forest Service (USFS)

Cascade Head Scenic Research Area (Congressional designation), The Nature Conservancy-headlands, private industrial forest-uplands, Oregon State Parks and rural residential along the lower reaches of main-stem Salmon River. Residential and commercial development in the mid 1900's impacted the intertidal portion of the Salmon River estuary. One marsh system remained intact, this became known as the reference marsh. The reference marsh informed the restoration strategy of each altered marsh system as all other tidal marsh systems were altered to prevent tidal inflow and control freshwater outflow. Modified drainage and flooding of lowland estuarine ground, in high demand for agriculture, restricted tidal inundation. A former amusement park, built in 1969, impacted a 70 acre tidal marsh, tidal channels and wetland. The entire park was self-contained by a dike preventing tidal flow with tidal channels truncated by tide gates. A residential development was built on 50-acres, with similar infrastructure and impacts to the estuary. Both developments were dismantled and restored to reference marsh elevations and vegetation using LiDAR and field surveys as the foundation for the design. The estuary was restored incrementally from 1978 through 2016 in 9-10 year time intervals. This has provided the opportunity to study subsidence and revegetation of the restored tidal marshes. As well as study salmonid use of the tidal channels once barriers, tide gates were removed. Nearly the entire estuary is now restored to a natural, historic tidal regime, resulting in significant regeneration of native biodiversity. The last remaining dam is United States Highway 101.

Cumulative Effects of Avian Predation on Survival of Upper Columbia River Steelhead

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Traditional oral presentation (20 minutes)

Predator-prey interactions involving piscivorous colonial waterbirds and anadromous juvenile salmonids have been the subject of numerous research, monitoring, and evaluation studies in the Columbia River basin. Previous research has identified predation by Caspian terns, double-crested cormorants, and California and ring-billed gulls as a significant mortality factor for juvenile salmonids during smolt outmigration in the basin. Previous research has largely focused on the impacts of predation by birds nesting at specific breeding colonies, but many salmonid populations must migrate through the foraging ranges of breeding birds from multiple colonies during outmigration. These cumulative, system-wide impacts of colonial waterbirds on smolt mortality in the Columbia River basin are largely unknown. Juvenile salmonids are also subject to numerous other non-avian sources of mortality during outmigration (e.g., hydroelectric dam passage, predation by piscivorous fish, disease, and others) and determining to what degree avian predation limits smolt survival relative to these other sources of mortality is critical for prioritizing recovery actions for ESA-listed salmonid populations in the region.

As part of a multi-year (2008-2017), system-wide study we investigated the cumulative effects of avian predation on survival of ESA-listed Upper Columbia River (UCR) steelhead smolts and estimated what proportion of total smolt mortality was due to avian predation during outmigration. Survival and predation rates were estimated in multiple river reaches following tagging (passive integrated

transponder; n=71,036) and release at Rock Island Dam on the middle Columbia River, with predation from multiple avian species (terns, cormorants, gulls) nesting at up to 14 different breeding colonies evaluated. We used a state-space, mark-recapture-recovery model that used live and dead detections of tagged fish to jointly estimate predation and survival. Results indicated that consumption by birds included in the study was the dominant mortality factor for UCR steelhead smolts during outmigration from Rock Island Dam to the Pacific Ocean, with cumulative predation rates (all colonial waterbird species and colonies combined) ranging from 31% (95% credible interval {CRI}= 27-38) to 53% (95% CRI = 42-64) annually. Predation rates were highly variable by river reach, avian predator species, colony, and year. Comparisons of total mortality (1-survival) and mortality due to avian predation indicated that predation from colonial waterbirds was associated with most of the mortality in UCR steelhead smolts during outmigration from Rock Island Dam to Bonneville Dam, with birds accounting for 47% (95% CRI = 37-61) to 69% (95% CRI = 54-88) of all mortality annually. Results indicated that smolt losses from the 14 bird colonies included in the study were greater than losses associated with all other smolt mortality sources combined in nine of the 10 study years evaluated.

Designing biological reserves on stream networks

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Traditional oral presentation (20 minutes)

Biological reserves are a common conservation tool for terrestrial and marine ecosystems, which can be easily represented in 2-D Euclidian space. Designing biological reserves on stream networks is less common and more complicated. I used a quadratic integer programming algorithm originally developed for financial portfolio optimization to design reserves on stream networks. End-users can define limits to reserve size and fragmentation, and import stream reach attributes. The algorithm then finds the optimal "investment" in individual stream reaches that meet reserve criteria. The performance of the technique is explored using real stream topology with simulated habitat attributes.

Water Management in Oregon: Protecting Sensitive, Threatened, and Endangered Fish from Proposed New Water Uses Under OAR 690-033

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Traditional oral presentation (20 minutes)

Oregon is fortunate to have laws that designate fish habitat and aquatic life as beneficial uses [ORS 537.332(4)(b)] and require the state to consider impacts to sensitive, threatened, and endangered (STE) fish habitat before issuing new water rights [OAR 690-033]. In order to determine whether a proposed

new use will impair or be detrimental to the public interest with regard to STE species, the Oregon Water Resources Department (OWRD) consults with an Interagency Review Team (IRT).
The Oregon Department of Fish and Wildlife (ODFW) and Oregon Department of Environmental Quality (ODEQ), as members of the IRT, review water right applications to identify detrimental impacts to STE fish habitat and provide recommendations to OWRD that condition or mitigate the use to offset impacts identified. ODFW recommends conditions primarily related to fish screens and passage facilities and maintenance of biologically-necessary flows. ODEQ recommends conditions to maintain water quality characteristics required by the most sensitive beneficial uses, namely aquatic life and fish habitat. Both agencies also recommend mitigation, when appropriate.

If the IRT recommends mitigation, applicants must provide a Mitigation Proposal that, in most cases, is consistent with ODFW's Fish and Wildlife Habitat Mitigation Policy (OAR 635-415). Mitigation is simplest when a bucket-for-bucket proposal provides water at or upstream of the proposed use and within the same season. However, for some types of habitat impairment, an applicant may propose other measures, such as removal of a fish passage barrier or stream restoration project.
As water becomes more scarce and mitigation more common, challenges arise. For applicants, mitigation opportunities are not yet widely identified and costs for hiring consultants and securing mitigation may be high. For agencies, the lack of real time flow and water quality data state-wide presents issues for determining science-based impacts. OWRD has modeled flow data, but this does not adequately reflect current conditions or variances in flow between good and bad water years. In addition, ODFW has not yet determined biological flow needs of STE fish for all streams across the state, making the identification of impacts due to a reduction in flow challenging. For water quality, modeled stream temperatures exist for the month of August, but information for other stream characteristics are lacking in large parts of the state. Also, the state has not adequately studied cumulative impacts or the impacts of altered flow regimes from increased winter storage and summer releases. Finally, a changing climate amplifies water quantity and quality challenges, as models of future habitat conditions are only in the early stages of development. Because water rights are issued in perpetuity, habitat impacts need to be equally identified and considered for conditions long into the future in order to sustain Oregon's fish populations."

Post-release performance of Acclimated and Direct Stream hatchery Chinook Salmon smolts released into the Imnaha River

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Traditional oral presentation (20 minutes)

Currently, the preferred method for releasing hatchery-reared Chinook Salmon (*Oncorhynchus tshawytscha*) smolts into the Imnaha River is to first acclimate the smolts for two weeks at the Imnaha River Weir and Acclimation Facility. Then, the hatchery smolts are allowed a two week volitional release. However, acclimation is expensive, and due to space limitations at the Acclimation Facility, a portion of

the hatchery smolt production is released directly into Imnaha River at the Acclimation Facility. The goal of this study was to evaluate juvenile and adult survival rate metrics between Acclimated and Direct stream releases from Brood Years (BY) 2010-2014. We calculated juvenile survival rates from the Acclimation Facility to Lower Granite Dam (LGD) using juvenile hatchery smolts from each release group that were tagged with Passive Integrated Transponder (PIT) tags. No difference was found in the mean (± SE) juvenile smolt survival rate to LGD for either the acclimated (69.7 ± 5.8%) or direct stream (69.3 ± 5.0%, P=0.84) release strategies. To examine adult return rates, we calculated mean (± SD) Smolt-to-Adult Survival (SAS) rates to Bonneville Dam using both coded-wire-tags (CWTs) and PIT tags. For all available BYs, the mean SAS rates calculated with CWTs and PIT tags were positively correlated (R2 = 0.91) and the mean CWT derived SAS rates for the Acclimated releases (0.735 ± 0.56%) were not significantly different from the Direct stream releases (0.720 ± 0.71%, P = 0.35). However, the mean PIT tag derived SAS rates from the Acclimated releases (0.634 +/- 0.51%) were significantly greater than mean SAS rates from the Direct stream releases (0.559 + 0.57%, P = 0.036). Because the BY2014 returns are not complete (i.e., age 5 returns from BY2014 are expected in 2019), we re-ran the analysis for complete BY's 2010-2013. Excluding BY2014, no significant differences in mean SAS rates were found between Acclimated and Direct stream releases for either the CWT SAS (P = 0.176) or PIT tag SAS (P = 0.170) rates. Preliminary results from this study suggest survival rates were similar between the Acclimated and Direct stream release strategies for Chinook Salmon hatchery smolts released into the Imnaha River.

Cougar Fish Passage: The Past, Present, and Future Cougar Fish Passage: The Past, Present, and Future

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Traditional oral presentation (20 minutes)

In its 2008 Biological Opinion (BiOp), the National Marine Fisheries Service (NMFS) concluded that the Proposed Action for continued operation and maintenance of the U.S. Army Corps of Engineers' (Corps) Willamette Valley Project (WVP) is likely to jeopardize the continued existence of Upper Willamette River (UWR) Chinook salmon (*Oncorhynchus tshawytscha*) and UWR steelhead (O. mykiss), which are listed as threatened under the Endangered Species Act (ESA), and to adversely modify or destroy designated critical habitat for these species (NMFS 2008). NMFS provided the Action Agencies (Corps, Bonneville Power Administration (BPA), and Bureau of Reclamation (USBR)) with Reasonable and Prudent Alternative (RPA) to supplement the Proposed Action. The RPA is a package of measures that allows for the survival of these species with an adequate potential for their recovery. The RPA contains categories of substantive measures for fish passage, water quality, flows, water contracts, habitat, and hatcheries.

Cougar Dam construction was completed in 1963 with the authorized purposes of flood damage reduction, power generation, water supply, low-flow augmentation, and recreation. Adult and juvenile

fish passage at Cougar Dam has ranged from abandoning fish passage to construction of a new adult facility and the proposed Floating Screen Structure for juvenile passage. This presentation will look at the past, present and future fish passage at Cougar Dam.

Surveying Schools with Sound: Pairing acoustics with video to count semi-pelagic rockfish in Oregon's rocky reefs

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Coauthors: Leif Rasmuson, Kelly Lawrence, Matt Blume, Polly Rankin
Traditional oral presentation (20 minutes)

The rugged rocky reefs of Oregon's nearshore pose a unique challenge for collecting fisheries independent data. Further, as this is the primary location of recreational fishing effort, this lack of data is detrimental to the sustainable management of these fisheries. While trawl surveys are often used to estimate the abundance and biomass of many marine species, trawls are unable to be operated over rocky reefs. Therefore there is a need for alternative methods to survey the rockfish on these reefs. The Oregon Department of Fish and Wildlife has been testing the application of active acoustics paired with stereo video to survey semi-pelagic rockfish species, specifically Black and Deacon Rockfish, to provide population estimates for stock assessments.

The data collection process involves deploying a portable scientific echosounder and running acoustic transects to identify the location of schooling fish and collect measurements of backscatter as sound reflects off the swim bladders of the rockfish. Following the acoustic survey, a benthically anchored suspended stereo camera is dropped on the previously detected schools of fish to identify species and collect fish length data. Processing of acoustic data uses specialized software to conduct echo integration for large schools and single target analysis for individual rockfish. Stereo video is reviewed to extract proportional data of the target species and size estimates. Acoustic and video data are combined to calculate an estimate of abundance of Black and Deacon Rockfish for the reef system surveyed. After multiple field tests across many reefs, these methods have proved to provide valuable fisheries independent data and the future goal is to implement the survey state-wide.

Balancing Act: Competing priorities in designing spatially and temporally extensive monitoring programs

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Traditional oral presentation (20 minutes)

Managing species over broad extents presents some formidable challenges to collect relevant data at the necessary spatial and temporal scales. Different goals often oppose each other and managers must often make difficult decisions and think creatively to mitigate the trade-offs of monitoring for competing demands. For example, how can we balance the need for continuity in long-term data sets against the desire to implement emerging tools and hypotheses? When the appropriate spatial scale for a given process is fine, how do we simultaneously make assessments over broad spatial extents? I will present a brief history of fish monitoring at the ODFW with special attention to different approaches that have been tailored to the species, physical conditions, questions and available resources at hand. In this high-level fly-over of monitoring in Oregon we will consider census vs. convenience samples vs. statistical samples including GRTS designs; foot surveys vs. continuous monitoring at fixed stations vs. remote sensing; emerging techniques like eDNA; and strategies to use multiple approaches simultaneously to augment each other.

Vast Coastal Ocean Dataset Now Available from the Ocean Observatories Initiative's Endurance Array

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Traditional oral presentation (20 minutes)

The National Science Foundation's Ocean Observatories Initiative (OOI) is delivering in situ data from coastal Oregon and Washington waters. OOI includes the Endurance Array, which consists of moorings and profilers at each of three sites located off the central Oregon coast at 25, 80, and 580 meters depth. The Endurance Array also includes three analogous sites off the central Washington coast, and a network of gliders surrounding all six sites. Some components off Oregon are connected to an undersea fiber optic Cabled Array, which also includes two profilers at full ocean depth further west. At each site there is a broad range of physical, chemical, and biological sensors measuring time series of everything from currents, waves, and winds to nitrate, pH, and oxygen to phytoplankton, zooplankton, and underwater images. Data from every platform are available in near real-time.
This contribution will show what OOI has been deploying for the last several years, how to access these data, and how to influence future OOI sampling. Data presented will highlight sampling in Oregon's Territorial Sea. This will include data from Oregon's first oceanographic mooring to collect continuous surface water measurements over-winter this close to shore, time series of high vertical-resolution full water-column profiler data during hypoxic events and chlorophyll blooms, and weekly glider transects that extend across the continental shelf. In October 2018, OOI started a new 5-year award, so data from these platforms should continue to be collected. Improved data accessibility and quality are the main focuses of the new award. The goal of this presentation is to encourage more people to utilize OOI."

Development and evaluation of an adult lamprey wetted wall structure at Bonneville Dam

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Traditional oral presentation (20 minutes)

Lamprey-specific passage structures (LPSs) have been employed to allow Pacific lamprey (Entosphenus tridentatus) to bypass difficult passage areas in traditional fishways. Areas of particular concern for lamprey passage include vertical slot and serpentine weir sections such as those at Bonneville Dam (Oregon) fishway exits. However, after lamprey enter the serpentine weir sections, they must move downstream to access the LPSs. To provide lamprey with an alternate route from the serpentine weir section to the adjacent area containing an LPS, a vertical wetted wall was installed in the Bonneville Dam Bradford Island (BI) fishway. This allowed lamprey to climb out of the main ladder and have immediate access to the LPS. The structure design was based on one used in successful lab tests. Non-invasive assessment of lamprey use and salmonid responses to the structure was based on video monitoring. Additional evaluation capitalized on adult lamprey PIT-tagging conducted for other studies. During the 2018 lamprey passage season we collected video of the wetted wall's vertical collector and exit. Video was evaluated over three time periods: May 1 - 23, July 24 - August 8, and September 3 - 10. Passage events and details of lamprey ascending the structure and exiting to the adjacent makeup water channel were documented. Interactions with the wetted wall by salmonids were also catalogued. During the video review periods we observed 343 individual lamprey passing from the Bradford Island fishway using the wetted wall structure. At least three of the lamprey that used the wetted wall were PIT tagged. These fish were originally released downstream from Bonneville Dam, were detected using the wetted wall, and then exiting the BI LPS. Of the lamprey using the wall, 99.7% passed at night and took less than 2.5 minutes on average. Flow to the wetted wall was higher starting in July than during the May period; all lamprey found and used the structure at the higher flow. The higher flow may have made the wetted wall easier for lamprey in the serpentine weir section to detect. Throughout all video review periods and at all flow levels, no instances of salmonid interactions with the structure were observed.

Video observations provided valuable insights into lamprey passage that can inform operation and design modifications. Alternative power supplies should be implemented to improve monitoring capability and passage estimation. In its first year of operation the wetted wall provided an alternative passage option to lamprey in the serpentine weir section of the BI fishway and ultimately to passage over the dam. Such structures could be used to direct lamprey into alternative routes, to provide passage over small barriers, or to provide access to larger lamprey passage systems in locations with structural or space constraints.

Juvenile Outmigration and Survival to Adulthood of Triploid Summer Steelhead

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Traditional oral presentation (20 minutes)

Introgression with non-native hatchery summer steelhead *Oncorhynchus mykiss* has been identified as a potential factor impacting ESA-listed native winter steelhead in the Willamette River. To assess if sterilized summer steelhead could be used as a conservation tool while continuing to provide a fishery, we PIT-tagged and released 22,152 triploid juvenile summer steelhead into the South Santiam (2014 and 2015) and Middle Fork Willamette (2015) rivers and 21,679 diploid juveniles that served as the control group. We monitored the outmigration of juveniles and the return of adults at tag interrogation sites. Once adjusted for release group size, the proportion of diploids detected at Willamette Falls was significantly greater than the proportion released for all release locations and years, suggesting they outmigrated more successfully than triploids. The travel time of diploids to Willamette Falls was significantly shorter than for triploids; a median difference of 4-9 days depending on release basin and year. Tag recoveries at East Sand Island in the Columbia River provided evidence of substantial avian predation (4.2% of all fish released), but selection for the ploidy groups was mixed; relative to the release group sizes tag recovery was disproportionately high for South Santiam River diploids and Middle Fork Willamette River triploids. In 2016, 35 adult triploid steelhead returned to Willamette Falls (0.36% survival to adulthood) compared to 215 diploids (3.07%). Nine diploids and no triploids returned in 2017, an extremely poor run year when only 2,182 summer steelhead returned to the basin. Including these data reduced the overall survival estimates to 0.16% (triploid) and 1.03% (diploid). Combined with previous results of saltwater rearing trials using the first cohort (those spawned in 2013), we concluded that the performance of triploid steelhead was poor and survival declined progressively as the fish matured. However, to our knowledge this was the first study that documented triploid steelhead returning from the ocean as adults after being released in freshwater as juveniles. Additional work comparing the performance of different species, stocks, or family groups could further determine the value of triploidy as a genetic conservation tool for anadromous salmonids.

Long-term evaluation of fitness and demographic effects of a Chinook salmon supplementation program

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Traditional oral presentation (20 minutes)

While the goal of supplementation programs is to provide positive, population-level effects for species of conservation concern, these programs can also present an inherent fitness risk when captive-born individuals are fully integrated into the natural population. In order to evaluate the long-term effects of a supplementation program and estimate the demographic and phenotypic factors influencing the fitness of a threatened population of Chinook salmon (*Oncorhynchus tshawytscha*), we genotyped tissue samples spanning a 19-year period (1998-2016) to generate pedigrees from adult fish returning to Johnson Creek, Idaho USA. We expanded upon previous estimates of relative reproductive success (RRS) to include two full generations and used generalized linear models to determine if origin (hatchery or natural) or phenotypic traits (timing of arrival to spawning grounds, body length, and age)

significantly predicted reproductive success (RS) across multiple years. Our results provide evidence that this supplementation program with 100% natural-origin broodstock provided a long-term demographic boost to the population (mean of 4.56 times in the 1st generation and mean of 2.52 times in the 2nd generation). Overall when spawning in nature, hatchery-origin fish demonstrated a trend towards lower RS compared to natural-origin fish ($p<0.05$). However, when hatchery-origin fish successfully spawned with natural-origin fish, they had similar RS compared to natural by natural crosses (1st generation mean hatchery by natural cross RRS = 1.11 females, 1.13 males; 2nd generation mean hatchery by natural cross RRS = 1.03 females, 1.08 males). While origin, return year, and body length were significant predictors of fitness for both males and females ($p<0.05$), return day was significant for males but not females ($p>0.05$). These results indicate that supplementation programs that reduce the potential for genetic adaptation to captivity can be effective at increasing population abundance while limiting long-term fitness effects on wild populations.

Early observations from monitoring of a Sockeye Salmon reintroduction program

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Traditional oral presentation (20 minutes)

The historical distribution of Sockeye Salmon (*Oncorhynchus nerka*) in the Columbia River Basin has been constrained by the species dependence on nursery lakes for juvenile rearing. Several productive lake systems that were impounded by dams during the last century lead to the extirpation of Sockeye Salmon from many nursery lakes in the region. Recent efforts to re-establish populations in historically natal areas are exemplified by the Cle Elum Lake reintroduction program. The program is founded on outplanting of adult fish from two donor populations in the middle Columbia River with different adaptive potentials. We used genetic stock identification methods to differentiate stock origins between Osoyoos Lake (OSO) and Lake Wenatchee (WEN) donor stocks, and to evaluate the relative productivity from two brood years (2011 and 2012) of natural spawning in the novel environment. Spawning ground surveys revealed assortative mating between earlier spawning WEN fish that were more abundant farthest upstream and later spawning OSO fish that were concentrated (82%) downstream nearest the lake. Hybrids accounted for only 5% of sampled smolts and 4% of adult returns. Smolts rearing in Cle Elum Lake were significantly larger overall (OSO- 140 mm, WEN- 129 mm) than smolts in either donor population (84 mm). However, the average size of OSO smolts varied among emigration years, suggesting slow growth in some years, and relative smolt abundances favored the WEN stock (70% overall), indicative of a rearing survival advantage. In relation, the WEN stock exhibited a better average rate of replacement (0.80) in adult-to-adult escapement compared to OSO (0.17). Continued monitoring will focus on trends in productivity and potential demographic shifts that may arise in the Cle Elum Lake population and will help inform managers concerning limiting factors in the environment that might impact similar approaches to reintroductions in other lake systems.

Successful Teams Through Supported Voices

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Coauthor: Shannon Richardson

Traditional oral presentation (20 minutes)

Within the fisheries sciences, research and management of resources and their habitats incorporate practices that are, at their core, complex and interconnected. Rarely does effective research and management occur under a single jurisdiction and success is often found when a variety of knowledge, skills, and experiences are employed. With some heavy lifting, we see successes: a population, a landscape or an ecosystem functioning on multiple levels. It should follow, then, that when we extend this approach to our working teams, we may reap similar benefits. Leaders within the natural resource management arena have put forward efforts to work toward diverse workplaces. We know that the greater the diversity of voices at the table, the more innovative, resilient and productive we become. But what happens once we decide to act at a local level? How, then, do we work together to facilitate diverse working groups that provide an environment where every voice counts? Often, we act under the assumption that a group moves forward on the same path with the same experiences and interpretations of those experiences. In reality, each person encounters a unique set of obstacles, challenges and experiences along the path. This is why we, at every level, need the tools and understanding to not only create complex work groups but to foster working communities that support opportunities for success and inclusion that are equal for every individual on our teams.

The purpose of this panel is to hear the voices of professionals that represent an array of backgrounds and lived experiences. Through conversation, learn how to identify and counter biases and stereotypes while finding your unique voice and using it to help others, generating success for yourself and your team. Questions and discussions will focus on establishing strength and comfort in your identity at work, how to facilitate a cohesive work group that is innovative and inclusive, and practices for fostering supportive work communities.

Development of Oregon's Sportfishing Regulations

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Traditional oral presentation (20 minutes)

The development of the Oregon Sportfishing Regulations occurs on an annual basis. This process involves the close coordination between twenty Fish Districts and other staff across nine Angling Zones to provide a balance of angling opportunities and conservation of a variety of species. Even though the Sportfishing Regulations are developed annually, in any given year due to many factors there is a need to make in-season changes to the regulations to protect the fish resources, provide protections to public health, or to provide increased opportunity. This talk will focus on the annual regulation development process and protocols and will describe some of the factors and strategies that are considered that lead to in-season changes.

Predation on Salmonids by Smallmouth Bass in the Lower Yakima River, Washington

Sean Gibbs
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Coauthors: Tara Blackman, Ian Courter
Traditional oral presentation (20 minutes)

Non-native smallmouth bass can adversely affect native salmonid populations through predation on outmigrating juveniles. In the Columbia River Basin, the consumption rate of salmonids by Smallmouth Bass differs between sub-basins and can change over time, making it difficult to quantify predation. In this study, we estimated Smallmouth Bass predation on salmonids in the lower Yakima River, Washington, by estimating Smallmouth Bass populations in three sections of the river using a mark-recapture design and then sampling diets of Smallmouth Bass (>100 mm fork length). Weekly sampling occurred between April and June, 2018, along shoreline habitat using a raft electrofisher. Stomach contents were collected from a random subset of Smallmouth Bass (n=587) via non-lethal gastric lavage and prey items were identified, enumerated and weighed in a laboratory. Consumption rates were extrapolated to Smallmouth Bass population abundances to estimate predation loss of salmonids at weekly intervals. Preliminary results suggest high predation on salmonids by Smallmouth Bass and that sub-yearling fall Chinook are particularly vulnerable. Additionally, we find evidence that Smallmouth Bass 100-150 mm fork length, a size class that has not been well studied in the Columbia River Basin, may be significantly contributing to salmonid mortality in the Yakima River.

Beavers as partners in a lamprey habitat restoration project

Damon Goodman
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Coauthor: Reid Stewart
Traditional oral presentation (20 minutes)

Lamprey ammocoetes (larvae) rear in burrows constructed in low velocity depositional areas of stream channels, a habitat feature often enhanced by beaver-induced channel modifications. We investigated ammocoete distribution patterns within a constructed off-channel pond restoration site that was colonized and modified by beaver following construction in Grass Valley Creek, Klamath River drainage. Beaver modifications include a network of dams and pools that influence water surface elevation, sediment deposition and pond configuration. We evaluated distribution, abundance and habitat preference variables within the pond system in 2016 and 2018. Ammocoetes were widely distributed in the pond system, with densities up to 81 per square m, but not evenly distributed. Their distribution also varied by sample year, as did pond bathymetry and water surface elevation. Habitat variables related to lamprey abundance including depth, velocity, aquatic vegetation and sediment oxygenation.

To evaluate future management strategies of the pond system, a series of experimental water-surface elevation draw-downs were executed and ammocoete distribution monitored to evaluate if fluctuations would induce lamprey movements. We found no evidence to support lamprey movement to deeper areas with changing water-surface elevations. The information on lamprey use of the ponds, behavior with water-surface elevation changes, and beaver behavior were incorporated into recommendations for future management of this pond system and application to other restoration projects.

The Lamprey Toolbox: Conservation Recommendations

Ann Gray
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Traditional oral presentation (20 minutes)

Pacific lamprey are an important native, anadromous fish species in decline; however, these fish are often overlooked when conducting in-water work or designing and implementing stream restoration actions for other anadromous species. Over the past two decades, there have been increasing efforts to research and define how to protect and conserve Pacific lamprey. Today, there are several publicly-available websites and documents that can help restoration practitioners incorporate the biological needs of lamprey into both the design and implementation of instream projects. These resources include consolidated information across the range of lamprey, addressing habitats, behavior, passage needs, salvage methodologies, and other best management practices, including ways to minimize impacts during instream work. This presentation summarizes available resources that can assist mangers and practitioners in their efforts to protect and provide for lamprey during in-water work and restoration activities. Specifically, this talk will briefly familiarize the audience with information in the following documents:

Practical Guidelines for Incorporating Adult Pacific Lamprey Passage at Fishways (2017)
Design Guidelines for Pacific Lamprey Passage Structures (2015)
Pacific Lamprey Habitat Restoration Guide (2015)
Best Management Practices to Minimize Adverse Effects to Pacific Lamprey (2010)

In addition to these guideline documents, the presentation will also introduce a website maintained by the USFWS as part of the Pacific Lamprey Conservation Initiative, a collaborative group of agencies, tribes, and others working to develop and share information to conserve lamprey. This website is updated regularly and has lamprey distribution maps, technical write-ups, educational resources, and links to other useful information available on the internet.
The purpose of this presentation is two-fold: (1) to provide a variety of information resources to meet the various needs of restoration practitioners (i.e. engineers, biologists, project managers, fisheries managers), and (2) to reach out to the broader restoration community to gather any additional information and resources that can then be added to the guidelines and website.

Project Update: Implementation of the Winter Lake Restoration phase of the Coquille Working Landscapes Project

Michael Gray
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Traditional oral presentation (20 minutes)

We presented "Coquille Working Landscapes Projects--"Beef in the Summer and Fish in the Winter" at the 2018 OR-AFS Annual Meeting. This large-scale, phased project began with the China Camp Creek phase, replacing a failing tidegate structure in 2017. Implemented in Summer 2018, the Winter Lake Restoration phase created meandered tidal channels that mimic historic channels, and filled-in large drainage ditches. Together, these two phases improve overwinter habitat for Coho Salmon and waterfowl on over 1,700 acres of Coquille River bottomland, while striving to meet objectives for agricultural production and fish/wildlife conservation. This presentation will briefly recap the China Camp Creek phase, update with the completion of the Winter Lake Restoration phase, and demonstrate a Working Landscapes approach that successfully partnered agricultural and conservation interests.

Incidental No More: Pacific Lamprey Spawning Surveys on the Entiat River, WA

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Traditional oral presentation (20 minutes)

Little is known about the timing and distribution of Pacific Lamprey spawning in most Mid-Columbia River tributaries. What information is available is typically incidental, gleaned from spawning ground surveys targeting other species thought to spawn earlier (steelhead) or later (Chinook Salmon) than Pacific Lamprey. To address this this data gap, we investigated spawning in the Entiat River during the presumed Pacific Lamprey spawning season. Our study occurred in summer 2018, during which time an exceptionally large run of Pacific Lamprey was available to spawn in the Entiat River. Weekly cataraft and kayak-based surveys were conducted over four river reaches covering 45 river kilometers. Pacific Lamprey spawning was observed in all four reaches, but was concentrated in the lowest reach. A total of 233 adult lamprey observations were recorded on the spawning grounds, in association with 153 occupied nests, and 118 unoccupied but probable nests. Nest size was highly variable, owing to both cluster nests and superimposition. Nesting activity was observed from June 11 to July 13, at water temperatures ranging from 9.5 to 17.0 °C. The large number and size variability of nests observed in this study required us to adapt our redd-based methodology to focus on adult lamprey observations. We suggest that future lamprey spawning studies consider using adult observations in lieu of nest counts when individual nest size, detectability, and longevity are highly variable.

Factors associated with the regional patterns of steelhead survival in the Columbia River Basin

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Traditional oral presentation (20 minutes)

Steelhead populations within the Columbia River basin enter the hydropower system at different locations with different levels of exposure to operational and environmental conditions during their juvenile outmigration. However, these populations share a common estuarine and oceanic environment following passage through the hydropower system. These common versus differential experiences allow for useful comparisons of population- and life-stage-specific survival rates and the factors that may be associated with those rates. In this presentation, we present mark-recapture estimates of in-river survival, ocean survival, and smolt-to-adult return rates for wild steelhead populations from the Entiat/Methow, Yakima, John Day, and Snake rivers and examine how these survival rates vary over time and with environmental factors. Through simulation studies that incorporate these patterns of variability, we explore survival targets and hydropower operations that may be necessary to support conservation objectives and population recovery.

Perfect timing? Modeling optimality of thermal refuge migration phenology under energetic and physiological constraints

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Coauthors: Jordan Ortega, Christopher Derrickson, William Tinniswood, Matthew Sloat, Jonathan Armstrong
Speed oral presentation (7 minutes)

Many salmonid species behaviorally cope with temperatures above their thermal optimum by exploiting small patches of cold water. In many systems fish use these thermal refuges during warm periods lasting days to weeks. In contrast, our past research has shown that redband rainbow trout in the Upper Klamath Basin spend 3-4 consecutive months on refuge habitats tens of kilometers from lethally hot lake foraging grounds. We hypothesized that the phenology of this thermal refuge migration is a temperature-dependent Bernoulli process that results in most fish leaving the lake under stressful but sublethal temperatures, so as to maximize foraging opportunity in the hypereutrophic lake. We paired two years of radio telemetry data with USGS water quality monitoring to model migration probability as a function of maximum daily lake temperature. Preliminary results indicate lake temperature is strongly correlated to migration and significantly exceeds the thermal optimum for rainbow trout (15C) during periods of peak movement.

Energetic trade-offs of seasonal thermal refuge use in Klamath redband rainbow trout

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Coauthors: Jordan Ortega, Christopher Derrickson, William Tinniswood, Matthew Sloat, Jonathan Armstrong
Traditional oral presentation (20 minutes)

Amid mounting interest in prioritizing conservation efforts under climate change, many studies seek to broadly identify critical habitat for a species based on an optimal summer temperature range that maximizes metabolic scope for growth. While easy to implement across taxa, this approach is limited where such optimal temperatures and foraging opportunity vary asynchronously over space and time, forcing animals to make trade-offs between energy gains and costs when selecting habitats. We have previously shown that redband rainbow trout spend spring and fall in warm, hypereutrophic Upper Klamath Lake and summer in cool, less productive thermal refuges; thus these fish provide an opportunity to quantify such trade-offs. We assessed energetic condition of fish across these habitats and seasons using Fulton's K and bioimpedance methods. We also paired gut content analysis with compound-specific stable isotope analysis of prey and fin tissue in order to characterize diet composition on both short and long timescales. From this diet information we estimated energy budgets associated with each season and habitat. We found that energetic condition is generally lower in summer refuges than in the lake, which is associated with a pronounced dietary shift from fish to insects. Our results suggest that seasonally unsuitable lake habitat provides redband trout the energy needed to fuel summer thermal refuge use and winter spawning. Thus, habitat analyses that focus exclusively on summer conditions may fail to identify the habitat features that allow fish populations to remain productive in seasonally warm watersheds.

Coho Salmon Life History Variants in Humboldt Bay Tributaries

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Traditional oral presentation (20 minutes)

The decline of Coho Salmon in California is the result of various anthropogenic effects across the landscape, affecting all stages of their anadromous life history. As salmon habitat becomes more fragmented through human actions, the need to better understand interactions between connected salmonid populations only grows. Monitoring a subset of the remaining populations is essential to evaluate the success of management plans and develop new restoration projects. Defining the appropriate scale for this monitoring and restoration depends on the frequency and extent of dispersal of individuals across watershed boundaries. Coho salmon life-cycle monitoring in California tracks abundance of juveniles and adults over time in selected focal watersheds. If individuals frequently leave these watersheds for rearing or spawning, the abundance estimates might not accurately reflect current conditions. We are assessing movement among watersheds at the Freshwater Creek life cycle

monitoring station on Humboldt Bay. Using PIT tags and mark-recapture multi-state modeling, we will evaluate the movement of juvenile and adult Coho Salmon among Freshwater Creek and two other Humboldt Bay tributaries. This research will quantify the frequency of dispersal between nearby streams at different life stages to evaluate the need for changes in both management and monitoring. If there is significant movement between these watersheds, effective management and monitoring strategies of Freshwater Creek may need to be expanded to include nearby streams.

Evaluating the influence of past experience on swimming behavior and passage success in adult Pacific lamprey

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Traditional oral presentation (20 minutes)

During spawning migration, adult Pacific lampreys (Entosphenus tridentatus) navigate through fishways that have water velocities reaching ~2 m/s. As this exceeds critical swimming speed estimates (~0.86 m/s), lampreys can expend considerable amounts of energy as they approach anaerobic levels. Although several studies have examined the role a short-term or single passage challenge has on swimming ability and passage success, few studies have examined cumulative effects on endurance from overcoming multiple obstacles. The primary objective of this study was to evaluate Pacific lamprey endurance capacity in response to exhaustive exercise challenges in an experimental flume located in the adult fish facility (AFF) at Bonneville Dam. Additionally, the metabolic costs of various swimming behaviors lamprey exhibit when passing through the hydropower system is largely unknown. The objective of a pilot study was to evaluate the application of accelerometer biotelemetry to estimate energy expenditure for fish navigating through the serpentine weir section at the Washington-shore fishway at Bonneville Dam. In the exhaustive exercise trials, passage success was measured according to ability to pass a 1.00 m vertical-slot weir in response to five treatment combinations of water velocity (0 m/s, 1.0 m/s & 1.4 m/s) and trial duration (0 min exercise, 20 min exercise only & 20 min exercise, then 10 min rest, then 20 min exercise). 36 fish were evaluated per treatment. Additionally, adult lampreys tagged with biotelemetry accelerometers were placed in an experimental flume for observation of different swimming behaviors and activity levels during passage. Fish were released and monitored just downstream of the junction of the upstream migration tunnel and Washington-shore ladder at the Washington-shore fishway. In the exhaustive exercise experiment, lamprey passage success was lowest (52.2%) during the high-velocity, long-duration treatment ($Z = 3.26$, $P = 0.001$). Lamprey size was not related to passage success. These results support the hypothesis that adult passage success at Columbia River dams is mediated in part by physiological limits of lampreys while they are in fishway sections containing vertical-slot weirs. Our results from accelerometer fish released at WA-shore fishway indicate they spend the greatest proportion of time in low-velocity, refuge areas with intermittent burst movement behavior. The recording of acceleration data is a promising method for being able to quantify the cost of different behaviors and movement patterns during passage.

Grow a Tree, Save a Fish: Riparian Management in the Middle Fork John Day River as a Restoration Priority for Chinook Salmon

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Poster presentation

Throughout most the John Day River Basin in Eastern Oregon elevated summer stream temperatures limit distribution of salmonids and therefore, the freshwater production potential of this habitat. Current climate change modeling suggests that future summer distribution of salmonids will be further truncated. The Heat Source model developed by ODEQ has been previously utilized on the Middle Fork John Day River to predict changes in stream temperatures as a function of a warming climate. In addition, this effort identified riparian shading as having the greatest potential to decrease summer water temperatures. Here we describe an effort to relate this restoration potential to salmon recovery. We conducted snorkel surveys to determine current rearing distribution and summer presence/absence of juvenile Chinook salmon throughout the Mainstem Middle Fork John Day River. We used these data to predict potential Chinook parr distribution at different shading scenarios described in the Heat Source modelling exercise. Using a logistic regression model we related Chinook parr presence or absence in each 100 m reach of stream across a range of seven day average, and seven day average maximum stream (7DAM) temperatures. We then related this distribution to seven day average maximum stream temperatures predicted from the Heat Source model. Under the mature riparian forest scenario the Heat Source model predicts a 4°C decline in seven day average maximum temperatures for much of the Mainstem Middle Fork John Day River. With a 4°C decline in seven day average maximum temperatures the probability of observing Chinook parr in habitat previously unoccupied due to high water temperatures would increase from 0 to .5 in a reach with a current 7DAM temperature of 28Â°C, and would increase from .2 to .8 in a reach with current 7DAM temperature of 26Â°C. In addition to increasing available habitat for Chinook parr, cooler water temperatures would improve survival and growth throughout the current rearing distribution of Chinook salmon. Restoring the riparian habitat of the Middle Fork John Day River shows the greatest promise for maintaining and potentially improving the population productivity of spring Chinook salmon in this watershed.

Aquaponics: How Aquaponics Systems are Helping Native Fish

Karen Hans
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Traditional oral presentation (20 minutes)

Did you know drinking craft beer can help native fish? Because so many people are drinking craft beer, a Hams and a Schmidt's brewery went out of business. There defunct breweries have been converted in

to urban aquaponics systems. Plus, craft breweries are partnering with aquaponics growers to convert leftover grains from the brewery into produce. So what is aquaponics?
Aquaponics is a system that grows produce and fish in one integrated unit. The produce is grown in a soil-less hydroponic system using water from a fish tank. The fish waste provides the food source for the plants and the plants filter the water for the fish. Since they don't use soil or chemical fertilizers to grow plants, aquaponics systems do not contribute to sediment or toxic pollution runoff into rivers. Because naturally occurring bacteria purifies the water, the water in the system can be used indefinitely. Compared to soil based agriculture, aquaponics systems use 1/10 the water to grow the same amount of produce. Aquaponics is scalable so they can be set up as a large commercial operation, or as a backyard system. These systems can be set up anywhere, growing fish and produce at a local level. Aquaponics reduces water demand, eliminates agriculture runoff of dirt and chemicals, can commercially produce food at a local level, and provide individuals the opportunity of food independence. All of these benefits can help native fish by keeping water in the river, reducing agricultural pollution, and reduce the carbon footprint of current agriculture practices. For my presentation, I will give the basics of how an aquaponics system works, talk about some of the challenges of managing a system, and give examples of how aquaponics systems are being used for large scale produce operations.

Evaluation of outmigration survival of juvenile Chinook salmon and steelhead in the lower Yakima River, Washington

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Traditional oral presentation (20 minutes)

A three-year study is underway to evaluate outmigration survival of juvenile Chinook salmon and steelhead in the lower Yakima River, Washington. Past research has shown that juvenile salmonids experience high mortality during their outmigration in the Yakima River where populations of avian and piscivorous fish species abound. In our study, acoustic telemetry is being used to monitor downstream movement of juvenile salmonids along with simultaneous collection of predator presence data. In 2018, we tagged 429 yearling Chinook salmon, 313 juvenile steelhead, and 344 subyearling Chinook salmon. Tagged fish were monitored at 10 sites in the Yakima River and at eight additional sites in the Columbia River between McNary Dam and Camas, Washington. This presentation will summarize findings from research activities in 2018 and provide an overview of the current state-of-knowledge on predation-related mortality on juvenile salmonids in the Yakima River.

Analysis of population trend for Bull Trout using an integrated approach

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Traditional oral presentation (20 minutes)

Understanding population trend over time can inform status assessment and management for species of conservation concern, such as Bull Trout, *Salvelinus confluentus*. Bull Trout are listed as threatened in the United States under the Endangered Species Act and better understanding and evaluation of population trend would inform conservation. Multiple types of data can be used to assess population trend and each type has costs and benefits. I assessed population trend of Bull Trout in the Walla Walla River Basin over the past two decades using two data sources: 1) redd count data modeled using a state-space exponential growth model; and 2) recaptures of PIT-tagged individuals modeled using a temporal symmetry (i.e., Pradel) model. I also examined the potential to increase precision and better evaluate trend using an integrated model that included likelihood components for both data sources. All analyses were completed using Bayesian methods. Integrated models combine data sources, which can help better understand population demographics such as trend, especially when data from one source are sparse. More accurate and precise assessments of population trend over time and understanding of factors that impact trend can help better conserve and manage species.

Thinking outside the pipe: fish passage restoration projects versus programs

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Traditional oral presentation (20 minutes)

Though fish passage restoration dominates headlines and investments in stream restoration across the Pacific Northwest, assessments of restoration opportunities are often limited in scope. Lack of a broad-scale perspective arguably limits the efficiency and effectiveness of investments in passage restoration. We illustrate this issue and the challenges of moving from a project to program-level perspective through three examples. The first case comes from the central Oregon coast, where large investments in passage restoration were individual projects were successful in restoring structures that passed fish, but at the programmatic level results were more modest in terms of considering fish abundance and distribution across the landscape. A second case, taken from the Great Lakes region, shows how integrating rigorous economic analyses with ecological data produces different restoration portfolios, depending on the type of investments and the scale at which passage restoration is considered. Finally, we review the real challenges of assembling comprehensive databases to inform broad-scale perspectives on passage restoration in the Pacific Northwest. These include the task of assembling consistent databases across multiple jurisdictions, uncertainties in quantifying fish passage impairment, and the challenge of estimating the costs of crossing restoration or replacement. Given the costs of fish passage restoration and demonstrated value of considering restoration at a broad extent, greater investment in prioritization tools could arguably result in efficiencies that total to tens of millions of dollars in the Pacific Northwest.

Between a ROCKfish & a HARD cap: how in-season regulations are used to meet harvest objectives for groundfish

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Traditional oral presentation (20 minutes)

To achieve sustainable fisheries, managers must ensure that harvest is consistent with biological conservation objectives that are scientifically determined, while also considering economic and social factors. Where monitoring is sufficient, regulations are commonly modified in near real time in response to developments such as effort levels or catch rates that are higher or lower than anticipated. These modifications are often referred to as "in-season changes". In Oregon, in-season changes to both sport and commercial nearshore groundfish fisheries are discussed daily, depending on the fishery, to successfully achieve fishery conservation, economic, and social objectives. I will use Oregon's groundfish fisheries as a case study to describe the in-season management process, including the regulation models used to project outcomes of alternative actions, and opportunities for stakeholder input.

Geomorphic Grade Line Methodology, a Process-based Approach to Restoring Depositional River Valleys to Stage 0

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Traditional oral presentation (20 minutes)

On National Forest lands in Pacific Northwest, as in much of the rest the world, a wide range of disturbances have greatly reduced stream health and resilience including riparian harvest, overgrazing, and floodplain modifications (i.e. road infrastructure). In depositional, or response valley types, the primary effect has been the conversion from likely lower energy, valley-bottom anastomosed channels, to incised and simplified transport channels. Early attempts at restoration largely focused on the habitat elements within the channel, with form based "stable" designs often aimed at providing apparent habitat needs for ESA listed salmonids. While these initial attempts appeared to address restoration objectives over the short-term, they failed to address the root-causes of habitat loss and degradation. As a result, the loss, or modification of multi-scale hydrogeomorphic processes over time continued to degrade habitat quality, abundance, and complexity, making it difficult to meet conservation and recovery objectives of at-risk salmonid populations.

Adoption of Stage 0 (Cluer and Thorne 2013), or process-based restoration approach, began as our attention shifted from the condition in the channel, to the conditions across the entire depositional valley floor. Rather than designing channels that were connected to the floodplain at a bankfull discharge event, we instead, started to fill incised channels to immediately disperse energy laterally across the floodplain. Key to the Stage 0 approach is the concept of stream power per unit width and

how this parameter becomes exaggerated in incised channels, often creating a firehose-like effect. Stage 0 restoration projects result in an anastomosing networks with an increase in habitat complexity and diversity across the valley floor. The newly formed template allows reestablishment of key processes that restore ecosystem stability and build and sustain properly functioning fluvial systems such as flood attenuation, ground water storage, sediment retention, sorting of substrates, channel movement, and complex cover for stream biota at all discharge stages. The Geomorphic Grade Line (GGL), a relatively simple valley slope, method was developed as a way to predictably design and implement Stage 0 valley bottom restoration. This presentation walks through how to design and implement Stage 0 projects using the GGL methodology (Powers et al. 2018).

Fishing for TE; causes and consequences of variability in trap efficiency estimates

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Traditional oral presentation (20 minutes)

Population estimates from rotary screw trap datasets are a key component of monitoring outmigrating juvenile salmonids in the Pacific Northwest. The number of fish passing a trap site can be estimated by combining counts of catch with an estimate of trap efficiency (the percentage of fish caught by the trap). Using a dataset from a trap on the John Day River in Northeast Oregon, we explore the causes and consequences of variability in trap efficiency estimates. The effects of changes in local conditions at our trap site, such as flow, temperature, fish density, and stream profile are examined using a generalized linear model. Handling effects from methodology associated with estimating trap efficiency are assessed by comparing trap efficiency estimates between volitionally migrating PIT-tagged fish and fish that were caught in the trap, PIT-tagged, and released upstream of the trap. Methods for discerning temporal breakpoints in trap efficiency are discussed, as well as the consequences for population modeling when erroneous breakpoints are chosen.

The potential for Pacific Lamprey recolonization into the Upper Klamath Basin following dam removal on the Klamath River

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Traditional oral presentation (20 minutes)

Anadromous fishes have been eliminated from over 400 miles of stream habitat in the Upper Klamath Basin since hydroelectric dam construction began on the Klamath River in 1912. Historical documents, evidence, and analyses have led to the conclusion that prior to construction of dams on the Klamath River, Chinook Salmon (spring and fall-runs), Coho Salmon, and steelhead trout occupied habitat in the

upper basin. Taxonomic confusion and other factors have confounded understanding of the historic distribution of Pacific Lamprey. However, they occur throughout the Klamath River Basin below the dams and historically there were no known barriers to limit their upper distribution. Thus, it is likely that Pacific Lamprey existed above the dams. The four-mainstem hydroelectric dams are scheduled to be removed in 2021. This will afford the opportunity for Pacific Lamprey to recolonize hundreds of miles of habitat that has been blocked for over a century. This presentation will focus on the characteristics of the newly available habitat, uncertainties regarding recolonization of Pacific Lamprey, and strategies for monitoring and evaluating recolonization. The uniqueness of the Upper Klamath Basin and its diversity of resident lamprey species presents a challenge to monitoring recolonization on one hand, and a great opportunity to investigate their responses to barrier removal on the other.

Rapid Colonization of a Constructed Stream Reach by Slender Sculpin (Cottus tenuis)

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Traditional oral presentation (20 minutes)

Slender sculpin (*Cottus tenuis*) colonized a newly constructed, artificial stream channel shortly after the channel was connected to the Wood River in the upper Klamath Basin in southern Oregon. The 4.3 km channel was excavated to restore a migration corridor for native trout in Sun Creek, where the natural stream alignment had been altered to provide flood irrigation for cattle pastures. Slender sculpin are common in the Wood River and nearby tributaries, but no sculpin occurred in Sun Creek prior to restoration. After the restored channel was activated in spring 2017, sculpin entered from the Wood River, and by mid-summer, occupied the lowest 200 m of the restored reach. By autumn, the species' distribution had expanded upstream 2.7 km. Distribution appeared to contract over the following winter, but then expanded to over 3 km by late summer 2018. Sculpin now occupy restored habitat in Sun Creek through a former pasture area as well as a forested section, and presence of young-of-the-year suggests the species reproduced in the restored channel during 2018. These results demonstrate that stream habitat restoration intended to aid threatened salmonids may also confer unintended benefits on native non-game species.

Assessing smolt status in differentially reared juvenile Chinook Salmon using gill Na+/K+-ATPase isoforms

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Traditional oral presentation (20 minutes)

The Wild Fishes Surrogate Project aims to rear juvenile Chinook Salmon in a hatchery setting so that their phenotype is more similar to a natural phenotype. Our project is interested in two migration phenotypes; one where juveniles smolt and migrate to the ocean in the fall and the other characterized by juveniles migrating as yearlings in the following spring. We hypothesize that these two phenotypes can be environmentally selected for through differential growth. To support the development of these phenotypes, structure, tank cover, water temperature, the amount of feed given to fish, and how it is given are manipulated in order to control growth. In this paper, we assessed the smolt status of fish reared to be released in either the fall or subsequent spring to verify that the manipulation of growth can produce fish that are either likely to migrate early or later in their juvenile life stage. Smolt status was determined by looking at RNA expression of two gill Na+/K+-ATPase1 isoforms using RT-PCR, where increased relative expression of isoform Na+/K+-ATPase1b and decreased relative expression of Na+/K+-ATPase1a suggests that fish are physiologically prepared to enter seawater. In this paper, we intend to physiologically define the smolt status of fish reared for migration in the fall or spring to provide insights into how to better select for differing migration phenotypes.

Increasingly perilous situation for endangered sucker populations in Upper Klamath Lake, Oregon

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Traditional oral presentation (20 minutes)

Lost River and shortnose suckers are long-lived endemic fishes of the Upper Klamath Basin in southern Oregon and northern California. Both species are endangered and have been targets of conservation and research since the 1990s. Status and trends of three separate spawning populations in Upper Klamath Lake (2 for Lost River suckers, 1 for shortnose suckers) are monitored with a capture-recapture program based on re-encounters of PIT-tagged fish. Over the last decade and a half, estimated annual survival for adult spawners has been relatively high, but populations have continued to decline because of a lack of new recruits. As of spring 2016, populations were reduced to 25-50% of what they were in the early 2000s. In 2016, spawning populations of Lost River suckers suffered higher mortality than they had in any of the previous 14 years, and shortnose sucker survival was poor but not unprecedented. The cause of poor survival in 2016 for both species is unknown. In the summer of 2017, a large die-off of Lost River suckers occurred in the lake and probably reduced overall survival in that year as well. As of the spring sampling season in 2018, we estimate that fewer than 5,000 females participated in the spawning aggregation for the Lost River sucker population that spawns at shoreline springs. The other Lost River sucker spawning population, which makes a spawning run up the Williamson River, is substantially larger and is considered separately in the recovery plan. Shortnose suckers also spawn in the river, and we estimate that in 2018 about 5,000 females participated in the spawning run. Because of the long recruitment drought, the spawning populations are primarily composed of individuals more than 25 years old. The maximum known age for shortnose suckers is 33 years, so senescence may be occurring.

Characterizing Riverine Fish Habitat with Bathymetric LiDAR

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Traditional oral presentation (20 minutes)

Traditionally, federal, state, tribal, and local management agencies have relied upon field surveying techniques to map or characterize existing fish habitat in riverine environments. These field survey efforts are often labor and time intensive and can be subjective in that they rely on interpretation of physical habitat by individual technicians or field crews. With the availability of high resolution bathymetric LiDAR, new opportunities exist to develop innovative approaches to riverine habitat characterization. This relatively new technology could have a number of advantages over traditional approaches including the extent, resolution, objectivity, and reproducibility of the resulting datasets. These advantages should help to support the following objectives: 1) the evaluation of entire watersheds or stream corridors rather than single reaches considered to be representative, 2) accurate analysis of change over time as well as direct comparisons between reaches and systems, and 3) the assessment of potential connectivity of existing off channel habitat features. While the value of topographic LiDAR has previously been recognized by the fisheries habitat community, the full potential of bathymetric LiDAR has yet to be realized. Quantum Spatial recently deployed this technology to map approximately 50 miles of the mainstem Tucannon River and its tributaries in southeast Washington to support ongoing habitat restoration efforts by the Confederated Tribes of the Umatilla Indian Reservation and the Snake River Salmon Recovery Board. In this presentation we provide a comprehensive overview of the sensor specifications and performance for the Tucannon River LiDAR project, as well as preliminary results from analytics performed on the resultant data. Our presentation will highlight how the data are currently being used for real-time habit restoration work on this system.

17 years of the Aquatic and Riparian Effectiveness Monitoring Program. What have we learned?

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Traditional oral presentation (20 minutes)

The Aquatic and Riparian Effectiveness Monitoring Program (AREMP) focuses on assessing the degree to which federal land management under the Forest Service's aquatic conservation strategy (ACS) of the Northwest Forest Plan (NWFP) and the Bureau of Land Management's Western Oregon Resource Management Plans have been effective in maintaining and improving watershed conditions. These plans encompass approximately 9.7 million ha (24 million ac) of federal lands in western Washington, western Oregon, and northwestern California. We used stream sampling data and upslope/riparian GIS and remote-sensing data to evaluate condition for sixth-field watersheds across the plan areas. Stream

conditions were evaluated at 4 to 10 sites in 214 watersheds based on sampling data collected from 2002 to present as part of an 8-year repeating (rotating) sample design. Challenges associated with a long-term, large-scale project like this include being consistent with other monitoring programs, evolving knowledge and techniques, and establishing benchmarks. Over time, AREMP has transitioned from electrofishing and doing amphibian searches to collecting eDNA at our sample sites for biological monitoring. QA/QC analysis has led to investments in increasing sample sizes for pebble counts. Some metrics remain difficult to collect consistently. Consistently identifying pools, measuring pool tail fines, and identifying bankfull indicators continue to be challenging. Accurate data collection is paramount and AREMP invests heavily in extensive training for our surveyors as well as multiple checks on data entry while in the field in addition to when data is downloaded. Despite the natural variable inherent to streams and across such a large footprint, the large sample size has allowed us to detect improving stream conditions in sediment, temperature, and macroinvertebrates following the implementation of the Northwest Forest Plan.

Do Fish Need Water? Fish and Water Management in the Upper Deschutes River Subbasin Brett Hodgson
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Traditional oral presentation (20 minutes)

Historically, the unique geology and hydrology of the Deschutes subbasin resulted in one of the most stable riverine instream flow patterns worldwide. This has been significantly disrupted through multiple anthropogenic influences, having profound impact on the distribution and abundance of fish populations.

Human population growth in central Oregon will result in greater demands on both surface and groundwater supplies. This presents challenges to providing instream flows that support ecologically, socially and economically valuable fish populations. Diverse stakeholders within the Deschutes subbasin have developed strategies in attempt to improve instream flow conditions. These have resulted in localized benefits, however, program implementation has revealed deficiencies in meeting fish needs. These include the Deschutes Groundwater Mitigation Program, Crooked River Jobs and Securities Act and the Allocation of Conserved Water statute.
Studies implemented by the USGS and OWRD have identified the hydrologic connection between surface and ground water, however, more information is needed to refine the analysis and determine localized impacts of water extraction and conservation projects.

Most climate change prediction models forecast more variable seasonal and annual precipitation patterns with more precipitation occurring as rain rather than snow. In the Deschutes subbasin this will likely have dual affects: 1) drought and dry years will be more frequent and 2) runoff will increase and recharge to the groundwater aquifer will diminish resulting in reduced spring inputs. Managers and stakeholders should consider these factors in developing and prioritizing water management and conservation strategies in support of protecting important native fish populations. Decisions accounting

for fish needs during dry year conditions will be most successful. Current programs addressing needs during good water years and largely dismissing them in dry years will progressively result in depressed fish populations across a broad scale. With increasing demands for surface water, protecting groundwater supplies will be critical to maintaining cold water refugia for fish.

Using high-resolution species occurrence databases and distribution models to identify climate refugia for conservation planning

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Boise Spatial Streams Group and the National Genomics Center for Wildlife and Fisheries Conservation
Traditional oral presentation (20 minutes)

Current and foreseeable rates of greenhouse gas emissions strongly suggest that the Earth's climate will continue to warm for much of the 21st century. Species distributions, composed of multiple local populations, will be forced to shift in space and/or time to adjust to environmental changes associated with global trends. In very large habitats, populations are likely to persist in climate refuges but range contractions and extirpations may occur elsewhere. To invest limited conservation resources most effectively, managers and conservation planners need broadscale, spatially precise information about current and future species distributions and the areas that are most likely to serve as climate refuges. Here, we demonstrate a taxonomically generalizable approach based on high-resolution species distribution models that was initially developed for bull trout and cutthroat trout as part of the Climate Shield project (https://www.fs.fed.us/rm/boise/AWAE/projects/ClimateShield.html). The approach consists of: 1) aggregating georeferenced surveys for the species of concern, 2) linking the occurrence of the target organism to aspects of habitat and climate that are represented as geospatial data layers, 3) developing a probabilistic predictive model that links species occurrence to the covariates, 4) using the model to create prediction maps throughout the species' range for current and future scenarios, 5) identifying the subset of areas that show high probabilities of supporting the target species in the future, and 6) documenting and distributing the prediction maps in digital formats for use in conservation planning. The prediction maps are useful for developing monitoring strategies to track existing populations, conducting efficient field surveys to determine habitat occupancy in areas of uncertainty, evaluating and executing assisted migration or recolonization efforts, and coordinating protections among stakeholders for populations that occupy habitats most likely to serve as long-term climate refugia. Although the approach may be most useful for resident species, it could also be used to predict where resident life history stages of anadromous species are least likely to decline because of climate change or the expansion of invasive species. Requisite data and resources currently exist to promulgate the approach for popular species but new surveys may be required for many nongame species to develop adequate databases. Regional efforts to develop taxonomically diverse databases have accelerated in recent years with the advent of eDNA sampling and the eDNAtlas project database (https://www.fs.fed.us/rm/boise/AWAE/projects/the-aquatic-eDNAtlas-project.html) has been designed

to host and distribute georeferenced species occurrence locations useful for distribution modeling and identification of climate refugia.

eBLIMP: The eDNA Basinwide Lamprey Inventory and Monitoring Project

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Traditional oral presentation (20 minutes)

Pacific lamprey were historically distributed along the Pacific Coast of much of North America and throughout the Columbia River Basin. Like most anadromous species, it has undergone substantial declines in abundance and distribution and may be at risk of further declines because of habitat degradation, difficult migratory conditions, changing climate, and shifting freshwater species assemblage. Conservation planning and evaluation of recovery efforts for Pacific lamprey require precise information about their distribution, but developing that information is challenging given the breadth of the species' range and the specialized tactics needed for sampling. To address that need and provide current status assessments within basins across the Northwest, the eDNA-based Basinwide Lamprey Inventory and Monitoring Project (eBLIMP) has developed rangewide lamprey occurrence probability maps, which are used to guide efficient collection of eDNA field samples. The maps were developed by combining historical species occurrence observations from the Pacific Lamprey Conservation Initiative website (https://www.fws.gov/pacificlamprey/) with reach-scale habitat variables derived from geospatial data layers for stream temperature, discharge, and reach slope. A logistic regression model was developed that predicted reach occupancy probability from the habitat variables that was accurate (AUC = 0.88), correctly predicted lamprey occurrence at 82% of the 345 locations used to fit the model, and had balanced errors of omission and commission. The occupancy probability maps have been used to designate sampling sites throughout Idaho, Oregon, and Washington, and biologists from seven cooperating agencies (U.S. Fish and Wildlife Service, Shoshone Bannock Tribes, Yakima Nation, Washington Department of Ecology, Idaho Fish and Game Department, Wild Trout Conservancy, and U.S. Forest Service) collected eDNA samples at 462 of those sites during the summer of 2018 using a standardized field sampling protocol. Those samples were supplemented by dozens of additional eDNA samples archived at the National Genomics Center for Wildlife and Fish Conservation that were collected as part of earlier studies for other species. Results regarding lamprey occurrence based on this dataset will be discussed in this talk and the occurrence records are available as geospatial datasets at the eDNAtlas website (https://www.fs.fed.us/rm/boise/AWAE/projects/the-aquatic-eDNAtlas-project.html). The occupancy probability maps are also available at the eBLIMP website (https://www.researchgate.net/project/eBLIMP-The-eDNA-Basinwide-Lamprey-Inventory-Monitoring-Project) as .pdf files and can be provided as ArcGIS shapefiles on request for use in planning additional status and trend assessments throughout the range of Pacific lamprey.

Global warming rates of salmon and trout rivers in the Pacific Northwest

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Traditional oral presentation (20 minutes)

Large rivers constitute small portions of drainage networks but provide important migratory habitats and fisheries for salmon and trout when and where temperatures are sufficiently cold. Management and conservation of cold-water fishes in the current era of rapid climate change requires knowing how riverine thermal environments are evolving and the potential for detrimental biological impacts. Robust estimates of warming rates, however, are lacking due to limited long-term temperature monitoring, so here we compile the best available multi-decadal records and estimate trends at 391 sites in the 56,500 km river network of the northwestern U.S. Warming trends were prevalent during summer and early fall months in recent 20-year and 40-year periods (0.18-0.35 °C/decade during 1996-2015 and 0.14-0.27°C/decade during 1976-2015), paralleled air temperature trends, and were mediated by discharge trends at regional and local levels. To illustrate the biological consequences of warming later this century, trend estimates were used to inform selection of river temperature scenarios and assess changes in thermal exposure of adult sockeye salmon migrating to four population areas as well as thermal habitat shifts for resident brown trout and rainbow trout populations throughout the region. Future warming of 1-3 °C would increase sockeye salmon exposure by 5-16% (3-143 degree-days) and reduce thermally suitable riverine trout habitats by 8-31% while causing their upstream shift. Effects of those changes on population persistence and fisheries are likely to be context dependent and strategic habitat restoration or adaptation strategies could ameliorate some biological impairments but effectiveness will be tempered by the size of rivers, high costs, and pervasiveness of thermal effects. Most salmon and trout rivers will continue to provide suitable habitats for the foreseeable future but it also appears inevitable that some river reaches will gradually become too warm to provide traditional habitats. This research was published in the Transactions of the American Fisheries Society and is available at: https://www.fs.fed.us/rm/pubs_journals/2018/rmrs_2018_isaak_d001.pdf

Principal components of thermal regimes in mountain river networks

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Poster presentation

Description of thermal regimes in flowing waters is key to understanding physical processes, enhancing predictive abilities, and improving bioassessments. Spatially and temporally sparse datasets, especially in logistically challenging mountain environments, have limited studies on thermal regimes but inexpensive sensors coupled with crowd-sourced data collection efforts provide efficient means of developing large datasets for robust analyses. Here, thermal regimes are assessed using annual monitoring records compiled from several natural resource agencies in the northwestern United States

that spanned a five-year period (2011-2015) at 226 sites across several contiguous montane river networks. Regimes were summarized with 28 metrics and principal components analysis (PCA) was used to determine those metrics which best explained thermal variation on a reduced set of orthogonal axes. Four principal components (PC) accounted for 93.4% of the variation in the temperature metrics, with the first PC (49% of variance) associated with metrics that represented magnitude and variability and the second PC (29% of variance) associated with metrics representing the length and intensity of the winter season. Another variant of PCA, T-mode analysis, was applied to daily temperature values and revealed two distinct phases of spatial variability: a homogeneous phase during winter when daily temperatures at all sites were < 3°C and a heterogeneous phase throughout the year's remainder when variation among sites was more pronounced. Phase transitions occurred in March and November, and coincided with the abatement and onset of subzero air temperatures across the study area. S-mode PCA was conducted on the same matrix of daily temperature values after transposition and indicated that two PCs accounted for 98% of the temporal variation among sites. The first S-mode PC was responsible for 96.7% of that variance and correlated with air temperature variation (r = 0.92) whereas the second PC accounted for 1.3% of residual variance and was correlated with discharge (r = 0.84). Thermal regimes in these mountain river networks were relatively simple and responded coherently to external forcing factors, so sparse monitoring arrays and small sets of summary metrics may be adequate for their description. PCA provided a computationally efficient means of extracting key information elements from the temperature dataset used here and could be applied broadly to facilitate comparisons among more diverse stream types and develop classification schemes for thermal regimes. This research was published in Hydrology and Earth Systems Science and is available at: https://www.fs.usda.gov/treesearch/pubs/57434

Thermal Regimes of Flowing Waters in the Western United States

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Poster presentation

Description and classification of thermal regimes in flowing waters is a fundamentally important step towards understanding the diversity of environmental conditions that aquatic organisms experience. Building on earlier work that described thermal regimes in mountain river networks (see companion poster), here we address the topic at a broader geographic extent using a dataset of annual monitoring records that spans a consistent five-year period (2011-2015) at 580 sites on free-flowing and regulated streams and rivers across the western U.S. Thermal regimes at the monitoring sites were summarized with 34 metrics that represented some aspect of magnitude, variation, frequency, duration, or timing and principal components analysis (PCA) was used to determine those metrics which best explained thermal variation on a reduced set of orthogonal axes. Similar to our previous findings for mountain river networks, many of the thermal metrics were strongly redundant and most of the variation (81-91%) associated with thermal regimes could be summarized by 3-6 orthogonal PCs. Principal component score coordinates for the PC axes were then used in a hierarchical cluster analysis to identify

distinct classes of thermal regimes. Preliminary results suggest at least five classes of thermal regimes exist, which consist of temporally stable regimes associated with spring streams, high elevation mountain stream regimes characterized by strong seasonal cycles and extended winter periods with near zero temperatures, low elevation coastal regimes characterized by seasonal cycles but relatively warm winter temperatures, mid-elevation continental thermal regimes, and regimes associated with flow regulation downstream of dams and reservoirs. After classification of regimes at the 580 sites, linear discriminant analysis was used to predict class assignments based on geospatial covariates that described landscape and network conditions (e.g., elevation, stream size, annual precipitation, etc.) and resultant discriminatory functions were used to map the thermal regime categories throughout the 343,000 km network of perennial streams and rivers in the western U.S. The mountain and continental thermal regime categories were most prevalent across the west; whereas stable thermal regimes were relatively rare and coastal regimes and those associated with flow regulation were intermediate in prevalence. Results of this analysis are useful for understanding patterns of aquatic biodiversity or community structure and predicting thermal characteristics at sites which lack monitoring data. High-resolution digital maps of the thermal regime classes will be developed in association with the future publication of this work and made available as ArcGIS shapefiles at the NorWeST website (https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html) where the water temperature dataset is also publically available.

Anadromous Population Responses to Multiple Instream Restoration Treatments Brian Jenkins
Smith River Watershed Council
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Traditional oral presentation (20 minutes)

This study used long term data sets estimating returning adult and out-migrating juvenile Coho salmon (*Oncorhynchus kisutch*) in one test basin, eight control basins and coast-wide estimates. Population trends for Chinook salmon (*Oncorhynchus tshawytscha*), Winter Steelhead (*Oncorhynchus mykiss*) and 2 lamprey species were produced for the test basin over the course of this study. The West Fork Smith River a 69 square kilometer basin located in Southwestern Oregon is a bedrock dominated system impacted by past land-use practices and has been the focus of extensive stream restoration projects since the 1980's. Coho smolt production increased dramatically within the test basin over the study period, as well as relative to control basins. Adult returns for the test basin show an increasing trend relative to estimates for the Evolutionarily Significant Unit and sub-strata. Spawning surveys conducted on a tributary reach, 1958- present, showed a marked decline in peak spawner abundance up to 1980 when in-stream passage and restoration began. Peak spawner abundance increased following treatments and continues to show an improving trend. Potential aquatic responses to the $1.6 million in recent basin-scale in-stream work that was based on over-winter survival studies and habitat modeling previously conducted within the basin.

A story of tags, fins, and simulations: How integrating genetics in creel surveys can improve decision making

Alexander Jensen
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Coauthors: James Peterson, Carl Schreck, Sandra Bohn, Kathleen O'Malley
Traditional oral presentation (20 minutes)

Genetic stock identification (GSI) assigns fish assemblages or individuals to their respective stock groupings and is widely used to inform harvest composition in commercial fisheries. Through integration with existing creel surveys, GSI may markedly improve the capacity to estimate stock-specific harvest rates in mixed-stock recreational fisheries. We tested the utility of GSI in the Buoy 10 fall-run Chinook salmon recreational fishery, located at the mouth of the Columbia River, by sampling landed fish, assigning individuals to stock using a pre-existing genetic baseline, and evaluating the ability of genetics to improve decision making through simulations. We collected fin clips from landed Chinook salmon during the Buoy 10 fisheries in 2017 and 2018, and thus far have successfully assigned the vast majority of individual fish from 2017 to reporting groups using a previously developed single nucleotide polymorphism (SNP)-based genetic baseline. Genetic assignments generally agreed with coded wire tag (CWT) stock assignments when available, and seasonal trends in genetic assignments tracked patterns in stock-specific CWT recoveries. Finally, we applied a fishery simulation model, designed specifically to capture essential processes in the Buoy 10 fishery, to forecast how integrating novel GSI and existing CWT recoveries will improve the ability to estimate harvest and make in-season decisions. Simulation results showed that combining information from GSI and CWT recoveries can substantially reduce error in both harvest estimation and subsequent in-season decision making. Genetic stock identification is a powerful tool in fisheries management, and we are encouraged for its application in the Buoy 10 mixed-stock recreational fishery.

The River Re-Wild: Juvenile Anadromous Salmonid Monitoring in the White Salmon River

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Traditional oral presentation (20 minutes)

Following Removal of Condit Dam Condit Dam, on the White Salmon River, Washington, was breached in 2011 allowing anadromous salmonids access to habitat blocked for nearly 100 years. A multi-agency workgroup concluded the preferred salmonid restoration action was natural recolonization. Though Chinook Salmon spawning surveys are conducted yearly and limited tributary spawning surveys for steelhead and Coho Salmon have been done, no post-dam juvenile monitoring occurred until 2016. During spring 2016 through 2018, we operated a rotary screw trap at rkm 2.3, used backpack electrofishing to assess juvenile salmonid distribution and abundance in the mainstem and tributaries, and collected genetic samples for Genetic Stock Identification (GSI). Screw trap captures include steelhead smolts, parr, and fry, Coho Salmon smolts and fry, and Chinook Salmon fry. We were able to estimate Steelhead and Coho Salmon smolt abundance during 2016 and 2018, but not during 2017 due

to high water and missed days. The steelhead smolt abundance estimates were 3,851 (SE = 1,454) during 2016 and 5,908 (SE = 1,133) during 2018. The Coho Salmon smolt abundance estimates were 1,093 (SE = 412) during 2016 and 1,308 (SE = 309) during 2018. Few Chinook Salmon fry were captured during 2016, but many Chinook Salmon fry were captured during 2017 and 2018 indicating some successful Chinook Salmon spawning upstream of the screw trap. Juvenile Coho Salmon are now present in Mill, Buck, and Rattlesnake creeks (all upstream of the former dam site). Steelhead abundance at our sample sites in Rattlesnake and Buck Creeks has been similar to pre-dam removal abundance of resident trout. With the addition of Coho salmon at these sites, juvenile salmonid abundance has, at times, exceeded that of pre-dam removal. PIT-tagged steelhead and Coho Salmon smolts from screw trap and tributary sampling have been detected at Bonneville Dam. To date several PIT-tagged steelhead and Coho Salmon have returned to Bonneville Dam as adults. Preliminary GSI analysis of juvenile steelhead show primary influence from the White Salmon River and secondary contributions from Skamania and lower Columbia stocks. Over 90% of the Lower Columbia typed individuals assigned to the E. Fork Hood River reporting group. Consistent with this finding, PIT-tagged juvenile steelhead have been detected moving between the Hood and White Salmon rivers. These juvenile sampling data support that anadromous salmonids are naturally recolonizing the White Salmon River, exploiting both mainstem and tributary habitat and producing viable smolts.

Can angler-caught brood improve catch rates in steelhead fisheries?

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Traditional oral presentation (20 minutes)

Results from a genetic tagging study on Oregon's Alsea River Fish behavior can be influenced by genetic factors. For example, adult run-timing in Pacific salmon (*Oncorhynchus spp*.) has been shown to correlate with variation at CLOCK and GREB1L-associated loci. Heritable differences in vulnerability to angling, presumably influenced by behavior, have been documented in Largemouth Bass (*Micropterus salmoides*).

Many coastal Oregon steelhead hatcheries use wild fish as brood, to both meet production goals and reduce the genetic risk from stray hatchery fish. But this practice may also serve to produce hatchery fish with traits that are particularly desirable to anglers. Wild fish used in integrated hatchery programs may be collected in various ways, including hook-and-line angling or with traditional adult fish traps. Heritable differences in the behavior of fish collected through alternative methods could potentially affect harvest rates of their hatchery-produced offspring. In this study, we test the hypothesis that winter steelhead produced by angler-caught brood would be caught by anglers at higher rates than offspring of trap-caught brood.

At the Oregon Department of Fish and Wildlife's Alsea Hatchery, we spawned 78 wild steelhead in 2015 and 99 more in 2016 to produce 37,655 and 82,595 offspring, respectively. Juvenile fish were marked

and released from the hatchery in the springs of 2016 and 2017. All brood fish were collected locally, either from adult fish traps or by anglers (44% angler-caught brood in 2015, and 46% angler-caught brood in 2016). Each female was spawned with a single male that had been collected in the same manner, and we sampled tissue from all fish spawned. During the winter of 2017-18, we conducted creel surveys on the Alsea River and collected 156 samples from hatchery steelhead that had been harvested by anglers. An additional 376 hatchery fish were captured and sampled at the Alsea Hatchery adult fish trap. We genotyped all parental and putative offspring samples at 15 microsatellite markers, and used genetic parentage assignments to determine the source of parents for fish that were trapped or caught by anglers in 2017-18.

We found a slightly greater percentage of angler-caught offspring in the creel (34.6%), relative to fish captured in traps (28.8%). However, this difference was not statistically significant (Chi sq = 1.451, 1 df, P = 0.228), suggesting little influence from the source of parents over the vulnerability to angling of their offspring. We discuss our results in the context of benefits provided through integrated hatchery programs and the importance of evaluating intended effects. "

Advances in Oxygen Supplementation Abstract

Tod Jones
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Traditional oral presentation (20 minutes)

The critical function of oxygen in animal respiration and life function is well known and documented. The ameliorating benefit of supplementing water bodies for salmonids has also been demonstrated and utilized for decades. Several devices for that purpose have been developed and deployed resulting in improved fish health and enhanced growth rates. Barnaby Watts, a US Forest Service employee, designed the LHO (Low Head Oxygen) unit for streams depleted in oxygen either through thermal pollution or biological oxygen demand. The principals of Redd Zone, LLC began using the LHOs at the Gnat Creek Hatchery in 2002 resulting in healthier Spring Chinook smolts and improved SARs. Redd Zone has now optimized pressurized systems taking advantage of that pressure to increase the absorption of O2 achieving in excess of 200% oxygen saturation while removing unwanted nitrogen gas.

Advances in Chilled Fog Incubation

Tod Jones
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Poster presentation

Poster documents with pictures and narrative the trial conducted.

Annual Variability in Estuary Rearing, Survival, and Life History Diversity of Coho Salmon in a coastal Oregon basin

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Coauthors: Trevan Cornwell, Daniel Bottom, Staci Stein, Steve Starcevich
Traditional oral presentation (20 minutes)

A long-term restoration program allowed juvenile salmon to access previously diked estuarine habitat providing connectivity to a full range of rearing environments. The restoration provided a novel opportunity to examine the use of freshwater and estuarine rearing environments, and the importance of connectivity between these environments for juvenile Coho Salmon. We quantified the population dynamics of the 2006 through 2011 broods of Coho Salmon using a life-cycle approach; estimated population abundance at each life stage and environment, described migration timing, estimated life-stage specific survival, and evaluated life history diversity across 6 brood years. Juvenile Coho Salmon displayed four life history patterns based on migration time, size, and rearing habitat. These rearing strategies were previously reported, but here we describe the patterns, survival, and contribution to the adult population in more detail. Movement of juvenile Coho Salmon from streams to the estuary during the fall and winter was substantial, with ~40% of the parr in the watershed moving to the estuary after the onset of fall freshets. Within the estuary, we observed movement throughout and between the wetland channels and into some of the tributaries, though no juvenile Coho Salmon were detected moving to the ocean during the winter. Surprisingly, the number of juvenile Coho Salmon that entered the estuary during the fall-winter period was similar to the number of stream-reared juveniles estimated at the lower river screw trap in the late spring. Survival of yearling smolts to adult tagged at the lower river screw trap in the late spring was consistently higher than that of parr that overwintered in the estuary, with the exception of the 2010 brood. Overwinter survival of juveniles in streams the winter of 2011-12 was very low relative to survival of juveniles in the estuary. For most brood years, the stream-reared yearling smolts contributed the majority of the returning adults, an average of 70%. However, the survivors of three distinct estuary rearing strategies totaled anywhere from 20 to 60% of the returning adults each year. The variability in survival rate and life history diversity demonstrates the importance of each of the rearing environments and connectivity between them to support the resilience of the population.

Applications for modeling recreational angler effort as a function of fish abundance

Michelle Jones
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Traditional oral presentation (20 minutes)

Fish restoration plans are often complemented by policies that intend to reduce catch by recreational anglers (e.g., introducing gear restrictions, size limits, bag limits, or seasonal closures). However, quantifying how specific management actions will change recreational fish populations is challenging because most recreational fisheries are unlimited entry. Unlike many commercial fisheries that are controlled by individual quotas, restrictions on recreational catch can be undermined by an increase in angler participation. Similarly, seasonal closures may simply cause a shift in the temporal distribution of effort. Without understanding the angler response to management policies, alternative management actions can't always be compared in a robust way, limiting managers to select specific management actions without fully understanding how these actions will change sport fish populations. Here, we begin to address some of the challenges in evaluating recreational fish policies by modifying predator-prey functional response curves to describe fishing effort as a function of Steelhead run-size. Our candidate models are fit to Steelhead creel data at multiple sites across Oregon. While similar models have been used to describe angler-fish interactions before (e.g., Walleye, Johnson and Carpenter 1994), we advance this approach by showing how angler-fish interaction models can subsequently be used in a larger simulation framework of a simplified fishery-management system to compare alternative management actions quantitatively.

Lessons Learned from the Design of a Stream Habitat Monitoring Project: The Columbia River Habitat Monitoring Program

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Traditional oral presentation (20 minutes)

Environmental monitoring is a long-term, large-scale venture. To generate data useful to support management decision making, environmental monitoring programs must generate information with known representation of spatial and temporal variability. However, space-time survey designs for large scale, long-term data collection enterprises are complex problems, often research projects in and of themselves. Unfortunately, too often implementers of data collection projects or consumers of monitoring data are not directly involved in the survey design process, resulting in disconnects between sampling rationale for critical components of the underlying statistical models. Conversely, as the sampling progresses through time, failing to periodically re-engaging with the original survey design statistician can result in missed opportunities for programmatic improvements. Ideally, environmental monitoring program design would explicitly include an initial learning phase representing data collection driven by the original survey design, a design evaluation phase representing an evaluation of the initial design with the initial phase data, and an updated implementation phase representing the incorporation of learning from the initial phase. In 2010 in the Columbia River basin, NOAA-Fisheries and Bonneville Power Administration embarked on a salmonid habitat monitoring program based on this phased development and implementation model. The Columbia Habitat Monitoring Program (CHaMP, 2011 - 2018) existed as a design and initial implementation project, but as is often the case with long-term, large-scale projects, was ended prior to its planned completion date. CHaMP was

ended before the completion of the initial learning phase (2019) and the design evaluation phase (2020). Currently, a preliminary evaluation of design lessons is underway. General lessons with broad applicability across a wide range of monitoring program structure relative to data management, program implementation, and survey and inference design will be presented.

Stock origins of Pacific Herring in the Strait of Juan de Fuca, WA 4Lower Elwha Klallam Tribe, Port Angeles, WA

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Poster presentation

Small schooling species of forage fish form the foundation of the piscatorial food web. Despite their ecological and economical importance, the population dynamics of forage fish in the Salish Sea are poorly understood. We have limited knowledge of the mixing of stocks or sub-populations outside of their spawning season. As part of Elwha River dam removal monitoring, consisting of over a decade of monthly beach seine sampling (April - September) at 24 sites along 70 kilometers of coastline in the Strait of Juan de Fuca (SJF), we have observed high variability in forage fish catch across years, sites, and seasons. Three forage fish species dominated our catch and are the focus of analyses: Pacific Herring (*Clupea pallasii*), Pacific Sand Lance (*Ammodytes hexapterus*), and Surf Smelt (*Hypomesus pretiosus*). These show species-specific variation across years, seasons, and sampling locations. We expanded on the current distributional descriptions through analyses of migrational patterns for Pacific Herring. A genetic baseline for Pacific Herring identified a suite of high-resolution DNA markers that assign Puget Sound Basin Pacific Herring to their stock of origin. We will use these markers to identify the stock of origin of juvenile Pacific Herring sampled from the Strait of Juan de Fuca (SJF). Their distribution in this region is interesting as we catch Pacific Herring in post-larval, larval, and adult developmental stages, yet there are no current spawning beaches for Pacific Herring in the near vicinity. Our preliminary findings clarify whether SJF represents a rearing area for specific stocks, is inhabited by a mix of Puget Sound stocks, or is utilized by Canadian stocks. If rearing by specific stocks is localized, it could leave individual sub-populations more susceptible to disruption from factors such as climate alterations, local disturbances, or pollution inputs. If Pacific Herring in the SJF represent if a broadly mixed population, it would change our understanding of migration patterns or the extent of dispersal occurring during the larval life history stages. These results could indicate why some selected stocks remain depressed despite existing conservation efforts. We are currently applying similar techniques to Pacific Sand Lance and other forage fish species to expand our broad understanding of forage fish population dynamics in the Salish Sea.

Using environmental DNA water samples to determine the timing and abundance of outmigrating Coho Salmon

Emerson Kanawi

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Coauthors: Mark Henderson, Andrew Kinziger
Poster presentation

Populations of Coho Salmon in northern California are a valuable ecological and cultural resource and they comprise a fundamental component of riverine ecosystems. Collection of reliable and timely survey information on fish abundance and distribution is therefore essential to monitoring long term population trends, as well as provide managers with data to analyze ecosystem feedback from recovery efforts. However, equipment, infrastructure, and personnel are all expensive for resource managers. The funding necessary to operate traditional fisheries sampling equipment limits the geographical and temporal area scientists can study. We examined the potential of using an environmental DNA (eDNA) sampling program to assess migrating salmon populations in conjunction with a traditional monitoring approach. Water samples, along with water-quality and flow information, were collected during the out-migrating Coho Salmon smolt season on two separate creeks in Humboldt County, CA during the spring of 2018. A standard volume of water was collected from three locations, in duplicates, within each creek, every-other-day from March 1st - June 27th in conjunction with the daily operation of a rotary screw trap. Samples were extracted using the Qiagen DNeasy Blood and Tissue kit. Genetic analysis was carried out using a well-established qPCR protocol. Results indicated a high variability of DNA copy number both within sites and between sites for each creek. Copy number of template DNA fluctuated throughout the season. Linear regression analysis found no significant relationships between measurements of fish abundance and eDNA copy number in either creek. Additionally, no significant relationships were found between water-quality or flow measurements and eDNA copy number. Our results highlight the need for continued investigation into the utility and methodology of eDNA monitoring to produce information relevant to resource managers. Environmental DNA has the potential to dramatically increase the quality and volume of information available to resource managers, however, knowing its limitations will lead to more appropriate use of this technology.

Willamette Floodplain Restoration Projects: impacts of process-based restoration on nutrient dynamics and allochthonous food webs

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Poster presentation

The tributaries of the Western-Cascadian Rivers make up some of the most oligotrophic streams in North America. Unlike other streams where phosphorous limits productivity, nitrogen limits the growth of microbes that make up the base of the food web. Monitoring changes in dissolved nitrogen species, nitrate (NO3), ammonia (NH4), total nitrogen, and total organic nitrogen found in these streams, may show how alterations to hydrology through restoration changes the stream ecosystem. Stage 0 restoration, like that which occurred on Staley Creek in the summer of 2017, may alter nutrient

dynamics significantly. We monitored medium duration nitrate trends as well as other nitrogen concentrations in stream water following carcass additions in restored and reference streams. Changes in stream morphology may alter nutrient dynamics, and primary productivity as a result. Distinct, stable isotopic signatures are diagnostic of marine sources of nitrogen. These isotopes, found in salmon carcasses, can be observed in the tissues of organisms that uptake those nutrients. Collection of macroinvertebrates, and analysis for 14N/15N ratios in their tissues, were done before and after carcass additions that mimic native fish runs. These ratios may illuminate the impact of changes in stream morphology on the residence time of marine derived nutrients in restored and reference streams.

Restoration of stream channels may alter the foundation of the freshwater food web. Primary productivity includes autochthonous productivity in the form of algal photosynthesis, and allochthonous productivity in the form of additions of organic matter from the riparian forest. These additions from the riparian can represent the majority of the organic matter introduced into oligotrophic, aquatic systems. In this project we examine restored and reference channels' ability to retain coarse particulate organic matter derived from riparian productivity, i.e. leaves. We conducted these experiments at several reaches at a variety of discharges. These data may influence our understanding of restoration's impact on the retention of leaves in the stream, and the potential benefits to the aquatic community that pertain to a stream's ability to retain coarse particulate organic matter.

Additionally, we explore the utility of using stable tracers in monitoring changes in connectivity of complex lotic systems.

The Art of Education for Salmonid Ecology: The Salmon River Estuary as a Learning Laboratory for Rural Coastal Students

Graham Klag
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Traditional oral presentation (20 minutes)

Oregon's coastal estuaries play a critical role in the life histories of salmonids and other species. While agricultural conversion have reduced the productivity of many Oregon estuaries, the restoration of environments such as the Salmon River Estuary within the Cascade Head Biosphere Reserve, represent a vital opportunity to study and showcase the role these new anthropogenic changes have made to fish and future generations. With the help of The Sitka Center for Art and Ecology, The U.S. Forest Service and The Salmon Drift Creek Watershed Council; Taft 7-12 students from Lincoln Ciry learned the story of the Salmon River's Estuary restoration and how agricultural and ecological histories have shaped what we see today. Students learned the role estuaries play in the life cycles of salmon and 70% of all marine organisms. Classes visited the estuary's reference and restored marshes were they conducted channel dimension and vegetative transect monitoring. Learning to identify native tidal marsh grasses and the species associations with estuary elevation. At the Sitka Center, students translated their field observations and coursework into wood block prints of what they thought sinuous estuary channels

should look like. The completed individual prints were then connected to form one long sinuous channel. This presentation will explore the confluence of art, education and ecology with places of ecological and inspirational significance. Creating art that serves the holistic messaging needs of biological conservation education; reuniting Oregon's coastal estuaries play a critical role in the life histories of salmonids and other species. While agricultural conversion has reduced the productivity of many Oregon estuaries, the restoration of environments such as the Salmon River Estuary within the Cascade Head Biosphere Reserve, represent a vital opportunity to study and showcase the role these new anthropogenic changes have made for fish and future generations. With the help of The Sitka Center for Art and Ecology, The U.S. Forest Service and The Salmon Drift Creek Watershed Council fromantic Taft 7-12 students learned the story of the Salmon River's Estuary restoration and how agricultural and ecological histories shape what we see today. Students learned the role estuaries play in the life cycles of salmon and 70% of all marine organisms. Classes visited the estuary's reference and restored marshes were they conducted channel dimension and vegetative transect monitoring. Learning to identify native tidal marsh grasses and the species associations with estuary elevation. At the Sitka Center, students translated their field observations and coursework into wood block prints of what they thought sinuous estuary channels should look like. The completed prints were then connected to form one long sinuous channel.

Economic optimization of carp control alternatives in Malheur National Wildlife Refuge

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Traditional oral presentation (20 minutes)

Invasive common carp (*Cyprinus carpio*) have reduced avian habitat value and other ecosystems in Malheur Lake, a central feature of the Malheur National Wildlife Refuge. Stakeholders are considering increased and sustained removal of carp from the lake as one strategy for restoring ecosystem services. A program of carp removal must weigh several trade-offs, including the spatial and dynamic prioritization of removal effort. Another important dimension of the problem is the stage-structured dynamics of the carp population itself. This research adopts a dynamic bioeconomic optimization approach for planning carp removal from Malheur Lake. The biological component of the model tracks the carp population over time in multiple life stages and accounts for the differential selectivity of removal effort. The optimal dynamic carp removal strategy obtained from the model is compared to various constant removal rate strategies in order to assess potential gains from varying removal effort over time to exploit biological and economic margins presented by the invasion.

BioSonics Scientific Echosounders as a Versatile Fishery Management Tool

Biji Kobara
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Traditional oral presentation (20 minutes)

Active acoustics are a preferred tool in fisheries management for both marine and freshwater applications. Split Beam sonar has been used in fish stock assessment, habitat mapping and assessment for over 30 years. In recent years new advancements in signal processing and software has provided inroads to many other applications. My presentation will provide a brief overview of these applications and potential other opportunities for monitoring and management of fish stocks. Acoustic surveys of marine and freshwater fish and habitat mapping will also be discussed.

Otolith morphology and microchemistry revealing life history patterns of Chinook Salmon in Oregon and Patagonia

Alex Koeberle
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Coauthors: Ivan Arismendi, Cecilia Di Prinzio
Traditional oral presentation (20 minutes)

In southern Chile and Argentina (Patagonia) introduced salmonids support commercial and recreational industries and attract anglers from around the world. In particular, multiple propagations of Chinook Salmon (*Oncorhynchus tshawytscha*) in this region have resulted in genetically diverse populations with mixed population establishment. Yet, few studies have documented specific life history characteristics contributing to the success of Chinook Salmon in Patagonia. This begs the question, can invasive species express multiple life histories, and if so, are these histories potential mechanisms for successful establishment? Here, we use otolith morphology and microchemical analysis to contrast among introduced Chinook Salmon populations in South America. In addition, we include otolith samples from wild and hatchery origin populations in Oregon. Northern Patagonia and Oregon have similar environmental conditions, physiography, and latitudes, and thus, we can compare life history strategies between freshwater and marine systems across hemispheres. Determining specific life history characteristics of Chinook Salmon in novel systems like Patagonia will help to better understand conservation strategies for wild and hatchery fish in their native range in the Pacific Northwest. Sampling efforts involve a network of local collaborators of scientists, volunteers, and anglers in Chile and Argentina as well as collaboration with Oregon Department of Fish and Wildlife for otolith samples in Oregon. This research has implications for future scenarios as better understanding life history plasticity will support management and conservation in the face of climate change and increased competition among native and non-native species, both in Patagonia and in North America.

State of Alaska's Salmon and People (SASAP) Project Overview

Meagan Krupa
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Coauthors: Meagan Krupa, Ian Dutton
Traditional oral presentation (20 minutes)

State of Alaska's Salmon and People (SASAP) is a group of experts working in 8 sub-groups to provide up-to-date interdisciplinary perspectives on Alaska's salmon systems and the people who rely upon them. The SASAP mission is to create an accessible decision-making platform for all stakeholders by addressing the information gaps in Alaska's salmon system through information synthesis, collaboration, and stakeholder engagement. We seek to answer three core questions: What do we know about Alaska's salmon system? What do we not know? How can we better integrate and share what we know for better decision making?

Three SASAP working groups are conducting broadscale, cross-cutting analyses of biological, cultural, and governance knowledge to provide a contemporary understanding of the state of knowledge of Alaska's salmon and the people who rely on salmon. Five more are providing insight into pressures on salmon and salmon communities, and options for response to those pressures. In addition to the 8 working groups, the Data Task Force is creating online datasets, which will allow the public to easily access comprehensive information about salmon. One of these datasets includes Board of Fish proposal data from 1959 to the present. We will present this new dataset, give an overview of its contents, and discuss its potential uses within salmon management.

Good things from rocky landings: A video lander study of a nearshore rocky reef area off the Oregon coast

Gregory Krutzikowsky
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Traditional oral presentation (20 minutes)

A video lander was used to survey an approximately 30.2 km2 area of subtidal nearshore rocky reefs in the marine waters from Cape Foulweather to Alsea Bay Oregon. The focus of the work was on investigating the use of the video lander as a tool to characterize the fish community, habitat characteristics and the potential for a lander to provide density and abundance estimates for fish species. Sixteen fish species were observed, with the blue/deacon species complex being counted as one. The frequency at which species were observed varied from 53.1 % of the 145 lander drops for kelp greenling to 0.7 % for wolf-eel and tiger and yelloweye rockfish. Based on the sum of MaxN species counts, the maximum number visible in a single frame, ten species made up more than 99 % of the fish identified to species with the remaining six species combined making up less than 1 % of the total. We calculated density and abundance estimates for species observed and also compared the estimates for black rockfish, which had the highest density and abundance for the species observed, to abundance estimates derived from previous PIT tag work in the same area.

Using targeted instream water transfers to increase climate resiliency in the Upper Klamath Basin

Chrysten Lambert
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Coauthor: Nell Scott
Traditional oral presentation (20 minutes)

Effective protection and recovery of native fish populations in the western United States must consider and plan for the likely impacts of climate change, particularly hydrologic changes such as seasonal reductions in instream flow and increased water temperatures. In watersheds with substantial appropriations of out-of-stream water use, these impacts are likely to be exacerbated as water withdrawals increase to meet increased crop water and municipal demands. In some cases, out-of-stream water demands and development of irrigation infrastructure have already led to the physical isolation of fish populations placing them at increased risk from potential catastrophic events or inbreeding effects. The State of Oregon has a relatively unique opportunity to address these threats as it enjoys some of the most progressive and actively used water rights laws for the enhancement of instream flow (Szepticki, L.F., 2015). In the Upper Klamath Basin, restoration partners have utilized permanent instream water right dedications as an important tool in the suite of restoration actions to recover Bull Trout (*Salvelinus confluentus*), which were listed as threatened under the Endangered Species Act in 1998. In addition to water transfers, recovery actions have included eradication of invasive Brook Trout (*Salvelinus fontinalis*) and restoration and reoccupation of historic tributary channels that were eliminated with the development of irrigation infrastructure in the mid to late 1800's. These restoration efforts allow Bull Trout to migrate between unique habitats and express a variety of life histories which are anticipated to increase population resiliency to climate change impacts. Partners in this work include the Oregon Department of Fish and Wildlife, Crater Lake National Park, US Fish and Wildlife Service, US Forest Service, Trout Unlimited and multiple private landowners (amongst others).

The best laid plans of mice and managers: lessons from recent avian management in the Columbia River Basin

James Lawonn
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Traditional oral presentation (20 minutes)

Predation by birds is considered a significant limiting factor for recovery of ESA-listed salmon in the Columbia River Basin. Consequently, three management plans designed to reduce avian-caused mortality of juvenile salmonids have been initiated in recent years, and all are approaching completion. However, while two of these plans have resulted in proximate survival gains for juvenile salmonids, none appears to have completely met its biological goals. On the Columbia Plateau, Caspian terns were successfully dissuaded from using two major colony sites, and overall tern predation rates for the region declined appreciably. However, large numbers of terns have begun nesting at a nearby unmanaged colony site, and apparent increases in gull predation within the region could offset survival gains from

tern management. In the Columbia River estuary, management of a major Caspian tern colony on East Sand Island has reduced local tern abundance, but after a decade of management, tern predation rates for some steelhead runs remain near 10%, approximately two to three times higher than their original biological targets. Also in the estuary, double-crested cormorant abundance has been reduced at a major colony site on East Sand Island, but colony growth at other locations in the estuary, most prominently the Astoria-Megler Bridge, may completely offset predicted gains in juvenile salmonid survival. For all three plans, future monitoring remains uncertain or appears inadequate to quantify putative survival gains. Among many factors that have frustrated management are: constraints associated with federal avian conservation policy; the willingness of birds to colonize new areas, some outside the jurisdictional reach of managers; the involvement of multiple governmental entities with overlapping authorities and sometimes competing mandates; and a somewhat Byzantine system for funding research, management, and monitoring needs in the Columbia River Basin. Additional work is needed to fully meet the biological goals the avian management plans were intended to address. Of foremost importance are (1) research on the influence of avian predation on adult salmon returns and (2) establishment of a robust monitoring program to investigate post-management trends in avian predation rates in relation to overall survival of juvenile salmon through the hydrosystem.

Instrument refinement to measure perceived ecosystem services

Anna Le
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Coauthor: Tommy Swearingen
Poster presentation

Ecosystem services plays a key role in marine resource management and incorporation in real life decision-making. Direct and indirect use of ecosystem services takes into consideration of market and non-market values associated with human use. A vital element of managing resource and human interactions is to make ecosystem-base management base on the direct and indirect use of ecosystem services. Indirect use of ecosystem services or cultural ecosystem services accounts for aesthetic, cultural identity, and spiritual relatedness to a natural environment. A main characteristic of cultural ecosystem services is the intangibility and emphasis on the physical, emotional, and mental benefits. This project aims at identifying cultural ecosystem services among Oregon coastal residents to address gaps within the Total Economic Value of ecosystem services of an existing study conducted by Oregon State University. A Likert Scale will be used in response surveys to allow Oregon coast residents to rate various cultural ecosystem services in terms of its individually perceived value. By taking existing perceived ecosystem services and expanding on the cultural aspects, natural resource agencies can better manage marine resources. This project aims to create and refine an instrument to assess cultural ecosystem services.

Natural Stream Community Assembly 36 Years After the Catastrophic Eruption of Mount St. Helens

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Traditional oral presentation (20 minutes)

In 1980, the eruption of Mount St. Helens obliterated a vast area of forest and transformed many freshwater systems. Existing streams on the mountain's North flank were buried by over 100 m of rocky debris and pumice. Following the eruption, mountain-side springs and snowmelt created four new (mostly perennial) channels flowing into Spirit Lake. Community recovery was predicted to take many decades to centuries, but stream surveys 36 years post-eruption have found significant periphyton and macroinvertebrate community development and differences in a variety of physio-chemical variables. Reach-scale surveys (n=21, July 2016) in the four watersheds revealed up to 10-fold differences in many variables: water temperature (3.9-21.6 °C), discharge (6-180 L s-1), conductivity (50-531cm-1), pH (6.0-7.9), nitrate (<1-69 L-1), and canopy cover (0-100 %). Many of the community metrics of riparian, periphyton, and macroinvertebrate taxa richness, density or biomass were significantly different between the Willow drainage and the Camp, Geo, and Clear drainages. Reaches in Camp, Geo, and Clear drainages had higher water temperatures, conductivity, pH, carbon, and alkalinity. Willow drainage reaches had greater summer discharge, stream widths, substrate size, nitrate, and orthophosphate. Reaches within the Willow mainstem, however, often had different community metrics than in its tributaries and other drainages. High profile soft-algae taxa, indicative of low disturbance conditions, were present at all reaches except in the Willow mainstem. Riparian plant taxa richness and benthic insect density and biomass were especially low in the Willow mainstem. We suspect that continual disturbances by floods and sediment movement keeps the aquatic and riparian communities in an earlier successional state in Willow compared to other drainages. The large differences in physio-chemical variables across the four drainages provide a unique opportunity to explore controls on understudied in-stream community development.

Environmental DNA for the enumeration and management of Pacific salmon

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Traditional oral presentation (20 minutes)

Pacific salmon are a keystone resource, generating annual revenues of well over ~US$500 million/yr in Alaska alone. Due to their anadromous life history, adult spawners distribute amongst thousands of streams, posing a huge management challenge. Currently, spawners are enumerated at just a few streams because of reliance on human counters and, rarely, sonar. The ability to detect organisms by shed tissue (environmental DNA, eDNA) promises a more efficient counting method. However, although eDNA correlates generally with local fish abundances, we do not know if eDNA can accurately enumerate salmon. Here we show that daily, and near-daily, flow-corrected eDNA rate closely tracks

daily numbers of returning sockeye and coho spawners and outmigrating sockeye smolts. eDNA thus promises accurate and efficient enumeration, but to deliver the most robust numbers will need higher-resolution stream-flow data, at-least-daily sampling, and a focus on species with simple life histories, since shedding rate varies amongst jacks, juveniles, and adults.

Monitoring the movements of juvenile lamprey in the Yakima River using acoustic telemetry

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Traditional oral presentation (20 minutes)

Using a newly-developed acoustic transmitter, we tagged, released and monitored 97 lamprey macropthalmia in the Yakima River during the spring and summer of 2018. The study was conducted in conjunction with an evaluation of juvenile salmon survival and used the monitoring arrays established for that study. Through collaborative efforts we also accessed lamprey detection data from monitoring arrays in the Columbia River, including at McNary Dam and Bonneville Dam. Juvenile lamprey were collected in May from the Yakima River and tributary creeks (36%), McNary Dam (50%), and John Day Dam (14%). Lamprey were tagged at the Chandler Fish Handling Facility and transported to two release locations: upstream of Wapato Dam and in the lower Yakima River near the river mouth. The acoustic transmitter was 12 mm x 2 mm, weighed 80 mg, and had a tag life of approximately 30 days at a burst rate of 5 s. We detected 89% of the tagged lamprey in the Yakima River and up to 98% in the Columbia River. Lamprey released near Wapato Dam reached the river mouth in an average of 3.5 days and moved from McNary Dam to Bonneville Dam in about 2.5 days (about 300 miles). Lamprey released near the mouth of the Yakima River reached Bonneville Dam in an average of 3.5 days (about 193 miles). All lamprey detected at McNary Dam arrived within 7 days after release and all lamprey detected at Bonneville Dam arrived within 11 days. Mean migration rates ranged between 30-35 miles per day both in the Yakima and Columbia rivers. A laboratory-based tag effects evaluation was conducted to support the field study, and lamprey that did not display fungal infestations when tagged showed high survival. This study provided new insights into juvenile lamprey movements and assisted with evaluation of the new lamprey transmitter. In 2019 the project will be expanded, with a modified transmitter (faster burst rate) and monitoring array as well as increased numbers of tagged lamprey.

Pacific Lamprey Migration and Passage in a Coastal System

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Traditional oral presentation (20 minutes)

Eel Creek is a coastal stream in a dunal system formed from the outflow of Eel Lake (Lakeside, Oregon). Eel Creek historically supported large runs of Pacific Lamprey (PL). Hwy 101 construction and other stream crossings, including the Eel Lake Salmon Trap, have created significant passage barriers to this species.

The Tenmile Lakes Basin Partnership (TLBP) worked with the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians to design and install a Lamprey Passage Structure (LPS) for passage enhancement through the Trap. In addition, the Oregon Department of Transportation (ODOT) designed lamprey passage enhancements to the Hwy 101- Eel Creek culvert. TLBP monitored these passage enhancements and used radio telemetry to track PL movements within the system to improve understanding of lamprey biology and future management and conservation actions in the Eel Lake Basin.

Thirty five Adult PL were collected, anesthetized, measured, photographed, surgically implanted with radio telemetry tags and tracked to identify migration behavior in the Eel Lake Basin, including habitats used for holding and spawning, movements and distribution throughout the basin, and interactions with the newly installed LPS and other artificial obstructions.
Mobile tracking occurred two to three times per week by airplane, car, kayak, and foot surveys. Tagged lamprey were located to within a few feet and habitat type use was recorded along with movement patterns and predation.

Tracking results show high levels of predation, possibly due to the lack of effective concealment in a shallow, dunal creek with little natural cover. Anthropogenic features such as rip-rap and concrete box culvert slabs may create useful holdover habitats as PL have adapted to the altered environment. ODOT and ODFW have designed and implemented lamprey passage enhancements within Eel Creek which may inform enhancement projects in other areas. Effective concrete culvert improvements included sloped interior baffle alterations and increased jump pool depth. ODFW's design of an LPS at Eel Lake Trap is being monitored for effectiveness and usability.

An overview of adult Pacific Lamprey translocation, artificial propagation and a sexual maturation study

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Traditional oral presentation (20 minutes)

The Yakama Nation Pacific Lamprey Project has been translocating adult Pacific Lamprey since 2012 and have developed protocols to help decrease mortality during transport. Our project collects adults from the three Lower Columbia River dams (Bonneville, The Dalles, and John Day) using a combination of PVC tube traps and newly installed lamprey passage systems (LPS) traps. Once collected, adults are transported to Prosser Hatchery located in Lower Yakima River. A combination of natural salt, temperature tempering, and increased oxygen has yielded the best results for increased survival. During

the holding duration at the hatchery, all adults are examined, measured, and tagged (PIT tag and genetically tagged) to help identify individual fish, location of collections for migration analysis and future parentage genetics comparisons. Non-invasive practices have been developed to help identify sex of the adults which are used to provide an estimate of the male/female ratio for each translocation release events.

During the spawning season in spring/summer (after an overwintering period), we have observed a wide variation in maturation timing from April through July with a portion of them overwintering twice to spawn the following year. Our research question here was "Does the holding water source, temperature, or combination of both affect the maturation of adult Pacific Lamprey?" We have conducted a study using holding tanks consisting of three proportions of water source (river/well ratio of 90/10, 50/50, and 10/90) during the fall and spring seasons using adults that were individually PIT tagged and measured. Well water temperature is fairly stable year around (14-15.5ËšC) and river water temperature reflects the Lower Yakima River temperature profile. Currently, the study is ongoing, but results will be available and shared at the meeting. An equal number of tagged fish were placed in each of the treatment tanks and were monitored during and at the end of the study duration. Interdorsal distance (an indicator for maturation) as well as secondary sexual characteristics will be measured and noted for comparing the adults from the three treatment groups.

During the spring season, our project will release the majority of the remaining adults collected the previous year while keeping a small number of adults to supplement the artificial propagation program. A small number of adults from Prosser Dam LPS will also be set aside for artificial propagation. During spawning, 3x3 or 4x4 male-to-female crosses are preferred to maximize the potential genetic diversity. Spawning protocols include a system of egg and milt extraction, egg to milt ratio calculations, fertilization, and incubation methods. These methods are tested and fine-tuned each year to help increase fertilization percentages and egg survival during incubation and results from the past spawning season will be discussed.

Corps' Avian Predation Management in the Columbia River Estuary

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Traditional oral presentation (20 minutes)

The U.S. Army Corps of Engineers (Corps) developed and implemented two avian predation management plans in the Columbia River Estuary to decrease predation of juvenile salmonids listed under the Endangered Species Act (ESA). The plans support reasonable and prudent alternatives developed by NOAA Fisheries in biological opinions or supplemental opinions issued in 2008, 2010 and 2014 for the Federal Columbia River Power System. The goal of the management plans is to increase survival of juvenile salmonids by reducing predation-related losses from Caspian terns (*Hydroprogne caspia*) (CATE) and double-crested cormorants (*Phalacrocorax auritus*) (DCCO) nesting at East Sand Island (ESI) in the Columbia River.

In cooperation with U.S. Fish and Wildlife Service (USFWS) and NOAA Fisheries, the Corps developed the Caspian Tern Management [Plan] to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. Prior to management, an average colony of 9,000 CATE breeding pairs at ESI consumed an average 22.2% of Snake River steelhead and 17.2% of Upper Columbia River steelhead last detected at Bonneville Dam. The CATE plan intended to redistribute a portion of the ESI colony by reducing nesting habitat while concurrently creating alternate nesting habitat outside the Columbia River Basin. In 2006, the Corps began constructing nesting habitat in Oregon and California and incrementally reducing habitat on ESI. By early 2015, the Corps had reduced the ESI breeding colony to 1.0 acre and created/enhanced 7.8 acres of alternate nesting habitat outside the basin. Following the reduction at ESI, the Corps detected a decrease in predation impacts from CATE. In 2018, 5,000 CATE breeding pairs on ESI consumed 6.9% of Snake River steelhead and 6.5% of Upper Columbia River steelhead last detected at Bonneville Dam.

In cooperation with the USFWS and the U.S. Department of Agriculture - Wildlife Services, the Corps developed the Double-crested Cormorant Plan to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary. Prior to management, an average colony of 13,000 DCCO breeding pairs at ESI consumed 5-10% of the juvenile salmonids last detected at Bonneville Dam. The DCCO Plan intends to reduce the ESI colony in two phases: Phase I involved lethal and non-lethal measures to reduce the colony to no more than 5,380 - 5,939 DCCO breeding pairs; Phase II involves primarily non-lethal measures to ensure management goals for the colony size are retained. The Corps implemented Phase I activities from 2015 to 2017, culling 5,576 DCCO and oiling 6,181 nests on ESI. The Corps began implementing Phase II activities in 2018, when 3,672 DCCO pairs nested on ESI, and will continue these activities in 2019. The Corps' ability to estimate DCCO predation impacts is hindered by a suite of factors influencing the breeding colony at ESI.

The discovery of Oregon Chub in the Yamhill River basin: lessons learned from similar basins and our approach to conservation

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Traditional oral presentation (20 minutes)

Oregon Chub (Oregonichthys crameri), a small minnow that is endemic to the Willamette Valley, were federally listed as endangered under the Endangered Species Act (ESA) in 1993. In 2015, the species became the first fish to be delisted from the ESA due to recovery. In preparation for delisting, a plan was written to monitor and determine if the species remained secure without ESA protection. Under this plan, managers and conservationists are encouraged to utilize the tools that were successful in recovering the species, especially in areas where Oregon Chub populations are low in number relative to strongholds. In 2018, the Oregon Department of Fish and Wildlife located a previously unknown population of Oregon Chub in the Yamhill River basin. Although the population has relatively high

abundance, there are a number of threats present within the habitat. Two other Willamette River tributaries containing Oregon chub, the Mary's River and the Luckiamute River, have characteristics in common with the Yamhill River. This presentation will describe the history and known distribution of Oregon chub in coast-range draining tributaries of the Willamette River, our findings and progress to date recovering the species in these basins, and our approach for conserving the Yamhill River population.

Light-Driven Changes in Aquatic Macroinvertebrate Community are not Reflected in the Diets of Coastal Cutthroat Trout

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Poster presentation

Stream light availability is an important factor influencing aquatic food webs. In forested headwaters, stream algal production is highly light-limited, and an increase in light often enhances benthic algal growth, which in turn increases food availability for primary consumers in the stream. In headwater streams, light availability is mediated almost entirely by the canopy structure of stream-side vegetation. Over the last century, many streamside forests in the Pacific Northwest were heavily harvested, leaving dense second-growth vegetation for the time being. Under current conditions we would expect dense closed canopies, little primary production, and a low abundance of invertebrates that feed on stream algae (those in the "scraper" feeding guild). Earlier research has shown that the increase in light availability associated with the removal of all, or nearly all, of the riparian forest can result in an increase in algae and stream invertebrate scrapers. But how do stream algae, stream invertebrates and ultimately stream fish respond to smaller changes in light that are more characteristic of the natural and anthropogenic disturbances that occur along headwater riparian streams today? In this study, we manipulated stream-side canopy cover of several streams in the western Cascades of Oregon by creating small (0-meter diameter) gaps in order to increase local light availability. We investigated the response of benthic periphyton, stream macroinvertebrates, and prey consumption by trout in gap and reference reaches. We hypothesized that increases in light availability would have a positive response on grazing macroinvertebrates due to elevated algal production, and predicted that this change in community structure would be reflected in the diets of trout. The study was designed with paired control and treatment reaches at five different sites. Pre-treatment benthic invertebrate samples were collected during summer of 2017, gaps were cut over the winter of 2017-2018, and sites were resampled for macroinvertebrates during summer of 2018. To determine if changes in macroinvertebrate communities affected prey consumption by trout, trout diets were collected in the summer of 2018 within 5 days of the benthic sampling. The response of macroinvertebrate communities (evaluated by taxa and by functional feeding group) were evaluated in each year by comparing differences in paired reference and treatment reaches. We also compared the relative abundance of invertebrate taxa in trout diets to the relative abundances in the benthic community in treatment and

control reaches. We found that the presence of a canopy gap increased the abundance of scraping invertebrates, but this change was not reflected in summer trout diets.

Predicting Larval Lamprey Habitat in the North Umpqua River

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Coauthor: Kelly Coates
Traditional oral presentation (20 minutes)

Lamprey are a culturally significant species and first food source for the Cow Creek Band of Umpqua Tribe of Indians (The Tribe). They also play an important role in river ecosystems throughout the Pacific Northwest. Recent declines in population abundance have led to more research into their life history and habitat requirements. The Tribe and the U.S. Geological Survey are working together to develop a model that will identify where potential burrowing habitat is located within a stream system. To ground truth this model, two major tributaries of the North Umpqua River (Rock Creek and Steamboat Creek) were surveyed by the Tribe in the summer of 2017. This information will help practitioners focus management and restoration efforts on areas that will be beneficial to lamprey during their larval life stage. The presentation will describe the model, survey methods, results and next steps of the project.

Restoring Wild Fish to Wild Places- A Novel GIS tool for Prioritizing Fish Passage Barriers

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Traditional oral presentation (20 minutes)

The Upper Columbia has over 2,000 miles (3,200 km) of salmon, steelhead, and bull trout habitat, a substantial portion of which is inaccessible to fish due to anthropogenic barriers. Since 1999, partners working in the region have addressed over 135 fish passage barriers, but as well-known high priority barriers were addressed, partners in the region identified the need to assess and prioritize remaining barriers. As in other areas, the challenge was the number of small barriers that remained and the lack of information on these barriers to prioritize them for removal or replacement. After a comprehensive assessment of hundreds of new potential fish passage barriers in the Wenatchee subbasin in 2016-2017, the Upper Columbia Salmon Recovery Board and its partners completed a GIS-based prioritization of barriers using species, habitat, and barrier metrics. In this talk I will describe the strategy that was developed and adopted to prioritize fish passage projects in the Upper Columbia and the results of prioritization in the Wenatchee subbasin. The resulting ArcGIS tool allows for rapid assessment of hundreds of barriers using commonly available data sources. It also allows has the

capability to change various aspects of the prioritization approach as needed (e.g. metrics and weightings) and re-run the prioritization tool as information changes or becomes available.

Development of a Tribal Co-Management Policy Framework for Natural Resources

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Traditional oral presentation (20 minutes)

Federally recognized Native American tribes are sovereign nations with a unique federal relationship. The exercise of sovereignty and federal tribal trust obligations, combined with changes in law and administrative policy, have spurred arrangements to share natural resources management authority between tribal, federal and state agencies. Such arrangements are referred to as "co-management". Tribal objectives for co-management range widely, including resource use, environmental protection, exercise of sovereign authority, power-sharing, and resolution of value conflicts. Implementation of tribal co-management has both directly and indirectly produced changes in natural resources policy, notably within fisheries management in the Pacific Northwest. However, policy process research has largely omitted the role of tribal governments, limiting the validity of predominant frameworks and their utility in predicting policy change and efficacy. In practice, a policy framework which includes tribes as sovereigns may assist practitioners in building co-management, evaluating agency and tribal policy, and studying of the role of tribes in the policy process. The goal of this research is to propose a policy framework for tribal co-management of natural resources that describes internal and external constraints and drivers, using qualitative content analysis of publicly available documents from two fisheries management cases. Here I present preliminary findings to highlight framework components within five themes: intended outcomes, tribal policy and internal operations, collaborative process, federal and state policy and internal operations, and attributes of the target resource.

Stream Conditions after 18 Years of Passive Riparian Restoration in Small Fish-bearing Watersheds

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Traditional oral presentation (20 minutes)

Many of the ecological processes in the riparian forests and streams across the Pacific Northwest have become impaired through production forestry practices common prior to the 1990s. Some of these practices included forest harvest without stream buffers, removal of instream wood, road construction and use, and harvesting large proportions of watersheds. Passive ecological restoration (the use of natural processes of succession and disturbance to alleviate anthropogenic impacts over time) is a

common practice used in the management of riparian forests previously subjected to production forestry. Eighteen years after the implementation of passive restoration of riparian forests, we used four common stream indicators (stream temperature, canopy closure, instream wood and salmonid densities) to assess restoration in small fish-bearing streams. Summer stream temperatures have decreased below unmanaged reference levels, whereas riparian forest canopy closure has increased beyond that in reference watersheds. Instream wood and age-1 or older salmonids appear to be either stable at reduced levels or declining, compared with production forestry and unmanaged reference watersheds. Overall, second-growth riparian forests need more time to develop allowing more light into streams (increasing primary productivity), while also allowing for the continuous recruitment of larger pieces of instream wood (creating increased winter habitat for salmonids). Using only passive restoration, stream conditions in second-growth forests are unlikely to increase salmonid production in the near future.

Quantitative decision analysis for the optimal allocation of Chinook Salmon habitat restoration projects

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Traditional oral presentation (20 minutes)

Anadromous salmonids (*Oncorhynchus sp*.) have declined substantially across the Northwest US during the past century. One critical factor responsible for the declines has been the degradation of freshwater habitats used for spawning and juvenile rearing as typified by streams in the California Central Valley. Mining activities, river impoundment, and channelization have resulted in significant losses of crucial freshwater habitats that also have been identified as bottlenecks preventing the recovery of native salmonid populations. We used a decision theoretic approach to identify restoration objectives and develop a probabilistic decision model for evaluating alternative Chinook salmon (O. tshawytscha) restoration actions. The fundamental objective of the decision makers was based on the legislative mandate from the Central Valley Project Improvement Act (CVPIA), which was to maximize the number of naturally produced fall-run adult Chinook salmon. We evaluated the potential effectiveness of two, cost equivalent, habitat restoration methods: adding gravel to the stream channel or excavating a stream bank to lower the floodplain in 400 m reaches of the Lower American River, CA. Using the decision model, we identified optimal state-dependent restoration policies based on the adult escapement, spawning and rearing habitat availability, and thermal regime. The optimal policy was identified as that would yield the largest number of Chinook salmon adults in the future. We then estimated the effectiveness of the optimal policies using simulation. Sensitivity analyses indicated that the optimal policy was strongly influenced by assumptions regarding habitat degradation through time and the survival of rearing juveniles. The results of our study revealed several state-specific rules for prioritizing restoration actions that may be applied to systems with similar constraints.

Recovering Oregon Coast Coho Salmon - How Badly Do We Want It? Exploring some Hurdles to Stream Restoration in Oregon

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Traditional oral presentation (20 minutes)

Oregon Coast coho salmon (*Oncorhynchus kisutch*) are protected under the Endangered Species Act. Coho are listed as "threatened" and thus a Recovery Plan was developed by the National Marine Fisheries Service and numerous stakeholders in December of 2016. One of the primary limiting factors in the Plan is "reduced amount and complexity of habitat". Stream and watershed restoration were identified as the primary strategies to address degraded habitat. In recent years, a number of timing "hurdles" have developed in completing stream restoration projects on both private and federal lands. These hurdles include wildlife restrictions, fire seasons, and in-water work windows. These "hurdles" can be managed individually, but when combined severely restrict the window in which stream restoration projects can be implemented. The restricted restoration season also makes it difficult to find willing contractors to implement restoration projects. Each hurdle will be discussed along with possible solutions to allow restoration practitioners more flexibility to recover Oregon Coast Coho Salmon.

Stage 0 Alluvial Valley Restoration on the South Fork McKenzie River, Oregon

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Traditional oral presentation (20 minutes)

For several decades, river restoration has been dominated by a form-based approach - one that creates a predictable and stable primarily single-thread channel connected to its floodplain at a particular discharge. In the last couple decades, there has been a strong call from the scientific community to prioritize natural process and function over form and to embrace a more holistic watershed or ecosystem approach. A process-based approach to river restoration addresses the root causes of degradation, restores natural processes, and allows the fluvial system to adjust dynamically in response to disturbances or future conditions. In contrast to a form-based approach focused on stability and predictability, the process-based approach welcomes dynamism and variability.

Concurrently with the rise of process-based restoration is the growing evidence and recognition that the assumed single-thread meandering channel does not accurately represent the natural configuration of a low gradient alluvial system and is not a universally appropriate target morphology for alluvial valley restoration. In the seminal paper by Cluer and Thorne (2013), they present a strong case that the pre-disturbance condition in alluvial valleys was instead an anastomosing network of channels and wetlands that frequently flooded. They refer to this anastomosing precursor stage in their updated Stream Evolution Model as Stage 0.

In 2018, a Stage 0 project was implemented on 150 acres of the lower South Fork McKenzie River, the largest tributary to the McKenzie River, draining about 138,000 acres. About 90,000cy of alluvium from berms, artificial features, and natural sediment deposits in the floodplain was used to fill and raise the streambed elevation (up to 14 feet in places) to create an anastomosing system with very high connectivity across the 2,000 foot wide valley bottom, even at base flow. Over 3,000 pieces of large wood were then placed with helicopter and heavy equipment throughout the valley bottom to create hydraulic complexity and to dissipate energy wherever channels may migrate. This approach does not dictate channel form or construct channels. Rather, it simply "resets" the valley bottom and allows natural processes to create dynamic channels, islands, bars, and complex habitat. Preliminary monitoring results show: increased base flow wetted area by 350%; increased base flow mean and maximum depth; decreased base flow stream velocity; shift from riffle to pool habitat; decreased substrate size and increased size class diversity and patchiness; increased available spawning habitat (14 Chinook redds within two months of implementation where there were none documented before). Additional phases in the coming years will restore over 600 acres of alluvial valley bottom to a highly complex, productive, anastomosing system, benefitting ESA-Threatened spring Chinook salmon and bull trout, Pacific lamprey, and the rest of the aquatic and riparian community.

Statolith chemistry of Pacific lamprey: Evaluating the potential to determine natal origins and migration history

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Coauthors: Jon Hess, Laurie Porter, Keith Parker, Trent Sutton, Keala Pelekai
Traditional oral presentation (20 minutes)

Greater understanding of natal source contributions and migratory patterns would aid recovery efforts for anadromous Pacific Lamprey in the Columbia River. However, lamprey lack otoliths, the chemical composition of which is used to identify natal origins and reconstruct diadromous migrations in teleosts. Therefore, we evaluated the potential of statoliths to characterize natal origins and reconstruct migratory history. We examined statoliths of 50 juveniles with known locations in the Snake River basin, inferred from parentage analysis. The Snake River is an upper tributary to the Columbia River. We also collected adults from the Willamette River (n = 124), a lower tributary of the Columbia River; the Klamath River (6), a coastal river in Oregon; and marine waters (19). Using statolith Sr/Ca, Ba/Ca, and 87Sr:86Sr, juveniles were correctly assigned to their presumptive natal region 90% of the time. 87Sr:86Sr ratios around 0.703-0.705 are associated with basalts and Cascade Igneous Rocks, which are common in coastal watersheds, whereas higher 87Sr:86Sr ratios (>0.710) are associated with interior portions of the Columbia River and other large watersheds with diverse and older geologic history. Marine 87Sr:86Sr is relatively invariant at 0.70918. For adults, Willamette River fish natal 87Sr:86Sr ranged from 0.70314 to 0.71688. The natal 87Sr:86Sr values of adults collected in the Klamath River and the ocean ranged from 0.70314 to 0.70776. Given the lack of evidence for natal homing in lamprey, it is somewhat surprising that we only observed the higher natal 87Sr:86Sr values in the adults collected in the Willamette River. Additionally we observed no clear evidence of marine residency in adult statoliths. Overall, it appears

that statoliths can provide robust estimates of natal origin but marine applications warrant additional research. Laboratory studies to determine rates of elemental partitioning in statoliths and evaluate the effects of ration, temperature, salinity, and ontogeny are also needed.

Cultural and Social History of AFS to Assist a Future Vision

Christine Moffitt
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Traditional oral presentation (20 minutes)

The American Fisheries Society will be celebrating its 150th birthday in 2020. This milestone can provide an opportunity to reflect on the changes in our profession, and in the landscapes that we study and manage. The barrage of social media and Instagram and breaking news can cloud our ability to examine where and how we got where we are and reflect on the lessons learned. We will review with the audience highlights, failures, and challenges of our profession over its 150 years to facilitate a dialog to capture visions for the future.

Adaptive Management in Practice: Navigating Social and Political Realities

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Coauthor: Jennifer Arnold
Traditional oral presentation (20 minutes)

Adaptive management has been widely advocated by natural resources scientists for over 25 years and is increasingly called for and even mandated by funders, agencies and oversight bodies like the Independent Science Review Panel. Defined as a systematic approach to improving restoration policies and practices by learning from the outcomes of ongoing actions, adaptive management ideally helps focus restoration efforts to have the greatest positive impact. Yet there are few examples of its successful application in fisheries and aquatic ecology or elsewhere. Experts in adaptive management emphasize that the challenges to implementing it are largely institutional and sociopolitical in nature, such as (i) resistance to acknowledging uncertainties about the outcomes of management practices, (ii) reluctance to invest time and resources in collaborative learning, (iii) lack of sustained funding and leadership for long-term monitoring, and (iv) overemphasis on planning and experimentation with little to no direct linkage back to decision making and on-the-ground actions. Based on our in-depth experiences as facilitators and social scientists working on adaptive management in a variety of contexts, we identify strategies and practical tools to design and effectively implement adaptive management, including guidance for what approaches may fit different sociopolitical contexts. Tools and strategies include: building strong working relationships among practitioners, scientists, and policymakers; designing effective learning forums; balancing rigorous experimentation with qualitative

observation; integrating new knowledge into decision making; and implementing structured, yet flexible, planning and review processes. By directly addressing the social and political challenges commonly faced by restoration scientists, this session will provide participants practical knowledge they can use to more effectively integrate adaptive management into their restoration work.

Esri's Apps for the Field

Terri Morganson
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Traditional oral presentation (20 minutes)

Use the power of location to improve coordination and operational efficiency in field workforce activities. Reduce or even replace reliance on paper. Ensure that both field and office workers use the same authoritative data to reduce errors, boost productivity, and save money. This session will provide an overview and update of Esri's field apps.

Pacific Lamprey oxygen consumption rates and hypoxia tolerance

Mary Moser
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Coauthors: Alexa Maine, Aaron Jackson
Poster presentation

Culture of Pacific Lamprey (Entosphenus tridentatus) requires transport and periodic holding of both adults and larvae under static (no flow) conditions. While Pacific Lamprey are assumed to have broader tolerance of hypoxia than salmonids, specific guidelines for maintaining adequate oxygen conditions are needed. To this end, we measured oxygen consumption rates of both mature adults and early larvae under static conditions. In addition, we recorded indicators of stress and terminated experiments as soon as the animals showed signs of discomfort. Adult Pacific Lamprey exhibited surprisingly high metabolic rates when at rest in static chambers. At 12 °C, a single adult typically reduced dissolved oxygen levels in 10 L to less than 2 mg/L in just 90 min (oxygen consumption rates of 100-200 mg/kg/h). In hypoxia tolerance experiments, adults often started to climb the walls of open static chambers when dissolved oxygen levels approached 2 mg/L. In this way, they were able to raise the gill pores into air where oxygen availability was higher. In contrast, larval oxygen consumption rates were nearly an order of magnitude lower (mean < 20 mg/kg/h) than adult rates. Larvae remained quiescent, even when oxygen levels dropped below 1 mg/L. This may reflect larval adaptations for living in silty substrates and in pool environments where relatively low oxygen conditions occur in the wild.

Oregon’s Toxics Monitoring Program: Findings from the First Ten Years and Future Direction

Michael Mulvey
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Coauthor: Daniel Brown
Traditional oral presentation (20 minutes)

In 2007, in response to widespread concern over toxic pollutants in the state of Oregon's environment, the Oregon Legislature authorized funding to the Oregon Department of Environmental Quality to develop a statewide program for monitoring toxic substances in the environment. Since 2008, DEQ's Toxics Monitoring Program has monitored a wide range of toxic substances in a variety of environmental settings, including surface water, sediment and fish. This presentation looks at the history of the first ten years of the program, an overview of what we found in the environment, and a preview of the monitoring program in the future.

Unintended consequences of selective water withdrawal for thermal restoration below Cougar Dam

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Coauthors: Sherri Johnson, Gregory Taylor, William Gerth
Traditional oral presentation (20 minutes)

Where a dam outlet draws water from can have important implications for downstream processes and biota. Large dams may be tens of meters or more in depth, resulting in strongly stratified reservoirs. Water withdrawal from the bottom of a stratified reservoir results in different downstream temperature regimes than what would occur in an unimpounded stream. At Cougar Dam on the McKenzie River in Oregon, such outflows following reservoir construction resulted in downstream waters which were colder during the summer and warmer during the fall. To minimize temperature related dam impacts a selective water withdrawal â€˜temperature control tower' (92 meter wet well) was constructed and began operations during May 2005. Here we use 6 years of summer macroinvertebrate data, three years before the temperature control tower began operations and three years following (2002-2007), to assess the impacts of mixing of outlet water for temperature control on the instream benthic macroinvertebrate community. We also examine dam impacts by comparing invertebrate communities in reaches upstream of Cougar Reservoir to reaches downstream. Initial years show increased macroinvertebrate densities below Cougar Reservoir, compared to upstream sites. Following the operation of the temperature control tower and selective water withdrawal, the downstream communities exhibited unexpected shifts away from upstream reference conditions. These shifts included reduced macroinvertebrate densities overall and increased filter feeder densities. This is hypothesized to be a result of shifting water withdrawals to the productive upper strata of the reservoir, exporting zooplankton downstream and increasing trophic subsidies to downstream reaches.

Determining Genetic Lineages of Chinook Salmon in the Buoy 10 Fishery Based on Scale Growth Pattern

Alexa Myers
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Poster presentation

Stock identification through scale growth patterns is a widely used tool in fisheries management, as it can provide a relatively inexpensive way to identify fish to management, or genetics-based stock groupings. There are three primary genetic lineages of fall-run Chinook Salmon in the Columbia River basin: lower river fall-run fish (Tules), upriver brights, and out-of-basin Rogue River stock (select area brights). These fish are an important recreational fisheries resource, especially in the high effort Buoy 10 fishery at the mouth of the Columbia River, but have different levels of conservation protection based on ESA delineations. Through application of scale-based stock identification, we may be able to assign each fish to genetic lineage without using coded wire tags or genetics. Thus, scales may provide more information about stock-specific harvest in a mixed-stock fishery and assist in decision-making and conservation of protected stocks. We used scales collected by ODFW creel sampling efforts during the 2017 Buoy 10 fishery to evaluate whether scale growth pattern could be used in stock identification. We first digitized images of scales from fish with coded wire tags, as these fish had known hatcheries and brood years of origin. We then divided these fish into groups based on hatchery of origin and dominant age-class: one select area bright hatchery (age 3-1, using Gilbert-Rich age notation with a dash preceding the subscript), one lower river Tule hatchery (age 3-1), and three upriver bright hatcheries (ages 4-1, 4-1, 4-2). Using AmScope image analysis software, we measured growth increments and counted the number of circuli between several features of interest, out to the tenth circulus past the edge of the first saltwater annulus. We used MANOVA and linear discriminant function analyses to identify differences in scale growth between groups and identify individual fish to their genetic lineages. We identified differences in the freshwater growth patterns based on variations in hatchery practices and genetic heritage, and classified fish to group based on these differences. In the future, we would like to apply the resulting classification models to untagged fish of unknown wild or hatchery origin to assess the usefulness of this tool in fisheries management. Identifying individual fish to their genetic lineage based on scale growth has the potential to become a complimentary tool to current methods, potentially improving fisheries management in the region.

Managing water, beaver and expectations in stream restoration projects

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Traditional oral presentation (20 minutes)

Beavers have a longstanding reputation as ecological engineers, with the capacity to maintain and possibly restore stream systems. As a result, there is growing interest in a suite of ecosystem restoration strategies grouped loosely under the title of "beaver-related restoration", or BRR. These strategies range from reintroducing beavers, to building artificial structures, to changing riparian management strategies, all in the hopes of attracting beaver to build dams that alter hydro-geomorphic conditions and lead to favorable ecological outcomes. Though there are many anecdotal reports of the successes of BRR, biophysical research and monitoring documenting these same successes are limited.
To address these gaps of knowledge, we've put together a new organizing framework that allows us to compile the social and biophysical data documenting beaver related restoration and evaluate the capacity of BRR to address various restoration goals. Our objectives in this research were to: (1) identify the typical goals of BRR projects (social, ecological, and hydrogeomorphic), (2) make implicit assumptions about the processes by which BRR is thought to create biophysical change explicit, and evaluate the capacity of hydrologic processes and beavers themselves to bring about the desired change, and (3) compare the outcomes of BRR perceived and observed by project participants (local knowledge, social) with documented outcomes of BRR from western scientific research and monitoring studies (biophysical) to see how well they align.

We synthesized a large body of biophysical literature, new interview data and first principles modelling to evaluate eight of the nine central expectations about what BRR can achieve. We found that biophysical and social data agree that BRR is typically effective at raising local groundwater levels and increasing the extent of riparian vegetation, but disagree regarding its benefits to late season streamflow. We found that some disagreement arose from differences in language used by various stakeholders, but that there is also a fundamental challenge to measuring changes due to individual restoration strategies when they are used in concert with other actions to achieve project goals. The use of biophysical data together with social data helps resolve some of these difficulties, but further work is needed to clarify how best to monitor change in such endeavors. More broadly, this research challenges some of our assumptions about the relationship between beaver and hydro-geomorphic conditions, and raises the question of what should fall under the heading of beaver-related restoration. This is of particular importance given ongoing debates over the appropriate regulatory approach to BRR and ongoing experimentation by practitioners and landowners.

Back to school: Pursuing a graduate degree after being in the field for 7 years

Travis Neal
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Traditional oral presentation (20 minutes)

After working in the field for 7 years, the decision to go back to school to pursue a graduate degree was not the easiest. I had become comfortable in my career conducting field work for the Oregon Department of Fish and Wildlife. I loved rafting rivers while conducting spawning surveys for salmonids in the Willamette Valley and the 40 hour work week was easy to enjoy. But there had always been a part of me that wanted to continue my education after getting my bachelor's degree, so when an opportunity for a master's program at Oregon State University was offered, I readily accepted it.

I have now been pursuing a master's degree for a little over two months and I have already learned a lot and noticed some things. Many fish and wildlife students have been in "the field" for a few years before going back to school, so while I am older than most of my cohort it does not feel like a big difference. It does takes time to learn how to study and take tests again. You will be surprised how much work you can get done in such little time. Your schedule constantly changes. You will work more than 40 hours a week and likely on weekends. Sleep has never felt so good. But I am loving it and I am learning every day. While it was not the easiest transition and I have zero doubt it will get harder before it is over, I still have no regrets. Everyone's path to graduate school and their experience while in will be different, but this one is mine.

Genetic and morphological evidence suggests cryptic speciation within the Torrent Sculpin across the Pacific Northwest

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Coauthors: Michael Young, Donald Zaroban, Brian Sidlauskas
Traditional oral presentation (20 minutes)

Dwelling on the bottom of large rivers to high alpine streams, freshwater sculpins (genus *Cottus*) occur in high densities across the Pacific Northwest, with 19 currently recognized species found in Oregon and Washington alone. Sculpin fill many ecological roles, with some species serving as important prey sources, and others competing with or predating upon juvenile salmonids. Fully understanding these ecological interactions requires the ability to recognize and diagnose co-occurring species. However, Cottus contains many similar looking species, leading to frequent misidentifications and the persistence of undiscovered species. We used multilocus phylogenetics and multivariate morphometric analysis to investigate the taxonomic status of Torrent Sculpin, *Cottus rhotheus* across the Pacific Northwest, and determine whether the current concept of *C. rhotheus* contains multiple cryptic, unrecognized species. Phylogenetic analysis reveals three distinct and geographically restricted clades, with the Columbia River and Cascade Range acting as allopatric barriers. Using forty-two unique measurements per specimen, our preliminary morphometric data corroborates the genetic divisions, with differences in the caudal peduncle region, pectoral fin width, and eye size easily separating clades lying north and south of the Columbia River in western Oregon and Washington. Upcoming analysis of more specimens from Idaho and Eastern Oregon will refine and test our hypothesis that genetic, geographic and morphological divisions reveal the presence of at least three species within *Cottus rhotheus*. Answering this question can improve our ability to understand, manage, and conserve the biodiversity in the Pacific Northwest.

Strategic Development: The role of anxiety and complexity in research bias and inclusion

Natalie Ochmanek
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Traditional oral presentation (20 minutes)

Our interpretation of inclusion shifts as we develop as adults. The evolution of how we define inclusion has a common pattern in cultures and individuals. Each stage of development, or lens that we interpret the world through, includes an ability to comprehend and embody greater complexity. Some lenses of inclusion include survival-based relationships, ethnocentric traditionalism, success orientation, scientific rationalism, ecological relationships, egalitarian diversity, integrative contexts and transpersonal relationships. Every lens evolves our interpretation of inclusion and focuses & distorts the increased complexity. At the highest levels of development, a systems approach that includes all these developmental lenses is possible and is currently being forged in our cultures, in our work, by us. Understanding & clearly communicating our individual & collective, conscious & unconscious patterns are foundational elements in a systems approach that has direction, integrity and responsibility. Integrating a systems approach in to our work and lives is supported by the tools of understanding context relationships, waking up, growing up, cleaning up and showing up. Our level of anxiety and aversion is a major limiting reactant in our evolutionary development as individuals and cultures. The more we are able to clearly recognize and take responsibility for our anxiety, the greater potential impact of our environmental research and practices.

Genomic and otolith variation in a recently described species, Deacon Rockfish

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Coauthors: Felix Vaux, Leif Rasmuson, Lisa Kautzi, Polly Rankin, Matthew Blume, Kelly Lawrence, and Sandra Bohn

Speed oral presentation (7 minutes)

The newly described Deacon Rockfish occurs in both the nearshore and offshore waters of Oregon. Previous stock assessments have combined this species with the Blue Rockfish; therefore, little is known about the demographic, ecological, and genetic variation within the Deacon Rockfish. To begin filling these information gaps, we investigated otolith shape and genomic variation among Deacon Rockfish sampled from two nearshore sites (Siletz Reef and Seal Rock) and one offshore site (Stonewall Bank). We found evidence for statistically significant differences in otolith shape and genomic variation among fish when we analyzed the three sites independently and when we organized the sites into nearshore and offshore groups. However, the degree of genomic differentiation was low and further research is necessary to determine the biological relevance of these results. We also identified outlier loci between males and females, likely representing sex-linked variation. The morphometric results indicated that there was significant secondary sexual dimorphism in otolith shape. Overall, the results of this study suggest that there is significant phenotypic and genomic variation among Deacon Rockfish sampled over a small geographic scale (<50 km2). This study is the first step towards understanding intraspecific variation and the management requirements of Deacon Rockfish.

Seasonal and spatial variation in lamprey parasitism of redband trout in the Upper Klamath Basin

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Traditional oral presentation (20 minutes)

The Upper Klamath Basin hosts several endemic lamprey species, including an adfluvial form of Pacific lamprey (*Lampetra tridentata*) that remains taxonomically unresolved. This adfluvial lamprey is known to be parasitic, but virtually no data exists describing its foraging ecology and how it affects valuable recreational host species, such as adfluvial redband trout (*Oncorhynchus mykiss newberii*). The objective of this study was to explore seasonal and spatial variation in lamprey parasitism of redband trout and to determine whether parasitism rates change when trout migrate to cold-water refuges during summer. From direct sampling and photographs collected by volunteer anglers, we quantified lamprey wound levels in 327 redband trout over two years. The number of lamprey wounds per trout was highest in the lake during spring (66% of sample had wounding) and exhibited a right-skewed distribution (most fish had few wounds, but some individuals had severe wounding). In contrast, redband trout sampled in thermal refuge habitat during summer had very low counts of wounds (6.5% of sample had wounding). Of the three primary cold-water refuge areas we sampled, the Wood River outlet accounted for nearly all summer lamprey wounds. Interestingly, this refuge also had the lowest level of use by redband trout in a concurrent radio telemetry study. Future work is needed to understand why lamprey parasitism declines when redband trout move to thermal refuges. While it may be related to conditions on refuges, it could also reflect lamprey ceasing feeding and emigrating to spawn.

Leveraging publicly-available remote sensing data to map river bathymetry, hydraulics and instream habitat in Northwestern rivers

Brandon Overstreet
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Coauthors: Gabriel Gordon, James White
Traditional oral presentation (20 minutes)

River channel complexity is a building block for aquatic habitats in fluvial environments. While many restoration and environmental flow programs seek to increase channel complexity, techniques for rapidly quantifying complexity at scales relevant to aquatic organisms, and the subsequent evolution of channel complexity that may result from restoration activities, is lacking. Recent advances in active and passive optical remote sensing technologies (for example, lidar and multispectral ortho-imagery) support a suite of tools for high-resolution mapping of river systems. However, the high resolution remote sensing data to drive these tools is often expensive and not financially feasible for individual projects. Increasingly, federal and state agencies are funding multispectral imagery and lidar data collection and making that data publicly available.

In this presentation we demonstrate that publicly available multispectral imagery can be used to produce high-resolution (<1 square meter), spatially-continuous water depth maps by forming a regression relationship between field-measured depth and image reflectance. We combine image-derived depth maps with near-infrared lidar topography and water surface elevation profiles to produce seamless digital elevation models of the streambed and floodplain. We construct two-dimensional hydraulic flow models using the remote sensing-derived digital elevation models. Finally, image-derived depth and model-derived flow velocity are used to create spatially continuous, high-resolution maps of instream habitat and morphologic units including pools, riffles, shallow bars and backwater areas. Altogether, these publicly available mapping tools and datasets provide an efficient, low-cost means of creating detailed river bathymetry maps to characterize river channel complexity, track changes in complexity over time, support multi-dimensional hydraulic models and habitat characterization. This presentation will describe the approaches, underlying datasets and application to habitat studies across a range of settings in Oregon and Wyoming.

Washington Instream Flow Science and Water Availability

James Pacheco
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Traditional oral presentation (20 minutes)

Washington passed the WRIA 55 Instream Resource Protection Program rule in 1976 and it was the first rule to include instream flows. Since then we have passed instream flow protections in 24 other watersheds in roughly 3 different phases with increasing levels of protections. We are currently experiencing a tension between instream flow and water availability for new rural homes using permit exempt wells and have been under a new instream flow moratorium waiting for a fix. Is our level of instream resource protection the problem? This presentation looks at water availability under the three general levels of Instream Resource protection we have used over the years.

Fish need water, but will they have (enough of) it?

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Traditional oral presentation (20 minutes)

The clock is ticking, faster than many realize, to ensure that Oregon's native fish species will have the water they need to persist into the future. Most of Oregon's water has already been fully or over-appropriated, largely for out-of-stream uses. As Oregon's population grows and the impacts of climate change worsen, the demands on this limited resource will only intensify. If we are to be successful at meeting the water needs of both humans and wildlife it will require smart planning, sound science, and a collaborative approach among all groups. To best represent the needs of fish in this discussion it is imperative that the community of policy makers, restoration practitioners, advocates for fish, wildlife,

and water; and scientists are working together. This talk will set the stage for the session by presenting a high level overview of the challenges, data gaps, and opportunities around ensuring a wet future for Oregon's native fish.

Lamprey re-colonization of the Elwha River post dam removal

Rebecca Paradis
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Coauthor: Dr. Mary Moser
Traditional oral presentation (20 minutes)

Initiated in 2011, removal of the two large dams on the Elwha River is one of the largest river restoration projects ever attempted in the Pacific Northwest. Along with the re-colonization of salmonids, native anadromous lampreys have been able to resume use of habitats that were inaccessible prior to dam removal. Both Pacific lamprey (Entosphenus tridentatus) and River Lamprey (*Lampetra ayresii*) likely inhabited the upper reaches of the Elwha River prior to construction of the dams. According to the Washington Department of Fish and Wildlife, both Pacific and River Lamprey are Federal species of concern while the Pacific lamprey is a State monitored species and the River lamprey is a State candidate for listing. After dam construction, lampreys were extirpated above the dams and records of anadromous lamprey downstream were scarce.

We used radio transmitters and passive integrated transponder (PIT) tags to document migration behavior and re-colonization of lamprey in the Elwha River basin after dam removal. We tagged 39 adult Pacific lamprey and 1 adult Dwarf Pacific lamprey with both a PIT tag and a radio tag to track their movements into tributaries (with PIT antennas) and throughout the drainage (with radio receivers). We employed both fixed sites and mobile tracking of the radio tags to document the timing and spatial extent of lamprey movements. We also surgically implanted 120 larval lamprey with PIT tags to monitor outmigration activity of juveniles. This work was coupled with genetic sampling for both species identification and parentage analysis. The resulting data indicated very rapid and extensive Pacific lamprey colonization of habitats upstream from the dam sites. The study confirms that, given access to historically-important habitats, Pacific lamprey can immediately colonize these areas and soon thereafter are able to contribute to restoration of healthy ecosystem function.

Evidence for the genetic basis and inheritance of ocean and river-maturing ecotypes of Pacific lamprey in the Klamath River, CA

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Coauthors: Andrew Kinziger, PhD; Jon Hess, PhD; Shawn Narum, PhD
Traditional oral presentation (20 minutes)

The Klamath Basin supports the highest diversity of lamprey species (n=5) of any single watershed in the world, with the anadromous Pacific lamprey suggested to have been the river's biomass-dominant fish species historically. Culturally, Pacific lamprey are a tribal trust fish species protected under tribal treaty and other rights. They continue to provide direct subsistence when other high lipid foods (e.g., salmon) are unavailable to Native American Tribes of the Basin, while providing the high caloric values (2x-4x kcal/g of salmonids) for indigenous people coinciding with the coldest season of the year. The Klamath River Tribes possess traditional ecological knowledge (TEK) of Pacific lamprey including run-timing, harvest methods, and indirect subsistence provided by the hunting of estuarine marine mammals which historically followed the freshwater migration of thousands of adult Pacific lamprey. Currently, Pacific lamprey harvest in the Klamath Basin has reduced substantially due to declines in abundance, impacting Klamath River tribes with adverse health, social, economic, and spiritual effects. Surveys of genetic variation have improved our understanding of the relationship between fitness-related phenotypes and their underlying genetic basis. We investigated the association of genetic variation with ecotypic differentiation in Pacific lamprey as they initiated their anadromous migration by intercepting 219 individuals over 12-months in the Klamath River utilizing Native American traditional methods of catch (eel hook). Each individual was genotyped (GT-seq) at 308 neutral and adaptive single nucleotide polymorphism (SNP) loci and recorded morphological traits, including egg mass as an indicator of female sexual maturity. The onset for freshwater migration for an ocean-maturing ecotype (mature eggs) identified was predominantly the winter whereas a river-maturing ecotype (immature eggs) entered during all seasons and a genetic basis of the ecotype diversity was revealed. Genotype-phenotype association mapping identified sixteen SNPs significantly associated to egg mass forming two groups of linked loci and ten other SNPs significantly associated to total length. A duplicate dominant epistasis inheritance model best supported the ocean- and river-maturing ecotypes, accurately predicting ecotype in 83% of the samples. The adaptive genetic variation revealed is useful for conservation planning as it indicates that the river-maturing ecotype carries standing genetic variation capable of producing both ecotypes (e.g., both heterozygous and homozygous individuals), while the ocean-maturing ecotype is almost exclusively homozygous. Therefore, when assessing stream restoration projects, the river-maturing ecotypes could perhaps be prioritized as they contain the genetic diversity capable of producing both ecotypes (i.e., heterozygosity), whereas the ocean-maturing ecotypes do not.

Incorporating climate change into salmon habitat restoration project design: a quantitative approach

Joe Parzych
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Traditional oral presentation (20 minutes)

Climate scenarios exist for the Columbia River Basin that provide a wide range of predicted impacts to our region and fisheries resources. However, a majority of habitat restoration project designs do not incorporate these data in tangible ways. While current industry funding and policy efforts emphasize

"resiliency" as a desired ecosystem function, many industry standards of practice rely on historical data sets and "resiliency" is not translated into quantitative project design criteria. Moving forward, additional work could be done to more explicitly incorporate climate change data and associated variability into site-specific project design. This talk will describe a method for incorporating existing climate change data sets, available from the University of Washington Climate Impacts Group, into salmon habitat project design. This analysis includes hydrologic model selection, calculation of flood magnitudes, and interpretation of hydrograph timing results. We will present a case study in the Methow River, Washington, where results from this analysis were used to inform site-specific design criteria from both engineering and fisheries habitat viewpoints.

EPA's National Monitoring and Assessment Surveys: Large-Scale Monitoring in the USA Steve Paulsen
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Traditional oral presentation (20 minutes)

The US Congress enacted the 1972 Clean Water Act to protect US waters. A critical section (305b) of the Act requires periodic evaluation of the success or failure of efforts to protect and restore these waters. The Government Accountability Office reviewed the available data and concluded that they did not adequately describe the condition of US waters as required by law. Based on previous research and piloting in its Environmental Monitoring and Assessment Program, the US Environmental Protection Agency initiated the National Aquatic Resource Surveys (NARS) in 2005 to fill this critical information gap. Addressing one waterbody type each year, NARS conducts annual surveys of streams, rivers, lakes, wetlands, and near-coastal waters in partnership with individual states, tribal nations, and other federal agencies. The surveys employ spatially-balanced probability designs to select waterbodies and collect biological, chemical, and physical data using standardized field data collection methods at each sample site. NARS scientists analyze this data to infer, with known confidence, the extent of each type in the US that is in good, fair, and poor condition with respect to values of quantitative measures of key ecological attributes expected under least disturbed conditions. Most recently, NARS summarized results from data collected in 2013 and 2014 from 1,835 sites representing 750,000 miles rivers and streams throughout the contiguous 48 US states and compared those findings with its previous survey of those waters in 2008-2009. Less than a third of the miles of US rivers and streams had healthy fish and macroinvertebrate assemblages. Nutrient (phosphorus and nitrogen) pollution was moderate to severe in 68 to 79%, and alteration of physical habitat is moderate to severe in 36 to 70% of the flowing water length. We discuss the opportunities and challenges of mounting aquatic resource surveys of this magnitude and extent.

Additive Mortality Effects of Caspian Tern Predation on Upper Columbia River Steelhead
Quinn Payton
Real Time Research

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Coauthors: Allen Evan, Nathan Hostetter, Brad Cramer, Ken Collis, Daniel Roby, Curtis Dodson
Traditional oral presentation (20 minutes)

A critical question in predator management is whether predation mortality is an additive or compensatory source of mortality. In particular, would reductions in predation rates result in higher prey survival (i.e., predation adds to mortality) or are individuals consumed by predators destine to die regardless of predation (i.e., predation is compensated for by other mortality sources)? If predation were completely compensatory, whereby predators exclusively consume moribund or otherwise ill-fated prey, then there would be no increase in survival associated with decreases in predation rates. Conversely, if predators consume prey that would otherwise survive in the absence of predation, this indicates predators are an additive source of mortality, and consequently reductions in predation rates would result in increased survival rates.

We investigate hypotheses of additive versus compensatory predation mortality in a study of Upper Columbia River steelhead survival and Caspian tern predation. We analyzed a ten-year (2008-2017) dataset involving the passive integrated transponder (PIT) tagging and release of live juvenile steelhead smolts at Rock Island Dam, their volitional live detection at Bonneville Dam during outmigration, volitional live detection at Bonneville Dam upon returning as adults, and/or, following death during outmigration, their subsequent recovery from seven Caspian tern colonies within foraging range of the migration corridor. We used a modified mark-recapture-recovery model to jointly estimate rates of survival and tern predation on steelhead. This model allowed us to assess the strength and magnitude of the relationship between steelhead survival and predation during both the smolt and smolt-to-adult life stages. A statistically significant, negative, linear relationship was observed in all study years and spatial-scales evaluated, indicating that tern predation on smolts during outmigration was associated with both lower annual smolt outmigration survival and lower smolt-to-adult return rates. We estimated that, in the absence of tern predation survival rates to Bonneville Dam would have been 0.08 (95% CRI: -0.02 - 0.18) to 0.32 (95% CRI: -0.04 - 0.51) higher each year. We further estimated that annual adult return rates would have been from 0.01 (95% CRI: 0-0.02) to 0.05 (95% CRI: 0.03-0.08) higher each year in the absence of tern predation. Collectively, our results provide evidence that predation by Caspian terns on steelhead smolts was largely an additive source of mortality and that in the absence of tern predation more adult steelhead would likely have returned to the Columbia River to spawn during the study period.

Evaluation of Pacific Lamprey statoliths and eye lenses as records of age and natal origin

Keala Pelekai
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Coauthors: Jon Hess, Laurie Porter, Jessica Miller
Poster presentation

Pacific Lamprey (Entosphenus tridentatus) is a cartilaginous fish that lacks the common hard structures used to elucidate demography and life history patterns in teleosts. Statoliths, analogous to otoliths in function, are calcium-fluorapatite concretions found in the auditory capsules of lampreys. Statoliths have potential to determine age and natal origin but require validation that the alternating band structure represents seasonal deposition and their composition reflects the chemistry of an individual's environment. Eye lenses are metabolically inert and grow external layers continuously, representing a potential record of individual age and chemistry. Eye lenses have been used in teleosts and mammals for elemental and isotopic analysis but remain relatively unexplored in lamprey. We will use lamprey ammocoetes of known age and origin to evaluate the accuracy of statolith-derived age and natal origin assignment. Left and right statoliths will be extracted and imaged laterally to capture banding patterns, then counted by multiple readers. Within-reader and within-specimen precision will be examined using average percent error. Accuracy of ageing will be evaluated based on the proximity of average increment band counts to the known age. The same statoliths will then be analyzed using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) to quantify elemental signatures. Accuracy of assignment to known origins will be assessed using discriminant function analyses. Eye lenses will be extracted from the same specimens to explore their potential to record age and chemistry. A subset of the lenses will be dyed to increase contrast among laminae, then mounted in epoxy and sliced to discern layers. Lens laminae will be enumerated and compared to known ages to determine if a relationship exists. Remaining lenses will be delaminated to the smallest layers manually achievable then analyzed separately using solution-based ICP-MS to quantify elemental signatures. Lens and statolith chemistry will be compared to determine if they display similar trends and whether they can be used together to increase accuracy of natal origin assignment.

Comparing multispecies eDNA to traditional approaches to evaluate species-level aquatic biodiversity in a stream network

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Coauthors: Tiffany Garcia, Laura Hauck, Kevin Weitemier, Rich Cronn
Traditional oral presentation (20 minutes)

Aquatic biodiversity has long-been a proxy for assessing environmental change. Traditional approaches for measuring aquatic biodiversity, however, have not been very comprehensive or standardized, and they can be time-consuming, expensive, and limited to certain taxa and habitats. Alternatively, environmental DNA is revolutionizing how we can survey biodiversity in streams by offering a rapid, accurate, and standard assessment of multiple aquatic species from various taxa. Here, we compare detection of multiple aquatic species using eDNA metabarcoding of taxon-general and taxon-specific primers using microfluidic multiplexed PCR and high-throughput sequencing to traditional approaches of electrofishing to understand the utility of multiplexed eDNA counts as a qualitative and semi-quantitative proxy for species-level identification of aquatic biodiversity. We evaluate the detection of multiple aquatic species of fish, amphibians, invertebrates, and pathogens in four neighboring stream networks below and above where fish reside in the network in the Trask Watershed in northern Coastal

Oregon. In this study, we are able to assess whether streams that are hotspots in productivity of fish are also hotspots in their upstream tributaries for amphibians. Our study also allows us to examine questions about assay performance, such as reproducibility, minimum detection limits, and the ability to estimate global aquatic biodiversity at individual sites and the global network. Our work broadens the scope of eDNA research by allowing for data-driven prioritization of conservation actions for multiple aquatic species.

Transitioning the CVPIA fisheries program to a science-based prioritization and adaptive management process… progress?

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Traditional oral presentation (20 minutes)

Natural resource decision making is fraught with complexity and uncertainty associated with ecological systems that is further exacerbated when accompanied by multiple competing stakeholder objectives and beliefs. This situation is typified by the Central Valley Project Improvement Act anadromous fish restoration program, where managers are charged with the restoring fish populations and their habitats while considering the objectives of large (50+) and diverse set of stakeholders. Here we describe a structured, multi-phase approach that allowed decision-makers to identify program objectives and guide planning of broad-scale fisheries restoration activities. We emphasize the importance of using a rapid prototyping process and following up with the development and adherence to a transparent governance framework and decision making process. We also discuss the need for flexibility in the structured decision making process to adapt it to the needs of the stakeholders, the real meaning of "buy-in", and the importance of allowing stakeholders to make mistakes. We illustrate our points using coarse-resolution decision-support models for evaluating the relative effectiveness of candidate restoration and conservation activities. Finally, we discuss the resource-allocation decisions from the last three years that resulted from the process and the next steps for inculcating the process.

State dependent management of desert spring fish and their habitats

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Traditional oral presentation (20 minutes)

Desert spring habitats are some of the most unique and diverse ecosystems, often containing fish species that are pluvial relicts. Desert springs wetland complexes are also often the only water source in large arid regions, making them a critical resource for both humans and wildlife. Thus, these aquatic ecosystems are often degraded by human activities leading to habitat loss and imperilment of endemic

fauna. This is typified by the Least Chub (*Iotichthys phlegethontis*), a small endemic fish species native to Bonneville Basin in western Utah, which was once widespread but is now consists of five isolated populations. The decline of Least Chub has been attributable to multiple threats including habitat loss, water withdrawal, non-native species invasions, and livestock grazing. To aid the desert wetland managers, we identified management objectives, alternative actions, and developed a probabilistic decision model that simulates desert wetland dynamics including Least Chub reproduction and persistence in response to variation in water levels, vegetative structure, and ungulate grazing. The models were parameterized using a combination of empirical data collected for more than a decade and expert judgment. Management objectives included Least Chub population size, wetland condition, and fiscal constraints and the decision set consisted of eight alternative grazing strategies, population supplementation, and manual vegetation removal. We solved the decision model using stochastic dynamic programming and identified optimal state dependent policies. Forward simulation suggested that implementing the state-dependent policies resulted in much greater population persistence and wetland health compared to implementing single grazing strategy across time. However, sensitivity analysis indicated that model predictions were strongly influenced by seasonal precipitation and assumptions regarding the rate of vegetation regrowth and ungulate damage. We believe that implementing the optimal management strategy with monitoring in an adaptive framework would improve the understanding of vegetative and ungulate grazing dynamics and their influence on desert fish management and restoration.

DNA Barcoding as a Tool for Generic and Species Level Identification of Salmonid Redds

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Poster presentation

Generic and species identification at early life-history stages can provide timely information to managers developing plans for invasive species control and native species conservation and recovery efforts. We successfully extracted DNA from fish eggs (Clark Fork River, ID/MT, n=19) and from larval fish (Clackamas River, OR, n=20) collected from visually identified salmonid Redds. We amplified samples to target Cytochrome c oxidase subunit 1 (CO1) and the targeted region was visualized using Sanger-Sequencing. After visually confirming and aligning sequences, we performed a BLAST search against the GenBank DNA sequence repository of the National Institute of Health (NIH) and compared our sequences side-by-side against sequences of fishes known to inhabit the geographical range in question. The results provided compelling evidence for generic level identification of each individual. Egg samples were identified to the species level as Brown Trout. For the larval specimens, CO1 did not provide adequate resolution alone to confidently distinguish amongst a closely related clade of Arctic char species. However, since only one species (Bull Trout) of this clade is known to inhabit the geographic region in question, we were confident in species identifying these samples, also. This study highlights the advantages and limitations of this technique as a tool for conservation.

Pacific Lamprey Conservation Initiative: How Can You Get Involved?

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Traditional oral presentation (20 minutes)

Pacific Lamprey abundance and distribution has declined precipitously throughout much of their historical range. In 2007 the Pacific Lamprey Conservation Initiative (Initiative) was developed in collaboration with Native American Tribes, state, federal and local Agencies. The Initiative represents a strategy to improve the status of Pacific Lamprey by promoting the coordination and implementation of conservation efforts in Alaska, Washington, Oregon, Idaho and California. To facilitate the identification and implementation of conservation measures, Regional Implementation Plans (RIPs) are developed by Initiative partners and stakeholders in 16 distinct geographic regions, or Regional Management Units (RMUs). Regional Implementation Plans are revised annually and summarize the status, distribution and threats to lamprey as well as identify and prioritize specific on the ground projects, restoration, research or monitoring needs that address threats to lamprey and their habitats in these areas. The purpose of the RIP process is to encourage communication and collaboration among stakeholders and facilitate the funding of high priority lamprey conservation actions that are currently unfunded by other programs. The RIP process has led to the successful funding and implementation of various lamprey projects across RMUs, but there is still a lot of hard work to be done. This presentation will provide an overview of the RIP process, schedule of events, current lamprey specific funding opportunities, examples of projects recently funded through the RIP process and information about how stakeholders can get involved in their local lamprey RMU.

Wild and wild fish surrogate juvenile Chinook Salmon survival in the McKenzie River

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Traditional oral presentation (20 minutes)

Anadromous salmonid populations in the Pacific Northwest have declined over the past 150 years. Initially, declines resulted from overfishing but this trend intensified with the construction of large dams throughout the Pacific Northwest during the 20th century and the associated habitat fragmentation and loss. These factors led to the 1999 federal listing of wild spring Chinook Salmon (*Oncorhynchus tshawytscha*) as threatened within the Willamette Basin, OR. Currently, practices to restore wild populations in the upper Willamette Basin involve trapping wild adults at the base of high-head dams and hauling them upstream to historic spawning locations. Their resulting progeny must migrate downstream past the dams, highlighting the necessity of effective juvenile passage. Ideally, studies evaluating downstream juvenile passage structures would use wild fish, but this is often not feasible

because of the large number of fish required for reliable estimates and the at-risk status of wild populations. Hatchery salmonids are available in large numbers and could serve as a possible alternative to wild fish. However, there is growing evidence for differences between hatchery and wild origin salmonids. The Wild Fish Surrogate Project at Oregon State University rears juvenile spring Chinook Salmon as substitutes for wild-origin fish that are intended to behave similarly to wild ones and emulate wild juvenile migratory phenotypes in the Willamette Basin. We compared survival and movement of wild and wild fish surrogate juvenile Chinook Salmon using a combination of PIT-tag detections at interrogation stations and seining recaptures in the McKenzie River Basin. We estimated survival with Cormack-Jolly-Seber models and compared survival between the two groups through time. Overall, detections and movements of wild and surrogate juveniles were similar, although wild fish surrogates tended to move several days earlier than their wild counterparts. Apparent survival differed between the two groups, and varied with environmental conditions. The survival differences observed between groups may have been influenced by differences in their movement patterns. This suggests that environmental conditions and responses to the environment may drive differences between wild and wild fish surrogate juveniles.

Scale of monitoring vs. scale of restoration: how does fish distribution and abundance affect monitoring results?

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Traditional oral presentation (20 minutes)

Stream habitat restoration is often purposed with the intent of creating fish population responses at the whole-reach or even the whole watershed scale. Detection of positive population responses, however, can be challenging and may require a monitoring approach that uses observations of habitat/patch use within treated reaches in a watershed. In-stream habitat restoration in the Entiat River, WA, has increased juvenile Chinook salmon abundance in pools with engineered log jams (ELJs); however, high spatial, temporal, and inter-species variation complicates the ability to distinguish treatment effects. Here we show that the results of monitoring studies can depend on the scale of surveys and that detection of an effect may require extensive sampling of untreated habitat. Increased fish abundance in pools formed by ELJs was very localized and whole-reach scale surveys are unlikely to detect the increases, compared with habitat/patch scale surveys. In fact, once the total area surveyed reached 2-3 times the area of the ELJ pool, total density was indistinguishable from unrestored habitat. Despite a monitoring design that is conducted the patch scale, we are able to show, via combining several restored reaches and reference reaches and multiple study years, that restoration increases habitat capacity for Chinook salmon 2-3 fold. Thus, even large-scale restoration targeted at entire watersheds may require extensive sampling at a relatively small sale, integrated over space and time, to detect restoration success.

Development of a new tool for estimating survival of Chinook salmon fry in Lookout Point Reservoir, Oregon

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Traditional oral presentation (20 minutes)

Estimation of the movement and survival of juvenile salmonids has been greatly aided by the use of mark-recapture field studies and statistical models. These mark-recapture survival models depend critically on a number of assumptions, including that the survival of marked fish is representative of the unmarked population. When the population of interest includes small fish, such as salmon fry, most commonly used types of marks (e.g. radio or acoustic tags and PIT tags) cannot reasonably be assumed to have no impact on survival. Parentage-based tagging (PBT), a type of genetic marking, offers a potentially promising means to estimate survival and movement of otherwise difficult to mark fish such as salmon fry. With PBT, genetic samples from captured juveniles can be linked to a specific parentage if genetic samples of the parents are also taken. This technique affords the opportunity to identify each captured individual as belonging to a replicate group.
We adapted an N-mixture model to estimate survival of Chinook salmon fry rearing in the Lookout Point Reservoir on the Willamette River. N-mixture models are used to estimate abundance and survival of populations where data consists of repeated observer counts at multiple sites. Under this approach, repeat visits to a site (primary occasions) each give rise to counts at a site which are then replicated either in quick succession or by multiple observers (secondary occasions). One assumption of this model is that each site is closed to emigration between secondary occasions. Applying this approach to fish survival in an open reservoir is challenging from a sample design standpoint, since the requisite secondary occasion replicate samples must be taken over successive days, which likely violates the assumption of closure at a specific sample site. By redefining what we mean by a â€˜site’ as fish with a common parentage as determined by PBT marks, the closure assumption holds, and it is possible to fit an N-mixture model to repeated fry counts. We show monthly estimates of fry survival in 2017 and 2018 obtained by applying this approach to an ongoing multiyear study in Lookout Point Reservoir.

Stage 0 Meadow Restoration at Whychus Canyon Preserve, Central Oregon

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Traditional oral presentation (20 minutes)

Whychus Creek is the focus of multi-year collaborative restoration efforts intended to support fisheries restoration, improve stream habitat and restore natural stream processes. In 2016 project partners broke ground on the first mile of a six mile restoration project along Whychus Creek at Whychus Canyon Preserve owned by the Deschutes Land Trust.

A process-based design approach using the Geomorphic Gradeline methodology (Powers et al. 2018) was applied to reset the valley floor allowing it to transition to the pre-manipulation state (Stage 0) in the Cluer and Thorne Stream Evolution Model (2013). The design approach, referred to as Stage 0 restoration, focuses on addressing root causes of stream and ecological degradation and relies on floodplain connectivity and processes such as floodplain wide riparian cover, erosion, deposition, and avulsion to create, maintain and support resilient terrestrial and aquatic habitat that can support all life stages of fish and wildlife species over time. The desired condition is a complex network of anastomosing flow paths, wetlands, and diverse aquatic habitats. The Whychus Canyon Preserve project sought to explore the degree to which the most ecologically productive stream condition, Stage 0, can be achieved through accelerating stream evolution and recovery to provide the most ecological uplift possible given existing site constraints and opportunities.

Project monitoring, ongoing since 2014, includes evaluating physical and biological metrics such as groundwater, fish habitat, geomorphology, macroinvertebrates, fish usage and plant community presence/extent. Physical monitoring parameters show an increase in instream habitat quantity and complexity, a water table sufficiently shallow to support riparian plants and numerous channels that have replaced the pre-restoration single-thread, deeply incised channel. Preliminary macroinvertebrate data suggest macroinvertebrate abundance in side channels well above that in unrestored reaches and EPT taxa richness post restoration equivalent to un-restored reaches. The results of measurements of vegetation, zooplankton, phytoplankton and periphyton studies performed in August 2018 along with fish density and relative growth rate data will also be presented. Monitoring results provide vital insights needed to evaluate the benefits and risks of Stage 0 restoration, assess whether improvements in long-term productivity, diversity and resilience justify the short-term disturbance, and inform future phases of restoration in Whychus Creek.

References:

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Recolonization Potential for Coho Salmon in California Tributaries to the Klamath River Above Iron Gate Dam

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Traditional oral presentation (20 minutes)

Four major dams on the Klamath River are slated for removal in 2021, restoring access to hundreds of miles of potential habitat for anadromous fishes. The coho salmon (*Oncorhynchus kisutch*) in the Klamath River are classified under the Southern Oregon/Northern California Coast evolutionarily

significant unit as a threatened species. We are using physical habitat and biological features of three major tributaries to the Klamath River above the dams to assess available habitat and its fundamental capacity to support coho salmon post dam removal. The intrinsic potential (IP) modeling approach developed by the National Oceanic and Atmospheric Association (NOAA) and the habitat limiting factors model (HLFM) developed by Oregon Department of Fish and Wildlife (ODFW) will be utilized to assess habitat. In addition, we are developing an occupancy model using a Bayesian approach and data from reference sites below the dam and from other watersheds to estimate the potential distribution and abundance of juvenile coho salmon at the sites. Results from this analysis can be used to make management decisions for habitat restoration efforts and future coho salmon population goals.

Adult Spring Chinook Abundance and Distribution in the Wilson and Nestucca River Basins

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Poster presentation

Oregon coastal Fall Chinook salmon have been monitored through a set of 56 standard spawning ground surveys, many conducted since the 1950's. Additional research and monitoring has been conducted by the Coastal Chinook Research and Monitoring Project (CCRMP). There has not been a similar, consistent, coast-wide monitoring program for Oregon coastal Spring Chinook salmon. In 2005-2008 Oregon Adult Salmon Inventory and Sampling (OASIS) conducted spawning ground surveys across the known extent of spawning habitat along the North Coast. The project was then picked back up in 2017 to present. This poster will summarize peak spawning estimates from 2005-2008 and 2017-2018 in the Wilson and Nestucca River Basins. It will also cover age class, percent hatchery origin spawners (PHoS), and adult distribution throughout basins.

Distribution of lamprey in the Rogue: a rapid survey, what we learned, and what it tells us about restoration needs for lampreys

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Traditional oral presentation (20 minutes)

We surveyed the Rogue drainage (13,295 km2) for presence/absence of lampreys. This project was locally developed and inspired by the Grizzly Peak Lamprey Working Group, an informal group of local biologists and funded by local watershed councils. Goals were to: 1) establish a basin-wide distribution of lamprey in 3rd order and higher drainages, 2) provide site information for restoration and conservation projects of interest to local stakeholders, 3) identify issues constraining lampreys, and 4) promote awareness of lampreys.

Streams were selected by including all 3rd order and higher tributaries to the mainstem Rogue downstream of two dams (both impassable), as well as 3rd order streams of major tributaries (Illinois, Applegate, Bear, Big Butte and Little Butte). This included 73 streams, with 34 additional streams of specific interest to local stakeholders. Survey methods followed Reid and Goodman (2015).
A total of 106 streams (164 sites) were surveyed for ammocoetes. All were identified to Entosphenus, presumably Pacific Lamprey (E. tridentatus). Of 71 streams (124 sites) where ammocoetes were not encountered, 17 were dry at all sites and 35 had marginal habitat: i.e. relatively high gradient (> 2%), dominated by bedrock, rock, cobble or larger gravels, lacking fines (sands or oxic sediments), or stagnant conditions. Lamprey were not found in 19 streams where the absence was not as clearly explained - will be discussed.

Lamprey were broadly distributed. Primary constraints were availability of permanent flow and presence of suitable rearing habitat. Few streams with areas of fine sediments did not have ammocoetes. These results suggest that we should consider our management of stream substrates to better understand the natural role of fine sediments and to manage for a natural substrate range. Are stream restoration goals that seek to reduce fines and prioritize coarser substrates (i.e. gravels and cobbles) limiting the potential distribution and rearing success of lampreys?"

Mud, flood and fire: turning disasters into positive conservation progress

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Traditional oral presentation (20 minutes)

The Modoc Sucker was formally listed as endangered in 1985 and delisted in 2016. Direct conservation actions addressing threats to the species and improved information led to its recovery, but the fish has also proved to be resilient over the 30 years of its listing. An important component in the conservation of the species has been continual informal (read unfunded) monitoring of the populations and interaction with the local community, further developing the relationships between the fish and the landowners who steward its streams.

Over the last two years three events have impacted the Turner Creek drainage in northern California, a Modoc Sucker stronghold. At first notice, all three might be considered 'disasters' that would adversely impact the local fish population. However, on further consideration, none of the three appear to have caused lasting adverse effects, and all may well have produced unexpected benefits to the aquatic community.

The first event was an incursion by cattle into a riparian grazing exclosure, resulting in short-term water quality impacts, but also opening the discussion for innovative grazing management approaches. The second was the breaching of a reservoir containing non-native fishes, resulting in a pulse of bass into one tributary (now mostly gone), but also removing a long-term source of non-native fishes. The third

was a major fire that swept up the entire drainage, resulting in a substantial loss of timber, but also causing little damage to the restored riparian corridors and a shift in the landowner's perspective on the value of restoration.

Annual Costs of Wild Salmon Recovery Efforts in the Columbia River Basin

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Traditional oral presentation (20 minutes)

How much is spent annually on wild salmon recovery efforts in the Columbia River Basin? I estimate that between $500 million and $1 billion is spent annually on restoring Columbia River Basin wild salmon. The answer to this question is dependent on a suite of assumptions. Thus, there is no universally accepted cost for how much is spent on wild salmon recovery efforts each year in the Columbia River Basin. There are multiple federal, state, private, and tribal agencies throughout the Columbia River Basin that spend money on wild salmon recovery. In addition, there are multiple stakeholders that are indirectly involved with salmon recovery efforts and while these stakeholders may work together to restore wild salmon populations, their costs are not easily identifiable and often times not reported or distinguished from each other. Multiple states, several federal agencies, and Canada work with similar sources of federal funding that is often just reported as a single vague number combined with other fish and wildlife expenditures. Various industries including dam operation, transportation, agriculture, and tourism pay in some way for wild salmon recovery but again don't report or consider the same costs associated with wild salmon recovery efforts. Even more important is the difficulty of defining a "cost". Also, forgone economic opportunities -lost electricity, transportation, farming, and Tribal over-the-bank salmon sales must be estimated to capture an overall recovery cost. Even more inexact, are the lost intangibles that cannot easily be converted to economic measures such as tribal ceremonial value but are nevertheless an element of the overall cost.

Through extensive research and first hand interviews this project works toward capturing a truly unbiased total cost of wild salmon recovery efforts in the Columbia River Basin. The U.S. Army Corps of Engineers, the Bureau of Reclamation and the Bonneville Power Administration, currently fund more than $500 million in actions each year to benefit fish and wildlife. In 2017, BPA alone spent just over $461 million in fish and wildlife actions. I estimate that a minimum of $500 million per year is spent on salmon recovery and this number could jump to $1 billion a year depending on how costs are defined and quantified.

Stage 0 Restoration on an alluvial fan at the Whychus Floodplain Project, Central Oregon

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Traditional oral presentation (20 minutes)

Process-based restoration that focuses on restoring key physical, chemical and biological processes for the long-term benefit of fish, wildlife and water quality has become an underlying principal in restoration work at Whychus Creek, a tributary to the Deschutes River, OR. The Whychus Floodplain project focused on restoring valley-scale processes associated with a large, moderate slope (~ 2%) alluvial fan. A Stage 0 restoration design approach using the early version of the Geomorphic Gradeline methodology (Powers et al. 2018) was applied to reset the valley surface allowing it to transition to the pre-manipulation state (Stage 0) in the Cluer and Thorne Stream Evolution Model (Cluer and Thorne 2013). Like most depositional areas along Whychus Creek, the stream and floodplain within the alluvial fan had been manipulated by development, flood control efforts after the 1964 flood, road building, and irrigation withdrawals. The large alluvial fan that extended through the City of Sisters had been reduced to a single-thread, deeply incised, simplified transport channel.

Instream flow restoration efforts in the past 20 years provide between 20 and 30 cfs baseflow to this previously dry reach, paving the way for habitat restoration in support of the spring chinook salmon and steelhead trout reintroduction effort. Building upon lessons learned at the Camp Polk Meadow restoration project located downstream on Whychus Creek, the Deschutes NF in partnership with the Upper Deschutes Watershed Council and others, implemented a Stage 0 restoration design over 160 acres of the Whychus alluvial fan in 2014 and 2015. Restoration actions included removal of a fish passage barrier dam and berms, filling of incised simplified channels, construction of island wood jams, and reactivation of relic channels.

Preliminary monitoring of the Whychus Floodplain project show an increase in channel habitat complexity and fish density within 1 to 3 years post-restoration. Benefits of this restoration approach include an elevated year-round alluvial aquifer, rapid establishment of a diverse riparian plant community, floodplain connection, and flood refugia. Instream habitat and biological benefits include increasing pool density, side channel length, instream wood densities, and redband/steelhead trout (*Oncorhynchus mykiss*) densities per 100m of stream up to 20 times the pre-restoration value. Continued monitoring will help advance our understanding of both the short and long-term ecological implications of this restoration approach.

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Cluer B. and C. Thorne. 2013. A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications 30: 135-154. https://doi.org/10.1002/rra.2631
Powers PD, Helstab M, Niezgoda SL. 2018. A processâ€based approach to restoring depositional river valleys to Stage 0, an anastomosing channel network. River Research and Applications 2018; 11. https://doi.org/10.1002/rra.3378

Response of Redband/Steelhead Trout and Juvenile Chinook Salmon After Habitat Restoration on Whychus Creek, Sisters, Oregon
Michael Riehle

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Traditional oral presentation (20 minutes)

Since 2008, stream restoration projects have focused on restoring floodplain connectivity in three reaches of Whychus Creek, a tributary to the Deschutes River in Central Oregon. These three habitat projects intended to create complex habitat that would benefit the juvenile life stages of redband/steelhead trout (*O. mykiss*) and chinook salmon (*O. tshawytscha*). Steelhead trout and spring chinook salmon have been reintroduced upstream of Pelton Round Butte Dams on the Deschutes River since 2007, including fry releases, smolt releases and passage of returning adults above the dams. Fish densities within the three project reaches was estimated before and after habitat restoration by mark-recapture experiments. We used ODFW habitat survey protocols to relate habitat conditions to fish densities before and after habitat restoration. To represent long term monitoring baseline conditions, we examined a decade of fish population density estimates conducted by Portland General Electric on 4 reaches of Whychus Creek. We compared baseline site densities of O. mykiss (without habitat restoration) to fish densities before/after habitat projects.

For Whychus Floodplain Project, O. mykiss densities ranged from 1 to 5 fish/ 100 m2 during pre-project conditions and were 25 to 32 fish/ 100 m2 post-project. Trout densities in the Camp Polk Meadow Project increased from 5-8 fish/100 m2 to 21-34 fish/100m2 before and after the habitat restoration, respectively. For Whychus Canyon reach 4, O. mykiss densities were 11 fish/100m2 pre-project and 31-38 fish/100 m2 post-project.

When fish per 100m of stream length were calculated, all three project reaches had O. mykiss per 100m ranging from 11 to 57 fish/100 m during pre-project to 379 to 469 fish/100 m. This difference in the number of O. mykiss per 100m of stream was related to the increase of wetted channel area, primarily resulting from increasing the number of wetted flow paths created from the specific restoration techniques. The percentage of side channel habitat was correlated with the increase in O. mykiss densities. Large wood/km was also correlated with increased densities of O. mykiss in all project reaches. Pools and riffles with higher concentrations of large wood were also correlated with higher fish densities.

Juvenile Chinook salmon densities were too low to be measured prior to habitat restoration. After restoration, chinook densities ranged from 3 to 14 fish/100m2. For chinook, reaches with complex pools and deep pools were related to higher densities.
Results from fish population studies show this specific technique of stream habitat restoration can increase juvenile fish densities. In addition, results showed positive correlations between specific habitat features post-restoration and fish densities that should be incorporated into future habitat restoration projects.

Changes in adult Chinook salmon (*Oncorhynchus tshawytscha*) survival in the lower Columbia River amid increasing pinniped abundance

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Traditional oral presentation (20 minutes)

This study was prompted by concern that increasing sea lion abundance within the lower Columbia River (CR) was preventing the recovery of threatened and endangered interior CR spring-run Chinook salmon (*Oncorhynchus tshawytscha*). Beginning in 2010, and continuing through 2018 we have been using Passive Integrated Transponder tags and active telemetry technology to estimate survival and run timing of adult spring Chinook salmon through the lower CR to Bonneville Dam (Rkm 234). From 2010 - 2015 we estimated 51 751 - 224 705 adult Interior CR spring-run Chinook salmon died annually within the lower river from sources other than harvest. Mixed-effects logistic regression modelling identified pinniped predation as the most likely source for this non-harvest related mortality. The odds of survival for tagged adult salmon was estimated to decrease by 32% (95% CI: 6%-51% decrease) for every additional 467 sea lions entering the river. For every increase of 1.5 in the log of American shad (*Alosa sapidissima*; a potential prey item for sea lions), the odds of survival was estimated to increase by 32% (95% CI: 8%-61% increase). The third covariate in our model included the adipose clip status of the salmon which indicated whether or not it was eligible to be harvested. The odds of survival for clipped fish was 34% (95% CI: 13%-51%) lower than for unclipped fish. Radio-telemetry studies indicated that 48% and 25% of the fish mortality we observed during 2016 and 2017 respectively occurred within the 4 mile reach directly below Bonneville Dam. The other mortality "hot spot" appeared to be within the estuary (below Rkm 67) where 33% of the observed mortality occurred in 2016 and 50% of the observed mortality occurred during 2017. We observed relatively little mortality within the reaches in between. Finally, a strong temporal trend in survival indicated early returning salmon populations were at higher risk for predation than later returning populations.

Mechanisms for Success: White Sturgeon Recruitment in the Lower Columbia River

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Traditional oral presentation (20 minutes)

Examining recruitment success is a key component to understanding the life history of White Sturgeon (*Acipenser transmontanus*). Our objective is to examine the mechanisms that determine recruitment success of White Sturgeon in the lower Columbia River below Bonneville Dam. White Sturgeon are collected annually using small mesh gill nets in the lower Columbia River since 2005 and the Willamette River since 2010. We calculated two metrics, the proportion of positive efforts (Ep; proportion of all gill net sets that captured at least one age-0 White Sturgeon) and catch-per-unit-effort (CPUE; average

number of age-0 White Sturgeon caught per gill net set), to assess annual recruitment. Since 2010, recruitment indices have decreased on the mainstem Columbia while substantial increases have been observed in the Willamette River. Recent research has demonstrated a strong correlation between flow during spawning and recruitment success. Here we will use multiple regression analysis to examine multiple mechanisms including discharge at Bonneville Dam, broodstock abundance, predation and abundance of stellar sea lions, and changes in management strategies. These results could have implications on future management decisions.

Adaption or innovation: a how large-scale, long-term monitoring program meets management needs

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Traditional oral presentation (20 minutes)

A major goal of long-term monitoring programs of streams and riparian areas on public lands is to evaluate current condition of streams subject to land use practices and whether habitat conditions are being maintained or improving through time. However, the highly dynamic nature of riparian ecosystems, and streams that traverse them, as well as variation in climatic conditions and the management of land use actions across the interior Columbia River Basin frequently put new pressures on long-term monitoring programs to address current day concerns while continuing to meet original program goals. The PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring program has been conducting stream and riparian monitoring since 1998. We describe the evolution of the PIBO program, common products for land managers, and examples of how the program innovates new approaches to drawing inferences from long-term monitoring data, and adapts aspects of the monitoring design to address shortcomings. Data from the PIBO Program suggest that natural process can drive changes in stream channels in the absence of anthropogenic disturbance. Therefore, innovative analyses of data on sites subject to various management actions and to minimal levels of land-use provide needed data to interpret current habitat conditions as well as to describe natural rates of change expected owing to large-scale drivers such as climate variability and natural disturbances. Understanding how stream channels have naturally changed over the last two decades, managers can identify reaches that are failing to keep track with natural rates of change or fall below expected conditions. In contrast, aspects of the original PIBO monitoring design appear to be insufficient to describe relationships between habitat conditions and grazing management adequately to inform future grazing practices. Therefore, we describe adaptations of the original monitoring design to better understand the relationship between this widespread land-use and aquatic resources that support sensitive aquatic species.

How to Prioritize Irrigation Upgrades to Protect Instream Flows for Fish

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Traditional oral presentation (20 minutes)

Given the extensive need for protecting instream flows that support native fishï‚¾but limited available funding opportunitiesï‚¾it is imperative that only the most effective irrigation improvement projects intended to enhance instream flows are implemented. The Freshwater Trust has developed a suite of methods for prioritizing potential on-farm irrigation efficiency upgrades and ditch improvement projects aimed at increasing protected instream flows in a basin. Analyses begin with an evaluation of water right reliability and use one of three approaches: 1. Regulation records; 2. Water right regulation model; or 3. Remote sensing of past use. The second step estimates current rates of water loss or non-consumptive use. For on-farm applications, this involves comparisons of evapotranspiration demand and water application. For conveyance infrastructure, this involves estimates of loss via infiltration that are validated with field-based seepage studies. With estimates of water loss complete, return-flow travel times to receiving water bodies are estimated based on groundwater travel paths. Lastly, conserved water potential is quantified based on irrigation and conveyance upgrade options (e.g., flood to pressure, earthen ditch to pipe) and associated cost. Ultimately, each potential project in a basin is ranked based on the following metrics: 1. Quantity of reliable water potentially conserved; 2. An estimate of the fraction of conserved water protectable instream based on return-flow travel times; 3. Location of resulting instream flows relative to priority ecological reaches; and 4. Cost of project implementation. This methodology is an efficient approach for prioritizing irrigation infrastructure upgrades based on resulting protectable instream flows and cost. This restoration approach addresses both the need for strategic irrigation improvements that incorporate protection for a portion of the water savings AND the need to focus investments in the places that matter most for fish. The Freshwater Trust's development of this method based in the John Day basin is highlighting that reliable water can show up where it is needed.

Fish density and in-tank structure affect caudal fin quality of juvenile Chinook salmon

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Traditional oral presentation (20 minutes)

There are longstanding concerns regarding fin quality of salmonids in production hatcheries. As tank density increases, overall fin quality tends to decrease. Similarly, hatchery rearing environments are thought to lead to increased fin erosion. Poor fin quality can include increased fin asymmetry, rounded caudal fin shape, and general fin damage. This could potentially influence swim performance and subsequent survival once salmon are released from a hatchery. To investigate rearing conditions that influence fin quality, we reared North Santiam juvenile Chinook salmon at the Oregon Hatchery Research Center in 4 treatments: high density/bare tanks, high density/structure in tanks, low

density/bare, and low density/structure. High density treatments had 1,500 individuals per tank and low density treatments had 500 individuals per tank (1.8 m diameter). We sampled and photographed subyearlings and then traced and measured each caudal fin. We assessed caudal fin quality by examining total fin area, length asymmetry, and the dorsal lobe length to midline ratio as a measurement for lobe roundness. Individuals in high density/bare treatments had significantly smaller caudal fins compared to individuals in the low density/structure treatment. Individuals in the high density/bare treatments also exhibited significantly less symmetrical fins compared to individuals in the low density/structure treatment. Lastly, individuals from the high density/bare treatments exhibited rounder caudal lobes compared to those from the low density/structure treatment which had more pointed fins. Higher densities were the primary driver for smaller caudal fin area, although the absence of in-tank structure was also a significant contributing factor. Conversely, the absence of structure was the most significant contributing factor to fin asymmetry, resulting in greater asymmetrical caudal fins. Higher fish densities also contributed to asymmetry. Interestingly, density was the only significant factor driving differences in the dorsal length/midline ratio. This suggests that rounded fins typical of hatchery phenotypes are the result of fish density within tanks. Adding in-tank structure and reducing fish densities within tanks may result in fish with large, pointed, symmetrical caudal fins similar to fin shapes of natural-origin juveniles. The caudal fin metrics examined in this study could be used to assess overall fin quality. Further study is needed to evaluate the effect of fin quality on swim performance, as this could influence post-release survival of hatchery juveniles.

Downstream Rearing Chinook Salmon in the Upper John Day River

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Traditional oral presentation (20 minutes)

Juvenile Chinook salmon typically follow an early life history pattern known as natal reach rearing (NRR) in which they remain in the colder reaches in which they were spawned until their second spring in freshwater. However, in some rivers a variety of patterns have been observed in the timing of the movement of juveniles between natal reaches and the estuary. In the Upper John Day River, juvenile individuals have been detected moving downstream during their first spring after emerging from the gravel. Though spring conditions appear to be favorable for these early downstream migrants, warm water temperatures and low discharge in the summer create inhospitable conditions, and some young Chinook salmon find thermal refuge in tributaries. We estimated the abundance of downstream rearing (DSR) fish passing a screw trap in the Upper John Day River in 2016 and 2017, we identified tributaries in which DSR fish find summer refuge by detecting marked fish movement into tributaries with PIT antenna arrays and by conducting multiple pass snorkel surveys, and we measured and compared summer growth rates of DSR fish and NRR fish with a capture recapture study at sites occupied by the respective life history types. Our results indicate that the DSR fish have high abundances in the mainstem of the river during spring, though not as high as the out-migrating yearling fish, and that in the early summer a small proportion of these fish move into the lower reaches of small tributaries or up

to 45 km upstream in larger tributaries. The DSR fish are significantly larger than the NRR fish in the spring, but they nearly cease to grow over the summer while holding in tributaries. Whereas, the NRR fish experience much higher growth rates through the summer, nearly eliminating the size difference between the two life histories. DSR Chinook salmon have the potential to make significant contributions to the abundances of out-migrating smolts and returning adults, however their negligible summer growth reduces any size advantage they had in the spring, and summer conditions may impair their survival.

The Influence of Stream Restoration on Community Connectance within the Oregon Coastal Range

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Poster presentation

Food webs provide an insight into the ecological responses of a community before and after restoration, by combining the study of an ecosystem's biodiversity and community function. As conservation continues to move towards ecosystem-based management, understanding the community ecology within these ecosystems, such as coastal streams, is becoming more critical. The connectance in a community is related to how resilient an ecosystem is relative to a disturbance. We aim to determine how coastal stream restoration can affect the connectance within stream communities. Archived data will be used to compare the macroinvertebrate taxa present within a natural coastal alcove and an artificial alcove, in order to construct two food webs. These food webs will be created using the R package, Cheddar, in addition to its WebBuilder function. These systems within the R program compile taxonomic lists and trophic interactions that automatically construct a food web that can be used to determine the resilience of the ecosystem. The overall ecosystem connectance for the restored and natural ecosystems can then be compared to determine how successful artificial alcoves are in supporting a stable resilient community network.

Assessing the distribution of lamprey species along the southern Oregon Coast using eDNA sampling methods

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Traditional oral presentation (20 minutes)

Despite the concern over the ecological status of lamprey species in Oregon, data regarding the geographic distribution and population structure of lamprey species remains elusive. This is due to both

a lack of historical monitoring effort and difficulties in field sampling. Traditional sampling methods include trapping, surveying spawning beds for redds, and electrofishing. However, several issues make sampling difficult for lamprey: 1) since lamprey are nocturnal they are difficult to observe, 2) species identification is very difficult for early life stages (ammocoetes), 3) species identification is not possible for redds, 4) electrofishing is disruptive and has variable catch efficiency. Environmental DNA (eDNA) is a new method to sample aquatic species that has two advantages over traditional methods. First, sampling requires only a water or sediment sample, therefore sampling does not disturb lamprey or their habitats. Second, species identifications are possible for all lamprey life stages. Therefore, eDNA is a potential method to map lamprey species distributions. In 2018, we started a project to test eDNA methods for the monitoring of lamprey species in two streams in the South Slough watershed using both eDNA and electrofishing. For eDNA sampling we took water and sediment samples and analyzed the samples using metabarcoding and qPCR eDNA techniques. Using electrofishing we identified both Pacific lamprey and western brook lamprey at the sites. Using eDNA metabarcoding we detected two different lamprey species in water samples. We are currently refining the metabarcoding method and processing qPCR and sediment samples. In this talk we will discuss methods and compare results from electrofishing with eDNA sampling.

Assessing the Fish Biodiversity of Gabon's Komo River

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Traditional oral presentation (20 minutes)

In 2017, our international team extensively surveyed the fish biodiversity of Gabon's Komo River and adjacent Mbei River above and below the site of a proposed hydroelectric dam at Ngoulmendjim. We sampled main channel and small tributary habitats with gillnets, seines, castnets and a backpack electroshocker, amassing a collection of 3500 samples comprising about 90 nominal species. We then used those specimens to assess whether the Komo and Mbei rivers provide critical fish habitat according to the International Finance Corporation Performance Standards (version 6), which place highest priority on endangered, range-restricted and/or migratory species, and high priority on potentially undescribed species. Our analysis reveals that the Komo and Mbei harbor two endangered species, five apparently undescribed species, and about a dozen regional endemics. Most of these priority species are diminutive cyprinodontiforms, characiforms, cypriniforms or siluriforms inhabiting small tributaries. Numerous potadromous species achieve high biomass in the rivers' main stems, with large bodied cypriniforms in Labeobarbus and Labeo particularly numerous. One of these migratory species may be new to science. We also noted substantial marine influence in the ichthyofauna of the Komo River below the site of the proposed dam, including juveniles of commercially important species like the Giant African Threadfin (*Polydactylus quadrifilis*). Overall, these priority species trigger three different criteria qualifying the Komo and Mbei for a high conservation value designation. Plans for the development of this region must balance biodiversity conservation of critical fish habitat with the need

to provide reliable electricity to the 700,000 people living in Gabon's capital of Libreville, which lies at the Komo's estuary.

Prey availability, environmental constraints, and aggregation dictate population distribution of an imperiled fish

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Traditional oral presentation (20 minutes)

Accelerated global loss of fish species underscores an urgent need to elucidate constraints on spatial and temporal population patterns and to mitigate human-mediated impacts accordingly. We analyzed 20 years of trawl data using a spatiotemporally explicit, hierarchically Bayesian model to define density distributions of an imperiled anadromous fish, the delta smelt, *Hypomesus transpacificus* in the heavily altered and highly used San Francisco Estuary. To reduce management reliance on an estuary-wide population index that minimizes data resolution and ignores uncertainty, our model took a spatiotemporal approach and explicitly accounted for sampling and observation variation through both stochastic and deterministic elements. Our model demonstrated that juvenile smelt density has decreased over annual time, and within years has been characterized by recruitment and immigration during March -June followed by mortality and emigration during June - August. Smelt density was highly spatiotemporally autocorrelated and strongly tracked prey availability, yet was also constrained by local hydrological factors (salinity, turbidity, velocity). Specifically, juvenile smelt preferred slightly saline, turbid, generally slow-moving water with ample copepod prey. However, poor swimming capabilities reduced juvenile smelt capacity to mix throughout the estuary and find optimal habitat, emphasizing the importance of accounting for spatiotemporal autocorrelation in species distribution models. Further, whole-estuary outflow appears to influence the spatial distribution of covariates and juvenile smelt, such that smelt densities tended to peak closer to the marine zone at a lower maximal value when outflow was high. The predictions of our model accurately matched observed patterns of juvenile delta smelt densities while embracing uncertainty, highlighting that data-driven improvements can be made to the analytical methods currently used to guide delta smelt management, and laying the groundwork for mitigating the impacts of water use, flow regimes, habitat alteration, and climate change on an endangered species in a highly impacted and economically consequential habitat.

Effects of Bonneville Dam on Hood River Winter Steelhead Migratory Behavior and Apparent Survival

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Poster presentation

Hood River winter steelhead (Lower Columbia DPS) were first listed as threatened under the Endangered Species Act in 1997 (62 FR43937; August 18, 1997). The Hood River Production Program (Bonneville Power Administration funded) was implemented in 1993 as a mechanism to increase steelhead production to a level commensurate with carrying capacity. Under the Production Program umbrella, steelhead recovery efforts have included substantial capital investments primarily focused on habitat restoration and hatchery supplementation.

Several within-basin limiting factors have been identified that limit population recovery including degradation of habitat, water withdrawals associated with irrigation, and reduced fitness of hatchery fish spawning in the wild. Recent data analysis indicates another potential bottleneck constraining the number of available winter steelhead spawners may be occurring between Bonneville Dam and the mouth of the Hood River (river mile 146 - 169). Using PIT-tag capture-recapture data, apparent survival of returning adult winter steelhead (wild and hatchery) was estimated using a Cormack Jolly-Seber model. Date of arrival and the number of days elapsed between Bonneville ladder entry and exit were included as individual covariates. Although the distance between Bonneville Dam and the Hood River is relatively short, average apparent survival through the reach was only 71.6% for wild winter steelhead and 76.5% for hatchery winter steelhead (spawn years 2012 - 2018) although a slight survival advantage was evident for early-arriving migrants. Interrogation and model data will be presented that characterize migratory patterns associated with winter steelhead and identify potential factors negatively affecting apparent survival. A better understanding of winter steelhead migratory behavior within the Bonneville Dam complex and neighboring upstream pool may contribute towards population recovery and ultimately provide a higher Production Program return-on-investment for BPA.

Evolution of Management, Fish & Fleet in Oregon's Nearshore Groundfish Trawl Fishery

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Poster presentation

Combining fisheries data from experiential sources (local ecological knowledge [LEK]; trawl logbooks, fish tickets, interviews with intergenerational fishermen) and scientific sources (SEK; agency and academic trawls) has potential to augment understanding of vitality and use of Oregon's nearshore (non-whiting) groundfish trawl fishery. This approach uses statistical analysis and modeling of nearshore trawl SEK from five periods from 1976-present day, and incorporates LEK to bolster data-poor areas. Regional execution of these mixed-methods serves to inform management through the historical reconstruction and perception of the fishery. Accurate assessment requires examining how compounded ocean climate condition variability, management regime shifts, gear and vessel adaptation and extraction influence long term target species adaptability and fishery resilience. This research strives to establish a framework for combined knowledge approaches that offers insight to sampling strategies, and historical knowledge of access to groundfish assemblages while providing baselines for future management. Early interviews and quantitative analysis show reduction in trawl

effort in the nearshore with increasing spatial management and gear restriction through time. LEK results indicate renewed interest in fishing access to these areas pending greater spatial accessibility with removal and restructuring of rockfish conservation areas (RCAs). Overall preliminary findings suggest mixed-methods may provide a thorough assessment of long-term interest in Oregon's nearshore groundfish fishery from the past and potential for the future.

Big Fish, Small Fish, Less Fish, More Fish; Tradeoffs Between Size and Abundance In Rearing Deschutes Spring Chinook Salmon

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Traditional oral presentation (20 minutes)

From previous work we determined that the Deschutes stock of spring Chinook salmon reared at Round Butte/Pelton Ladder were relatively large throughout the rearing process, had relatively high rates of precocial male maturation (minijacks), and skewed adult returns towards fish returning as 3-year olds (jacks). Along with hatchery managers, we designed an experiment to assess if rearing fish at half the size but at twice the abundance would affect smolt quality, increase SARs, and diversify age structure of returning adults. Using Deschutes stock of fish, two treatment groups were produced, bigs at approximately 8 fish per pound (fpp) and 80 thousand fish per raceway (low abundance) and smalls at approximately 15 fpp and 150 thousand fish per raceway (high abundance). In addition, we monitored a third group, a Hood River stock of fish, that was reared at 15 fpp (small) and 75 thousand fish per raceway (low abundance). Juvenile fish were sampled four times from Oct to April and monitored for size, growth rate, whole body lipid, Na+/K+ ATPase, and early male maturation. Preliminary data from two brood years, 2015 and 2016, suggests that rearing fish at a smaller size and increased abundance does not appear to adversely affect smolt quality. We are currently sampling fish from brood year 2017 and await adult returns to assess SARs and age class.

Regular feeding of liposomes has minimal impact on rotifer reproduction

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Poster presentation

Rotifers (*Brachionus sp.*) are often used as live feed for marine fishes in aquaculture. These microscopic animals are easy to produce in large quantities but do not provide larval fish with sufficient nutrients for proper development. Therefore, rotifers tend to be nutritionally enriched before being fed to larvae. The current method of enrichment is a two-step process in which the rotifers are cultured on an algae-

based diet, then a portion of the culture is removed to be nutritionally enriched several hours before they are fed to larval. Water soluble nutrient can be delivered to rotifers via liposomes. Growing rotifer cultures on algae and enriching them with liposomes simultaneously would remove this additional step and could greatly increase efficiency in marine fish larvae production. Rotifer cultures, in five different treatment groups were grown for two weeks. The cultures were fed a diet consisting of a proportion of algae and taurine enriched liposomes between 0% and 100% liposome concentration. Rotifer density was monitored throughout. In a second feeding trial, fluorescent liposomes were used, and gut content of individual rotifers was analyzed. Results indicated that rotifer cultures fed 75% algae and 25% liposomes experienced about an 11% decrease in density when compared to cultures given 100% algae. Fluorescent analysis suggested that as liposome concentration increases gut contents increase in liposomes and decrease in algae. Additionally, rotifers fed a diet in excess of 500% the recommend ration had higher florescence than those feed an amount adjusted for the culture density.

Dissolved oxygen dynamics in less-than-ideal environments

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Traditional oral presentation (20 minutes)

Dissolved oxygen (DO) has a fundamental effect on both the health and the biogeochemical function of aquatic ecosystems. In estuaries in particular, changes in DO relevant to biotic systems often occur over a wide range of temporal and spacial scales, forced by tidal inundation and rainfall, organic matter degradation, benthic and water-column photosynthesis, and air-water exchange. A mechanistic understanding of DO dynamics and the interplay among these drivers often requires time series data collected in very targeted (and sometimes not easily accessible) places. The advent of relatively inexpensive, programmable optical DO loggers allows generation of high-resolution time series over weeks to months without the expense and disturbance associated with multiple trips to the field. However, challenges remain in affixing sensors where they are a) in scientifically relevant locations, b) safe from both environmental and vandalism damage, and c) reasonably practical to deploy and recover.

In this work, we adapted a commercial DO logger (the Onset U26) to measure both sediment porewater and pore-gas oxygen dynamics as a function of tidal inundation, rainfall, and distance-to-channel in a mesohaline marsh in central Oregon. The intent of the work was to quantify the effect of water table changes on oxygen supply (both dissolved in pore water and in the gas phase) to the marsh soil in order to map the likely spatial extent of denitrification. The loggers were buried in the high marsh at various depths below grade by removing an intact block of soil, coring horizontally into the soil wall, installing the loggers, and then replacing the sediment block. The sensor end of each logger was placed distal to the sediment block which minimized any disturbance effect. Loggers were deployed for 6 months, allowing assessment of a wide range of tidal and precipitation effects. As expected, sites deeper in the sediment and further away from the channel were below the water table for a larger

fraction of time, spent more time anoxic or sub-oxic, were less affected by tidal and precipitation forcing, and were slower to respond to that forcing. Implications for application of this method to other difficult environments will be discussed.

Males are from Umatilla, Females are from Arlington: Behavior and Movement of mature White sturgeon in the John Day Reservoir

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Traditional oral presentation (20 minutes)

Spawning behavior and seasonal movement of sexually-mature White sturgeon (*Acipenser transmontanus*) within the John Day Reservoir represent a key knowledge gap in assessing recent trends in poor recruitment. In 2018, ODFW initiated a multi-year study to tag and track mature White sturgeon. We captured 15 male and 11 female White sturgeon on the spawning grounds in the McNary Dam tailrace and implanted them with 69 kHz acoustic tags. We deployed acoustic telemetry receivers in a dense array between the US-395/I-84 Bridge and McNary Dam (i.e. "the tailrace") to capture fine scale movement, habitat usage and possible direct interaction of tagged fish on their suspected spawning ground. In addition, acoustic "gates" made up of paired or tripled receivers were deployed at Irrigon, Boardman, Crow Butte, Arlington and the John Day River to assess large-scale seasonal movements. We used graph theory/social network analysis as a novel approach to assess mature White Sturgeon habitat usage particularly at the fine-scale in the McNary tailrace. More conventional methods were also used for comparison. Graph theory/social network analysis revealed interesting fine-scale movement and behavioral patterns within the McNary tailrace. Also, we found noticeable differences in seasonal movement patterns between the sexes. These differences in behavior and movement patterns while biologically interesting also have potential implications for White sturgeon management within John Day Reservoir.

The capacity for flow management to influence water temperature and reduce salmonid heat stress in the Willamette River

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Traditional oral presentation (20 minutes)

Elevated temperatures in northwestern Oregon's Willamette River and its major tributaries represent a key challenge to the health and survival of salmonids during summer. Temperatures in the Willamette River routinely exceed regulatory thresholds designed to protect the spawning, rearing, and migration of native cold-water adapted species, including federally protected Upper Willamette River spring

Chinook salmon and winter steelhead. As part of a study to assess the effects of dam operations on the thermal conditions in the Willamette River, the U.S. Geological Survey developed a suite of modeling tools to better understand the relations between air temperature, streamflow, and stream temperature throughout the Willamette River system. Using a combination of 1) mechanistic, two-dimensional models of the Willamette River and its major tributaries downstream of USACE-operated dams and 2) empirically-based regression models at specific locations in the Willamette River to predict stream temperature, this study evaluates the key physical processes controlling thermal conditions in the river and the capacity of specific flow-management actions to influence river temperature.

Preliminary results suggest that the influence of flow-management on temperatures in the Willamette River varies both spatially and temporally. In tributary reaches downstream of, but still near dams, the temperature of dam releases is the key control on stream temperature. However, regression models for Willamette River locations as far upstream as Harrisburg (River Mile 162) can predict weekly average stream temperatures with <1℃ error based only on streamflow and air temperature, indicating that the temperature of dam releases exerts minimal influence on stream temperatures with increasing distance (travel time) downstream. Model results supports this hypothesis, indicating that dam-release temperatures are 'forgotten' in this river system after about 2-3 days travel time. In contrast, results suggest that, by decreasing the travel time and increasing the capacity of streams to absorb heat inputs, flow augmentation can cause a modest reduction in stream temperatures, regardless of distance from dam outputs, but with the greatest effect closer to the dams. The results and models from this study can be used to address how flow management might reduce both chronic and acute heat stress to salmonid species in the Willamette Basin, including (1) the volume of flow augmentation necessary to influence temperatures at downstream locations, (2) the capacity for high-flow "pulses" to prevent lethal temperatures in the Willamette River during forecasted heat waves, and (3) the capacity for flow management actions to reduce the upstream extent of problematically high temperatures in the Willamette River.

Sediment and temperature effects on spring cyanobacterial bloom formation in reservoirs

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Poster presentation

Recently, cyanobacterial blooms have been of increasing concern in Willamette Basin reservoirs. Yet, the relative importance of environmental drivers of bloom formation are unclear. Cyanobacteria are likely to be influenced by sediment dynamics and temperature, variables that can be manipulated in a reservoir environment. As such, water management may provide an avenue for bloom management. We aim to improve our understanding of how the duration and timing of sediment exposure and water temperatures influence the potential harmful algal blooms (HABs) formation, through designing mesocosm experiments motivated by three hypotheses. 1) Bloom legacy is important to subsequent bloom formation. Resting stages of cyanobacteria from previous years may be stored in the sediment and serve as a source for following years. 2) Increasing duration of sediment exposure to air facilitates a

HAB dominated community that may be better adapted to unfavorable conditions than less tolerant algae taxa. 3) Warmer water conditions facilitate a HAB dominated community. This is due to time required for resting stages to hatch and become dominant in the algal community decreases, reproductive rates increase and green phytoplankton (Chlorophyta) are more cold water adapted. To address these questions, we are developing mesocosm experiments using sediments collected from Blue River and Detroit reservoir littoral areas. Our proposed design groups reservoir sediments by reservoir into long duration exposure (first exposed during summer), and short duration exposure (first exposed during late fall) blocked into warm and cool treatments. It is our hope that through these experiments we can achieve a better understanding of these algal dynamics; a first step to developing reservoir management practices that favor a non-toxic algal community.

Influence of a riparian canopy gap on vertebrate biomass in a forested headwater stream

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Traditional oral presentation (20 minutes)

The mid-succession riparian forests that currently dominate much of the western Oregon landscape tend to have uniform closed-canopies. The streams that run through these forests are heavily shaded and therefore, have low light availability to the stream benthos. Given the importance of light on basal food resources, we hypothesized that patches of light created in a riparian canopy gap experiment would create productivity hotspots that could enhance the biomass of trout and salamanders at the reach scale. We applied a Before-After Control-Impact (BACI) study design to determine gap influences on trout and salamanders in five headwater streams. We quantified abundance and biomass of cutthroat trout and pacific giant salamanders in reference and treatment sites in summer 2016 or 2017 efore gap treatments were applied. We then cut riparian canopy gaps that were designed to resemble in size those found in historical old-growth along comparable streams (between 20 and 60 linear meters of stream). Gaps were cut in fall 2017/winter 2018. In summer 2018, we re-surveyed sites to quantify responses. Preliminary data analysis indicates a moderate changes in fish and total vertebrate biomass per area.

Public support for marine reserves among Oregon coastal residents Public support for marine reserves among Oregon coastal residents

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Traditional oral presentation (20 minutes)

When the state legislature initiated a process for establishing marine reserves in territorial seas in 2008, the Oregon Department of Fish and Wildlife (ODFW) was charged with managing the system. One of the legislative mandates was to ascertain if the Oregon Marine Reserve System avoids significant adverse impacts to ocean users and coastal communities. To address this mandate, the agency conducts studies to determine the socioeconomic impacts of marine reserve implementation. In this context, a recent survey was conducted to ascertain the level of knowledge about and perceptions of marine reserves among Oregon coastal residents. A random sample of coastal residents was contacted to participate in the mixed mode (mail and internet) study, and 1172 respondents completed the survey. The instrument included questions concerning marine reserve awareness, perceived impacts, and support. Additional variables included measures of environmental values, subjective well-being, community and individual resilience, place attachment, and willingness-to-pay (a choice experiment), as well as employment and other demographic metrics. The focus of this presentation will be on marine reserve support and opposition, and the values and characteristics of individuals holding these views. In addition, the results of this research will be compared to the results of earlier related surveys among Oregon residents and marine reserve stakeholders. This qualitative comparison will emphasize whatever changes may have occurred in perceptions and support for marine reserves since inception.

Thermal effects on pre-recruit Pacific Cod phenology, early growth, and prey quality in the Gulf of Alaska

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Poster presentation

The Gulf of Alaska (GOA) ecosystem is influenced by thermal variation including climatic phenomena (e.g. El Niño Southern Oscillation) and anomalous warming events such as the marine heatwave (warm "Blob") of 2013-2016. Warming events are characterized by elevated ocean temperatures (up to 3°C) and are expected to influence the reproductive phenology and early growth of pre-recruit Pacific Cod (*Gadus macrocephalus*). Warm ocean years have potential to influence the timing and spatial distribution of spawning, accelerate growth across early life stages, and alter patterns of selective mortality for Pacific Cod. In addition, thermal variability can influence phytoplankton and zooplankton community composition and may contribute to shifts in the juvenile Cod energy budget. To address these questions, we will examine juvenile Cod across a 14-year timeseries (2006 - 2019) in the GOA. We will use otolith structural analysis to assess hatch date distributions, size-at-hatch and larval growth rates and determine summer growth rates in central GOA nurseries during different temperature regimes. We will also describe shifts in juvenile Cod prey quality and composition using a combination of stomach content analysis and fatty acid analysis. Understanding the impact of thermal variability on Pacific Cod early life stages may help inform management for a valuable commercial fishery and increase accuracy of response efforts in future warming events.

The Genetics of Adult Migration Type in Chinook and Applications for Conservation Tasha Thompson
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Traditional oral presentation (20 minutes)

Recent research revealed that variation at a single genetic locus (the GREB1L region) is strongly associated with adult migration type (spring-run and fall-run) in coastal Chinook populations. Here we review the current literature on adult migration genetics and discuss applications for conservation and restoration. First, we review the discovery of the GREB1L association and development of diagnostic markers. Next, we examine two case studies from the Rogue and Klamath Rivers where these markers were used to address conservation questions, then discuss experimental design considerations for other researchers interested in applying migration type markers. Finally, we discuss what is known about adult migration genetics in non-Coastal populations (e.g., interior Columbia).

Challenges to estimating salmonid loss to predation: how far into the weeds do you want to go?
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Coauthor: Ken Tiffan, John Erhardt
Traditional oral presentation (20 minutes)

Estimating the loss of juvenile salmonids to piscine predation is a complicated task that relies on many steps and assumptions. Uncertainty associated with each step in the estimation process is compounded, thus sampling and analytical approaches must be carefully considered. Estimating predator abundance in large, open systems is particularly challenging; and sampling efficiency, predator size distributions, and sampling frequency will affect the quality of abundance estimates. The two common approaches to estimating consumption rates, empirical gastric evacuation rate models and bioenergetics models, each contain advantages and disadvantages that should be carefully considered. Because of the difficulties in validating these models, it is important to assess error and uncertainty, evaluate assumptions, and compare models in order to improve confidence and define a plausible range of consumption estimates. Study designs must also account for the spatial and temporal dynamics in which predation occurs. We show that smallmouth bass predation on subyearling fall Chinook salmon in the Snake River following a hatchery release is intense, but short-lived. Therefore, increases in consumption rates in response to prey pulses must also be accounted for if sampling during the estimation period misses such an event. A common question that arises about juvenile salmon predation is, "What are the proportions of hatchery and wild fish consumed?" We show that stable isotope or parentage-based tagging analyses hold promise for addressing this difficult question. Ultimately, estimating predation loss will depend on study's objectives and how much effort is available to reduce uncertainty in estimates.

CRISPR/Cas9 Mutations in the esr1 Gene of Zebrafish (Danio rerio) Revealed by Next-Generation Sequencing

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Poster presentation

CRISPR/Cas9 is an important genome editing tool that can target genes in organisms, including fish, to understand basic physiological function, diseases and many other important aspects of biology. An important step when using CRISPR/Cas9 is to genotype mutated individuals to select founders for establishing mutated lines. The purpose of this study was to analyze Next-Generation Sequencing (NGS) data and identify mutation types in the esr1 gene in zebrafish. Two regions were targeted in esr1, an antisense target (T1) in exon 1 and a sense target (T2) in exon 3. Potential CRISPR founders (Go) were outcrossed with wild type individuals in pair-wise mating, DNA extracted from pooled embryos, amplified and barcoded with primers containing Illumina adaptor sequence, using a two-step polymerase chain reaction (PCR) procedure. Translated protein sequences were used to quantify mutated alleles, mutation types and select candidates likely to result in complete knockdown of esr1. Sequencing revealed a 93.3% mutation efficiency for T1 or T2 sites and 88.9% efficiency for both target sites across the 45 fish that were sequenced. Individual fish had anywhere from one to nine mutated alleles and 225 distinct alleles were detected. Of the 225 mutated alleles, 71.1% had deletions, 26.7% insertions, and 2.2% base-pair substitutions. Frameshift mutations occurred at 75.1% and in-frame mutations at 24.9%. Of the fish screened, 0.0% had alleles containing incomplete stop codons across T1, but 82.2% had premature stop codons across T2. Frameshift mutations and the presence of premature stop codons are most likely to disable protein function. As researchers explore genome modification in non-model fish species with long generation times, the screening and selection process becomes crucial. NGS is an important tool in the selection process of CRISPR founders, when establishing gene knockdown lines to explore biological function. The results in this study show that we can identify candidates most likely to produce loss of function in genes of interest by using NGS.

Piscivorous Colonial Waterbird Monitoring With Unmanned Aircraft Systems

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Traditional oral presentation (20 minutes)

The recent and rapid advancement of cost-effective and reliable small unmanned aircraft platforms and sensors, along with the 2016 modernization of the governance of unmanned aircraft systems (UAS) in the national airspace, has led to a boon in UAS use for a wide range of applications. Following a 2016 pilot study, we replaced our manned aerial photography surveys with unmanned surveys in 2017 and

2018, surveying 14 bird species at 18 sites across the Columbia River Basin and San Francisco Bay, totaling nearly 100 missions. The primary target species surveyed were double-crested cormorants (*Phalacrocorax auritus*), Brandt's cormorants (*Phalacrocorax penicillatus*), Caspian terns (*Hydroprogne caspia*), California gulls (*Larus californicus*), ring-billed gulls (*Larus delawarensis*), and American white pelicans (*Pelecanus erythrorhynchos*). The benefits gained from using UAS platforms are numerous, including cost effectiveness, mission and method flexibility, image quality, and workflow expedience. The greater image resolution achieved with UAS's compared to manned survey flights has improved our ability to leverage machine learning tools for automated feature extraction to quickly and accurately derive bird counts while reducing manual image interpretation time. As UAS technology and machine learning methods continue to evolve, our ability to quickly and accurately survey, inventory, and analyze avian colonies will continue to progress. Additionally, as guidelines for the use of UAS in the national airspace expand to accommodate currently restricted flight characteristics like "beyond visual line of site" flight, we will be able to extend the autonomy of these types of surveys, and realize greater gains in human safety, further cost savings, and expedited workflows from survey to analytical products.

Why do we manage predators?

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Traditional oral presentation (20 minutes)

Resource management has a long history of manipulating complex ecological communities and their habitats in route to socioeconomic-political cultural progress. This presentation will revisit the evolution of predation management and the motives that influence change. The talk will include some guiding theory and principles that have been used to address sustainability of multiple purposes while balancing our dependence on natural phenomena. Although by no means an end-all proclamation, this discussion seeks to explore realistic empirically-based goals essential for moving management closer to overcoming threats to preserving nature's function.

Adult Lamprey Passage Improvements at 3 Lower Columbia River Dams

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Traditional oral presentation (20 minutes)

Pacific Lamprey are native to the Columbia River Basin and are an important resource especially to local tribes. Pacific Lamprey abundance has been in decline from at least the 1960s reaching historic lows in 2009 and 2010. Scientist attributed the decline to several causes including pollution, habitat loss, irrigation, intentional removal, ocean conditions, and dam passage. This decline and apparent declines

outside the basin, led to significant concern regarding lamprey populations. As a result the U. S. Army Corps of Engineers began evaluating adult lamprey passage at Bonneville Dam. Telemetry and laboratory studies led to identification of lamprey-friendly design features such as rounded corners and attachment surfaces and development of novel Lamprey Passage Structures (LPSs or "lamprey ramps") as a means of bypassing problematic sections of adult fishways. Research, monitoring and evaluations were later expanded to upstream lower Columbia and Snake River dams.

Radio-telemetry suggested that fishway entrances and the collection channels, transition pools, junction pools (the lower sections of fishways) were problematic at Bonneville Dam (from 2007-2010 average dam passage efficiency was 52%) and other dams. At Bonneville Dam, the serpentine weirs of the control sections (near the top of the ladder) of the Washington Shore and Bradford Island Ladders were also problematic. Overflow weir sections of the fishways appear to be relatively successful at passing adult Pacific Lamprey at all dams. Passage efficiency at The Dalles North Fish Ladder (> 80%) was higher than passage efficiency through any other fishway evaluated.

Over the last ten years several LPSs and other modifications have been made at Bonneville, The Dalles, and John Day Dams in the lower Columbia River in an attempt to improve overall dam passage efficiency. In addition to LPSs, modifications made in fishways include plating over grating near weir orifices, rest boxes on fishway floors, lamprey specific orifices through serpentine weirs in the upper fishways, and operational changes. The overall goal of these modifications is to improve dam passage efficiency and help get these fish to historical spawning habitats in the Columbia and Snake River Basins.

Building a foundation for measuring progress - Oregon Watershed Enhancement Board's Focused Investment Partnerships

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Traditional oral presentation (20 minutes)

In April 2015, the Oregon Watershed Enhancement Board (OWEB) established seven Focused Investment Priorities that represent ecological significance to the State of Oregon: aquatic habitat for native fish, closed lakes basin wetlands, coastal estuaries, coho habitat and populations along the coast, dry-type forest habitat, oak woodland and prairie, and sagebrush/sage-steppe. In January 2016, the OWEB Board awarded funding to six Focused Investment Partnerships (FIPs) to support implementation of large-scale habitat restoration and to support resilient, sustainable partnerships capable of implementing effective restoration programs. A FIP is a partnership that addresses one or more of the OWEB Focused Investment Priorities; achieves clear and measurable ecological outcomes; uses integrated, results-oriented approaches as identified through a strategic action plan; is implemented by a high-performing partnership; and is eligible for up to six years of funding from OWEB.

The considerably higher level of funding and multi-year nature of this new program prompted OWEB to explore ways to help FIPs document and communicate progress toward their ecological goals. To this end OWEB initiated a collaboration with the Bonneville Environmental Foundation (BEF) to develop an approach that would help FIP partnerships track and report progress toward achieving implementation objectives and ecological outcomes. This progress monitoring framework also will inform a realistic adaptive management approach that allows FIPs to collect and document learning from their actions and adjust their plans and strategies as their knowledge base deepens.

The progress monitoring framework is inspired by foundational elements of the Conservation Measures Partnership's Open Standards for the Practice of Conservation and is primarily built around an articulated theory of change associated with each partnership's Strategic Action Plan. The BEF team worked with representatives from each of the six funded FIPs to interpret a theory of change from their respective Strategic Action Plans into a results chain, select key implementation outputs and ecological outcomes that represent a range of near-to-long-term predicted results, and identify indicators that can be measured as part of a strategic monitoring approach. The presenters will offer an example of how the Upper Deschutes FIP developed their progress monitoring framework and, using the results chain, identified additional, priority data gaps to be filled.

The fight for survival in intermittent streams: a case study of a threatened population of Lower John Day

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Traditional oral presentation (20 minutes)

Steelhead Streams that experience intermittent surface discharge are common within the range of anadromous Pacific salmon and steelhead. Dry conditions may be exacerbated by historic human induced impacts that include fire suppression, intensive grazing, intensive agriculture, and the eradication of beaver. In many cases, seasonally intermittent stream reaches will be utilized during the freshwater life-stages of salmon and steelhead. However, data remains limited that can describe the impact that seasonal intermittent flow may have on the performance of juvenile rearing salmonids. Further, examples of restoration practices that might alleviate the potential for seasonal intermittent flow to negatively affect juvenile rearing salmonids are lacking. Bear Creek, a tributary of Bridge Creek (Wheeler Co. OR) in the John Day Basin provides an example of a stream that is heavily utilized by a threatened population of steelhead for spawning and rearing that typically experiences intermittent surface flow for much of its length. Recent habitat restoration actions consisting of installing beaver dam analogs has begun on Bear Creek that aim to raise the water table and mitigate the impacts of intermittently dry stream reaches on riparian vegetation and the suitability of rearing habitat. In conjunction we have begun a monitoring program to document responses to restoration actions by fish, riparian vegetation, and surface water availability. In our first year of monitoring we observe fish movements in their fight for survival during the desiccation period on Bear Creek, and the impacts of

drying on density and fish condition. Our goal is to provide important information on how fish respond to drying in intermittent streams, and whether simple and cost-effective restoration actions like BDA installation can be used to mitigate impacts of drought to threatened populations.

Abundance trends for adult Pacific Lamprey in Western Oregon, USA

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Traditional oral presentation (20 minutes)

Pacific lamprey, an anadromous fish, native to the northern Pacific Ocean return to freshwater each spring along the west coast. Although their geographic range is well established, their relative abundance is much harder to determine. Dam counts and Native American tribal harvest numbers suggest a declining trend. In Oregon, the species is listed as "at risk of extinction." However, no wide scale monitoring has ever occurred. Escapement monitoring has generally been limited to downstream larval capture via trap sites and upstream adult dam counts, both of which have limitations. As part of the monitoring for winter steelhead spawning populations in Western Oregon, including tributaries of the Oregon Coast and Lower Columbia, Oregon Department of Fish and Wildlife (ODFW) field crew's record data on lamprey spawners and redds. Using peak lamprey redd counts from these surveys, as well as lamprey per redd ratios from the literature ODFW has generated a time series of Pacific Lamprey abundance index estimates. For this effort, we will: 1) explore the data for evidence of region- and time-specific trends in the relative abundance of Pacific Lamprey that could suggest lamprey returning to spawn in Oregon are exhibiting variable population spatial structure in space and time; and 2) determine whether dam counts correlate with estimates derived from redd counts. Despite several data caveats, the estimates generated from this work are proving helpful for managers in understanding relative abundance of these fish across large areas of Western Oregon.

Casting a broader net: Using multi-target metagenomics to capture aquatic biodiversity data from diverse taxonomic targets

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Traditional oral presentation (20 minutes)

Environmental DNA (eDNA) assays for single- and multi-species detection show promise for providing standardized assessment methods for diverse taxa, but techniques for evaluating multiple taxonomically-divergent assemblages are in their infancy. Here, we evaluated whether microfluidic multiplex metabarcoding and next-generation sequencing could identify diverse aquatic and riparian

assemblages from 48 taxon-general and taxon-specific metabarcode primers per assay. eDNA screening was paired with electrofishing along a stream continuum to evaluate congruence between methods. A fish hatchery located in the transect provided a barrier to upstream passage of hatchery species, and a point source for one non-native species (White Sturgeon).

Microfluidic metabarcoding detected all 13 species observed by electrofishing, with overall accuracy of 86%. Taxon-specific primers were more successful than taxon-general primers at classifying sequences to species. Taxon-specific and taxon-general markers detected a transition of downstream sites dominated by multiple fish species, to upstream sites dominated by a single species; however, we failed to detect similar transitions in amphibians along the same transect. White Sturgeon was only detected at the hatchery outflow, indicating eDNA transport was not detectable at ~2.4 km. Overall, we identified 878 predicted taxa, with most sequences (49.8%) derived from fish (*Actinopteri*, *Petromyzontidae*), Oomycetes (21.4%), Arthropoda (classes Insecta, Decapoda; 16.6%), and Apicomplexan parasites (3.83%). Taxa accounting for ~1% or less of sequences included freshwater red algae, diatoms, amphibians, and beaver. Our work shows that microfluidic metabarcoding can survey multiple phyla per assay, providing fine discrimination required to resolve closely-related species, and enabling data-driven prioritization for multiple forest health objectives.

Complex management in a complex system: Columbia River fisheries regulation

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Traditional oral presentation (20 minutes)

The Columbia River is known for its regulatory, biological, and social complexity. The states and tribal sovereigns have authority to independently enact regulations for recreational, commercial, and ceremonial/subsistence fisheries. However, management of mixed-stock salmonid fisheries in the mainstem Columbia River requires multiple parties working collaboratively to ensure meaningful harvest opportunity while adhering to the tenets of established case law, legislation, and policy. Fishery management agreements enacted under the auspice of the U.S. vs Oregon court case, federal authorization of fisheries impacting populations afforded protection by the Endangered Species Act (ESA), and policies adopted by the fish and wildlife commissions of Oregon and Washington provide much of the framework for management of these fisheries. The Columbia River Compact, ratified by Congress in 1918, is the agreement between the states of Oregon and Washington to adopt or modify regulations pertaining to the management of fisheries in the Columbia River, where it forms their common boundary, only with the mutual consent of both states. Today, regulations are considered, negotiated, and agreed to via procedures that have developed out of practical application of this Compact.

Management of Columbia River salmonid fisheries entails an annual three-part process of pre-season planning, in-season monitoring of fishery performance and fish abundance, and post-season assessment. Input from the public is solicited and considered during the pre-season and in-season

regulation-setting processes. Species-, stock-, or run-specific abundance forecasts are developed pre-season by a technical committee established by the U.S. vs Oregon Management Agreement or, in some instances, by state or tribal staff. Initial season structure is developed based harvestable surpluses, ESA limitations, allocation policies, and user-group priorities. Monitoring programs provide harvest and abundance information in-season. This allows fishery managers to make modifications to the regulations in response to up-to-date information. During critical periods, in-season assessments of fishery performance and salmonid abundance are often done weekly. Post-season estimates of harvest and abundance are used to assess fisheries performance and compliance with ESA-take limitations and harvest agreements and policies.

Using detailed hydraulic models to quantify the effects of flow management on salmonid rearing habitat in the Willamette River

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Traditional oral presentation (20 minutes)

Managers of multi-purpose reservoirs must balance multiple mandates in dam operations and the allocation of stored water, including flood protection, hydropower production, downstream water demand, and downstream ecosystem needs. Quantified relationships between streamflow and habitat availability for aquatic species and their various life stages can provide flow managers with the tools to better manage water releases. Advances in bathymetric data collection methods and computation speeds provide new opportunities to efficiently simulate and analyze the effects of flow management at spatial resolutions meaningful to fish along entire river corridors.
To inform flow management decisions, this study quantifies relationships between flow and rearing habitat availability for federally protected spring Chinook salmon and winter steelhead along 200 km of the Willamette, North Santiam and McKenzie Rivers in northwestern Oregon using high resolution (<5m2) two-dimensional hydraulic models. Preliminary results show that habitat response to changes in streamflow are spatially variable, where some reaches (1 km) are sensitive to small changes in streamflow, but others require significant flow increases to meaningfully increase habitat area. Similar variability can also be seen at larger scales (20+ km), especially when contrasting laterally dynamic with laterally stable river segments, highlighting the control geomorphology plays on habitat. Model results also highlight the potential application of large-scale hydraulic modeling to inform restoration practices, such as identifying limiting habitat factors at targeted flows. Future phases of this effort will incorporate temperature and life-cycle modeling to determine relationships between flow-dependent habitat availability and total fish capacity.

Climate-mediated interactions between native and invasive trout species revealed by a high-resolution, public eDNA database (eDNAtlas)

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Traditional oral presentation (20 minutes)

Aquatic environmental DNA (eDNA) sampling is rapidly transforming our ability to describe and monitor biological communities via precise records of species occurrence locations. Adoption of this sampling technology is occurring broadly across many natural resource organizations and now results in thousands of new samples being collected each year in rivers, streams, lakes, ponds, springs, and wetlands. To reduce redundancy and maximize data sharing among organizations, the National Fish & Wildlife Foundation commissioned development of the Aquatic eDNAtlas project, which is composed of a comprehensive interagency database spanning the western U.S., eDNA field sampling template maps with predetermined coordinates, and a website to distribute this information.. Currently, the eDNAtlas database contains data from approximately 8,000 samples collected by dozens of agencies and analyzed at the National Genomics Center for Wildlife and Fisheries Conservation (https://www.fs.fed.us/rm/boise/AWAE/projects/the-aquatic-eDNAtlas-project.html). Species occurrence data from the eDNAtlas can be used directly in many ways, but the database also links to physically-archived samples which can cost-effectively be repurposed for new analyses; an application of the resource that we illustrate with a case study. Building on a rangewide bull trout eDNA survey effort, we repurposed 630 samples for brook trout eDNA detection over an area of nearly 10,000 km2 and built an accurate species distribution model (AUC = 0.96; prediction accuracy = 0.90) for bull trout that incorporated an interactive effect based on the abundance of invasive brook trout. We then used this model to project possible climate change and brook trout invasion scenarios for bull trout forward in time. The environmental DNA sampling results were concordant with traditional electrofishing samples previously conducted in the basin and revealed species patterns that were consistent with previous studies: Bull trout were positively associated with larger stream sizes and negatively associated with high brook trout abundances. However, our modeling also revealed an important nuance: At high abundance, brook trout appeared to exclude bull trout from small streams, even those below the thermal optima for brook trout. Climate projections suggest a loss of suitable bull trout habitat as streams warm and summer flows decrease, which could make deleterious interactions with brook trout more common in the future. We conclude that where brook trout are invading bull trout habitats, streams that are both large and cold are most likely to provide native bull trout with long-term refuges. As the eDNAtlas database continues to grow, it could enable development of similarly accurate distribution models for many species throughout the Pacific Northwest.

Population level response to 21st century fish passage infrastructure in the upper Clackamas River basin

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Traditional oral presentation (20 minutes)

Portland General Electric (PGE) operates a 3 dam 123-MW hydro-complex (Project) on the Clackamas River with dams ranging in physical height from 14-63 meters (FERC 2195). In 2010 PGE received a 45 year license from FERC to continue operation of the Project. In response, construction of license mandated fish facilities ensued from 2006-2015. Associated facilities either built and/or improved within the Project area relevant to this analysis are 1) new River Mill adult fish ladder, 2) 14 m3/s River Mill surface collector, 3) 28 m3/s North Fork floating surface collector, 4) 11.4 km juvenile fish bypass pipeline, 5) juvenile sampling building, 6) adult fish sorting facility 7) spillway exclusion net, 8) and a suite of habitat improvement/minimum flow increases.
Unlike many other Columbia and Willamette tributary hydro-systems built in the 20th century, the Clackamas hydro system had functioning upstream and downstream fish passage infrastructure originally integrated with varying degrees of efficacy. This offered a unique opportunity to investigate the impact of 21st century fish passage infrastructure on established ESA listed populations of spring Chinook, coho, and winter steelhead. A long term (1958-present) data set from Project facilities and site specific evaluations were used to identify population level responses associated with infrastructure improvements. Topics of interest included in this presentation are:

1. Adult run timing advancements of 2-4 weeks at the 25th, 50th, and 75th percentile completion dates and subsequent spawning distribution changes.
2. Relationship between the expansion of juvenile life history strategies collected and potential increase in the age class diversity of returning adults (portfolio effect).
3. Temporal emigration trends of downstream migrants following infrastructure improvement.
4. Observed juvenile collection efficiency increases affect on recruits per spawner analysis.
5. Adult return trends of Clackamas spring Chinook and winter steelhead relative to regional conspecifics after infrastructure improvement.
6. Observed reductions in spring Chinook pre-spawn mortality

New Technology for Old Problems: A pilot project to develop DNA Methods to Monitor Fish Assemblages in Estuarine Systems

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Traditional oral presentation (20 minutes)

Environmental monitoring programs are essential foundations for effective estuarine management. Advances in DNA methods and rapid reductions in analytical costs present an opportunity to harness this new technology and fundamentally improve our capacity to monitor biological communities and individual species. Environmental DNA (eDNA), or DNA present in an environmental sample (e.g., water, sediment) provides information on species present in an aquatic ecosystem without needing to employ traditional methods to capture and identify individual organisms. Traditional methods require extensive

field time and large research teams, limiting adequate replication to assess ecological communities and detect rare or evasive species. Here, we will present the results of a pilot project conducted in and near South Slough National Estuarine Research Reserve (SSNERR) in 2018. A primary objective of this collaborative project will be to develop, test, and publish eDNA protocols for assessment of estuarine fish assemblages, and for the detection of rare species.

In the summer of 2018, water and sediment samples were collected at four sites in coordination with existing traditional monitoring programs (seine netting). Water samples were filtered and eDNA analyzed and compared to a reference library for species identification. Initial results show that local fish species were identified in water eDNA samples, however, there was dissimilarity between fish communities that were established by traditional and eDNA methods. We are continuing to improve these methodologies by refining the eDNA process, expanding the DNA reference library, incorporating expert knowledge, and conducting field studies to create optimal sampling designs. By augmenting traditional fish survey methods with eDNA samples we may be able to reduce sampling effort, detect rare or evasive species, identify species indistinguishable in the field, and potentially detect exotic species during the early stages of invasion.

The Implementation of Ecohydrological Models to Support Forward-thinking Fisheries Restoration and Conservation Planning in Oregon

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Traditional oral presentation (20 minutes)

Climate change is predicted to have dramatic effects on the quality, distribution, and availability of fish habitat. Freshwater systems, such as those along Oregon's coastal region, are expected to experience earlier peak flows and decreased summer flows as warmer winter temperatures reduce mountain snowpack. For anadromous fish species such as Coho Salmon (*Oncorhynchus kisutch*) these changes in the freshwater hydrological regime could have profound impacts on the ability of fish to navigate streams and find suitable habitat to support the needs of their various freshwater life stages. To assess how various climate scenarios might impact flow conditions for species such as Coho Salmon, the Oregon Department of Fish and Wildlife's Fish Research Evaluation and Data Decision group (REDD) has been implementing an ecohydrology model developed by the Environmental Protection Agency to visualize and quantify changes in streamflow in areas occupied by Coho populations along Oregon's coast. The Visualizing Ecosystem Land Management Assessments (VELMA) model integrates digital elevation models (DEMs) with corresponding soil, land use, weather, and disturbance data to predict streamflow under various climate and land management scenarios. For this presentation we calibrated and validated VELMA for the Siletz River basin under current climatic conditions and then applied future climate scenarios to visualize the effect of increasing temperature on the hydrological regime throughout the basin. This modeling effort aims to provide essential information to inform species distribution models, restoration and water right prioritization, and conservation planning to help

support sustainable management plans that will support fish populations under future environmental conditions.

Assessing network patterns present in food webs of headwater streams in the Cascade Mountains; what role do Cutthroat Trout play?

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Traditional oral presentation (20 minutes)

Understanding the structure and functionality of food webs is a key component of effective ecosystem management. Conceptualizing and quantifying changes to food webs as aquatic habitats warm is vital to managing these environments as climate change progresses. Headwater streams play a direct role in the integrity of downstream systems, affecting nutrient transport, primary production, and fisheries. Using long-term data collected from headwater streams at the H.J. Andrews, I constructed food webs using the Cheddar package and WebBuilder function in R. These tools allow users to quantify web attributes such as connectance, linkage density, and generality, and therefore compare differences between food webs from streams along spatial and environmental gradients. Comparisons of communities without a top predator (*Oncorhynchus clarkii clarkii*) were made with more diverse webs in the river network to identify the influence that Cutthroat Trout plays in the structural complexity and stability of stream food webs. Finally, a non-metric multidimensional scaling analysis was preformed to assess the overall similarities and dissimilarities of all food webs in the headwater network. Implications of structural heterogeneity to community stability are covered, and preliminary results are presented from a subset of the food web data analyzed.

45,000 tissue samples and counting! The newly established State Fisheries Genetics Lab (SFGL) Tissue Sample Repository and Database

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Poster presentation

The State Fisheries Genetics Lab at Oregon State University and the Oregon Department of Fish and Wildlife are collaborating to create the first centralized tissue sample repository and database for the state of Oregon. The repository and database is composed of fish and invertebrate tissue, scale, and otolith samples collected for genetic analyses. The major focus for this database is to inventory and store information on previously collected samples of Pacific salmonids and other species, as well as for samples collected in the future.

We are utilizing Progeny © (Progeny Genetics LLC, Delray Beach, FL), a database software, which was first created to archive and analyze human genetic data; however, the same components can be used for fish and other wildlife. Progeny is robust database software with the capacity to store information on hundreds of thousands of samples. Through Progeny we keep track of phenotypic (e.g. fish length, sex, age, etc.), genotypic (e.g. microsatellite allele calls, single nucleotide polymorphisms), and other sample information (e.g. location, date, tissue type, preservation method, etc.). To date, we have inventoried 45,646 samples into Progeny, representing Chinook, steelhead, coho, Dungeness crab, Albacore tuna, Pacific lamprey, and multiple rockfish species. A centralized database will serve as a resource for researchers to address specific questions about Pacific salmonids and other species. "

Assessment of Habitat Suitability for Bull Trout Reintroduction in Three Upper Willamette Watersheds

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Poster presentation

Reintroduction of Bull Trout into watersheds where they have been extirpated may provide a productive approach to improving the status of the species. Feasibility of reestablishing self-sustaining populations hinges on multiple factors, including the existence of sufficient habitat to support the full range of life stages. We conducted an assessment of habitat in the North Fork Middle Fork Willamette River (NFMF), Salmon Creek, and Salt Creek watersheds near Oakridge, Oregon to assess suitability for spawning, early rearing, and migration. This included reconnaissance surveys to identify cold spring-fed reaches and barriers to migration, installation of temperature loggers at key locations to obtain detailed temperature data over multiple years, and electrofishing or snorkeling surveys in potential spawning reaches to characterize fish assemblages and assess presence of Brook Trout populations. We compared these data to reference conditions for remnant Willamette Basin populations (upper McKenzie River basin) as well as regional and rangewide Bull Trout criteria. Results indicated that cold, accessible stream reaches exist in all three watersheds, especially in the upper Salmon Creek watershed. Water temperatures in the majority of potential spawning and early rearing reaches in the NFMF and Salt Creek watersheds and in downstream main stem reaches exceeded those in the McKenzie reference streams but not necessarily in other portions of the species' range. Partial barriers to migration exist on lower Salmon Creek, but the degree to which these might impede upstream migration of adult Bull Trout is uncertain. We found Brook Trout only in the upper main stem NFMF, where they could pose a hybridization risk to Bull Trout. Overall, suitable habitat exists in these watersheds, but potential constraints warrant consideration. Further research could prove useful in evaluating reestablishment potential specific to possible local donor Bull Trout stocks under the conditions that exist in these watersheds.