ABSTRACTS

SPEED TALKS

Middle Fork Willamette River Sub-Basin Lamprey Occupancy Survey

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Michael C. Sheehan

Douglas C. Larson

Past efforts by the United States Forest Service (USFS) to characterize the distribution of fishes across the Willamette National Forest (WNF) have been biased toward the detection of salmonids, leaving us with limited information about the historic and current distribution of "non-game" native fishes. In particular, the status of lamprey populations is poorly understood. Given the recent addition of Pacific lamprey (*Entosphenus tridentatus*) to the Interagency Special Status/Sensitive Species Program (ISSSP) list, and that the phylogeny of brook lamprey (*Lampetra* spp.) remains unresolved, additional data is needed to evaluate potential impacts to lamprey populations from USFS/BLM resource management and habitat restoration activities. Our objectives are to: (1) determine the distribution of lampreys across federally managed lands within the Middle Fork Willamette River (MFWR) sub-basin, Oregon, USA; (2) develop a protocol to assess reach-level occupancy of larval lampreys; (3) identify landscape-level and reach-level variables associated with lamprey occupancy at the sub-watershed level; and (4) describe the morphological and genetic variability of lampreys across the project area. In 2015, we surveyed 56 reaches from 25 sub-watersheds and 9 watersheds in the MFWR sub-basin. Lamprey occupied 30% of all sampled reaches. We collected 113 specimens for morphological and genetic analysis (results pending further analysis). We will complete our assessment of the MFWR sub-basin in 2016, and expand our effort to include the rest of the Willamette National Forest.

Fish, and Other Things, in the Waters of the Turks and Caicos Islands

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Fish. Tropical. Warm. Nice. OH MY GOD THAT SQUALL IS GOING TO KILL US. OK, everything's fine now. Wait, why is that shark following me? Wow, Scott actually does work while he's there. Water still nice. Look, more pretty fish. Hey, that's not a fish.

Salmon River: Providing a Coordinated Response

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Christine M. Clapp

Jitesh A. Pattni

John L. Spangler

The winds of change blew hard through Salmon River Hatchery in 2015. Changes to fish management resulting from implementation of the Coastal Multi-Species Conservation and Management Plan, shifts in hatchery production and staffing, and additional research to support the Pacific Salmon Treaty prompted a strong and vocal response from the local community. Following a robust public outreach effort, ODFW staff worked to create a network to support the subsequent outpouring of volunteer interest. Staff used a combination of online tools, advertising, and word-of-mouth to connect community members, students, and anglers with volunteer opportunities. Further, staff coordinated with local volunteer-run foodshares to ensure that food-grade surplus hatchery fish went to those in the community who needed them most. While the initial coordination effort was time-intensive, the resulting tools proved to be useful for both volunteers and staff and will be maintained for use in this and future projects.

Developments and Diversity in the Oregon State Ichthyology Collection

Brian Sidlauskas, Department of Fisheries and Wildlife, Oregon State University
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Twenty slides will highlight the diversity of ongoing projects involving the quarter million preserved fishes in the Oregon State Ichthyology Collection (OSIC). In under seven minutes, explore the collection's new website and online database, glimpse species yet to be described, learn about the unexpected diversity of Oregon's nongame fishes, follow a biodiversity survey in Gabon, trace the evolutionary history of South American headstanding tetras, compare specimens collected in the 1940s with those collected recently, visualize fish skeletons without dissection, see how the OSIC can assist your own work, and meet the team of people who make these projects possible.

Alternative Genetic Techniques to Quantify Fish Predation on Listed or Rare Species

Dana Stroud, Cramer Fish Sciences dana.stroud@fishsciences.net

Gregg Schumer

Paul Bergman

David Delaney

Scott Blankenship

The use of traditional visual identification of ESA listed juvenile salmon in fish predator diets is painstaking and prone to error. The extent of listed fish mortality that is attributable to predation in many systems is unknown due to extensive flow modification, altered habitat, the diversity and abundance of invasive fish and bird species, temperature and dissolved oxygen limitations, and overall reduction in historical salmon population size. Genetics techniques such as qPCR can be used to identify listed species in predator diet samples and bioenergetic style modeling approaches can quantify how many grams of prey were consumed in a 24 hour period. Together, U.C. Davis and Cramer Fish Science applied this approach to 4 study reaches in the North Delta to test hypotheses regarding the relationships of biotic and abiotic factors in relation to listed species predation rates. This approach offers an objective identification of prey items and with proper modeling design, can be used robustly to rigorously test spatial and temporal hypotheses surrounding predation.

TRADITIONAL ORAL PRESENTATIONS

Amazing Underwater Pictures of Marine and Freshwater Fish

Laura Tesler, Oregon Department of Fish and Wildlife tesler2291@comcast.net

Rich Grost*

This presentation will showcase some of the beautiful diversity of marine fishes in the Pacific Northwest with a small amount of freshwater salmonids also featured. All pictures taken while scuba diving or snorkeling with a camera in an underwater housing with external strobes.

Development of Analytical Tools for Classification and Assessment of Riparian Ecosystems in Northwest Oregon

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Management of riparian areas in forested landscapes has been an area of active development in policy and science in recent decades. Questions remain concerning how best to balance restoration of riparian and aquatic ecosystems and other goals of land management, such as

timber harvest or recreation. One tactic for shedding light on this subject is to apply scientific understanding of species'€™ biology and landscape dynamics in the context of detailed geographic information to describe the intrinsic potential of different segments of a landscape to produce ecological benefits. In addition to assessing current conditions, understanding historical variability of ecosystems in the absence of overt human management provides useful context for planning and management. However, information on historical variability for riparian forests is lacking. Our intent is to develop an analytical approach that will provide a transparent, logical pathway for planning management of riparian vegetation on federal forest lands in northwest Oregon. The analysis will describe the physical and biological capacity and variability of riparian ecosystems. This analytical approach will provide the context for assessment of both historical and current conditions of riparian vegetation. The first steps are to state explicitly the ecosystem functions of interest, link these functions to general characteristics of vegetation (e.g., plant life-form, tree stature), infer from the scientific literature the environmental factors and disturbance processes that condition these aspects of vegetation, and then develop a site-classification scheme encompassing potential vegetation, fluvial and other geomorphic processes, and non-fluvial disturbance processes (e.g., fire). We will map the units of this classification scheme across forest lands in northwest Oregon to generate a stratification for historical reference conditions. We will use both measurements and modeling to infer historical reference conditions. Measurements include interpretation of historical imagery and ground observations of unmanaged areas. We will also use mapped vegetation attributes for contemporary unmanaged areas based on Landsat imagery, and where available, LIDAR. We will collect new data and exploit state-and-transition simulation models as necessary to augment other sources of historical reference conditions. Current conditions will be assessed by some combination of imagery and ground measurements. To date we have identified focus areas within three ecoregions with important differences in geology and hydrology (Coast Range, Western Cascades, High Cascades), and delineated the larger spatial context within which to assess reference conditions for the three focus areas.

Evaluation of a Fish Ladder Designed with Pacific Lamprey in Mind

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Brian Pyper

Maggie David

River Mill Dam was completed by Portland General Electric on the Clackamas River in 1911. At the time of its construction the associated ladder was considered a model design for its day. While the ladder performed adequately for salmon and steelhead, no consideration was given to Pacific lamprey in its design and passage conditions for lamprey were poor. With a new License to operate the Clackamas Hydro Project imminent, a new fish ladder was built at River Mill Dam in 2006. The new ladder incorporated modern design features and specific consideration was given to passage of Pacific lamprey. Adult lamprey effectiveness monitoring

was completed in 2013 and 2015. Results from PIT tagged and radio tagged lamprey indicate that the new ladder is effective at passing lamprey. Passage rate estimates across years and tag types have ranged from 84 – 96% with relatively short residence times in the tailrace and relatively rapid passage times through the ladder. This presentation will cover design elements of the River Mill ladder and present the results of effectiveness monitoring.

A Threats-based Approach to Bull Trout Recovery Planning

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Bull trout were federally listed as a threatened species range-wide in the coterminous United States in 1999 and draft recovery plans were subsequently published in 2002 and 2004. These draft plans contained demographic recovery criteria that included bull trout distribution, abundance and trend targets for local populations and core areas within each draft recovery unit, in addition to criteria addressing threats to population connectivity (i.e. restoration of passage). In contrast, the final bull trout recovery plan, published in September 2015, does not contain demographic recovery criteria and instead relies on a threats-based approach with an assumption that effective management of known primary threats to bull trout will result in corresponding improvements in demographic parameters that will support long-term persistence of the species. Although lack of demographic criteria in the new recovery plan is a departure from previous draft recovery plans for bull trout, and more broadly from most final recovery plans published by the U.S. Fish and Wildlife Service (FWS), the approach is not inconsistent with the draft recovery planning guidance currently in use by the FWS. Moreover, while demographic criteria were not included in the final plan explicitly, the primary strategy outlined in the recovery plan calls for the conservation of bull trout so they are geographically widespread across representative habitats and demographically stable in the species' six recovery units. And further, that genetic diversity and diverse life history forms are conserved. Thus, while specific demographic criteria were not developed for the final recovery plan, the importance of demographics towards meeting the goals of the recovery plan is clearly acknowledged as is the valuable role of demographic information in assessing the current and future status of bull trout at the range-wide, recovery unit, and core area scales.

Streamside Buffers for Moderating Effects of Forest Thinning on Riparian Microclimates and Stream Temperatures in Western Oregon

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Uncut vegetative buffers are commonly used to moderate upland timber harvest impacts on aquatic and riparian habitats and functions. In an operational-scale experiment begun in 1993, we have assessed the effectiveness of alternative buffer widths in moderating the influences of thinning on riparian microclimate and stream temperature in second-growth Douglas-fir forests. Our most recent observations reinforce the effectiveness of variable width and one-

tree-height buffers in moderating the effects of heavy thinning. Differential air, soil and water temperature responses indicate that factors other than shade influence the thermal energy budget of riparian forests and streams. Flexible, context specific delineation of buffers may promote a beneficial balance between competing objectives.

How Extreme is Too Extreme? Examining Trout Population Responses Under Consecutive Droughts

Ivan Arismendi, Oregon State University Ivan.Arismendi@oregonstate.edu

Brooke Penaluna

Climate extremes are expected to become more frequent and more intense in the future, but our understanding of species responses to extreme conditions is limited. Here, we explore the role of single and consecutive droughts on the stability of stream-living trout populations using an individual-based modelling approach. We run simulations using combined scenarios of decreasing summer flow and increasing temperature. Although stream temperature did not exceed trout physiological limits, extreme low flows greatly restricted available habitat leading to a reduction in trout numbers or biomass. Our findings demonstrate how species' sensitivity to climate extremes may respond under successive extreme events. This has important conservation implications because risks of local extinctions may increase due to more often extreme events of hydroclimate expected by future global environmental change.

Restoration and Monitoring at the Miami River Wetlands, Tillamook County, Oregon

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We initiated a 58-acre tidal wetland restoration project at the confluence of the Miami River and Tillamook Bay in 2010. The site had been cleared and drained for agricultural uses and the restoration effort included overhead utility system removal, ditch filling, stream re-meandering, tidal channel excavation, in-stream and floodplain large wood placement, non-native plant control and native plant establishment. To evaluate the efficacy of our restoration actions and inform future tidal wetland restoration efforts in our service area, we began collecting data on a variety of physical and biological attributes (including water levels, selected water and soil quality parameters, vegetation structure and composition, and several fish and wildlife parameters) before restoration began, and have continued to monitor these attributes post-construction. I will briefly describe the restoration project and review and discuss preliminary results from our ongoing monitoring efforts.

Pacific Lamprey Recolonization of Hood River after Removal of Powerdale Dam

Cyndi Baker, Confederated Tribes of the Warm Springs cyndi.baker@ctwsbnr.org

Powerdale Dam, located at rkm 6 on Hood River was removed fall 2010. The dam was constructed in 1923 to provide electricity for increasing demands from farmers, orchardists, flour mills, food processing plants and canneries in the area. While a fish ladder was installed to pass Chinook and steelhead, Pacific lamprey were extirpated upstream of the dam. With BPA funding from Columbia River Accords, the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) began monitoring lamprey presence and distribution in streams within ceded lands, including Fifteenmile Creek, Mill Creek, and Hood River. During surveys fall 2012, the first larval lamprey, barely a centimeter in length, were sampled upstream of the old Powerdale Dam site. Genetic analysis confirmed the species was *Entosphenus tridentatus*, Pacific lamprey. Since then, the CTWSRO has been documenting the range expansion of lamprey into the East Fork Hood River, which has increased annually. While range of has broadened in parts of the subbasin, lamprey presence in most tributaries is still lacking.

How Did the Recovery Plan Aid in the Recovery of the Oregon Chub?

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Paul Scheerer

Shaun Clements

Ann Gray

Recovery plans are nonregulatory documents intended to outline measureable, obtainable actions that are believed to be required to recover and protect species listed under the Endangered Species Act (ESA). Oregon chub, small floodplain minnows endemic to the Willamette basin of western Oregon, were ESA listed as endangered in 1993. Prior to listing, the Oregon Chub Working Group prepared a multiagency conservation agreement that outlined actions that they believed would contribute to successful recovery; these actions were incorporated into the recovery plan for the Oregon Chub, published in 1998. The primary actions described by the recovery plan were 1) maintain existing populations, 2) establish new populations, 3) research life history, ecology, and interactions with nonnative species, and 4) public outreach and education. The recovery plan also described thresholds to measure conservation status of Oregon chub, and outlined criteria that, when achieved, may have warranted a review of the ESA status. The status of the Oregon chub improved dramatically since it was listed as endangered, and in 2015 became the first fish to be delisted from the ESA due to recovery. Recovery was achieved through implementation of the recovery plan, dedication of the working group, willing landowners and partners, increased knowledge about the species, and a number of other factors. This talk will explore the effectiveness of the recovery plan in providing the guidance needed to achieve the recovery of Oregon chub.

Modeling Alternative Conservation Strategies for Klamath Basin Sucker Recovery

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James Peterson

Listed as endangered in 1988, the Lost River sucker (*Deltistes luxatus*) and Shortnose sucker (*Chasmistes brevirostris*) were once abundant and widely distributed in the Klamath Basin in Southern Oregon and Northern California. Populations of both species have been declining since the late 1960s. Factors thought responsible for declines include naturally occurring disturbances (e.g., periodic drought), water resource and land development activities, degradation of habitat and water quality, and interactions with introduced exotic species. Detection of any substantial adult recruitment for the last few decades has been minimal. We used a quantitative decision modeling approach to explore potential outcomes of alternative conservation strategies that include captive propagation and catch grow and release. Uncertainty about the factors responsible for the apparent lack of recruitment was represented using alternative models of system dynamics Sensitivity analysis indicated that the model predictions were highly sensitive to population dynamics during early life stages and the alternative ideas of system dynamics. To address these uncertainties, we propose an adaptive approach to sucker recovery that integrates monitoring, research, and management.

Endangered Species Act Recovery Planning

Lynne Barre, NOAA Fisheries lynne.barre@noaa.gov

Rosemary Furfey

"Recovery is the process by which listed species and their ecosystems are restored and their future is safeguarded to the point that protections under the Endangered Species Act (ESA) are no longer needed. A variety of actions may be necessary to achieve the goal of recovery, such as the ecological restoration of habitat or implementation of conservation measures with government agencies and a variety of stakeholders. Recovery can be complex and challenging and a recovery plan is an important tool to organize, coordinate and prioritize the many possible recovery actions. Section 4(f) of the ESA directs NOAA's National Marine Fisheries Service and the US Fish and Wildlife Service to develop and implement recovery plans for threatened and endangered species, unless such a plan would not promote conservation of the species. ESA recovery plans must incorporate:

1) a description of site-specific management actions necessary to achieve recovery of the species,

2) objective, measurable criteria which, when met, would result in a determination that the species be removed from the list; and

3) estimates of the time and costs required to achieve the plan's goal.

Although recovery actions can, and should, start immediately upon listing a species as endangered or threatened under the ESA, prompt development and implementation of a recovery plan will ensure that recovery efforts target limited resources effectively and efficiently into the future. The recovery plan serves as a road map for species recovery — it lays out where we need to go and how best to get there. A recovery plan is one of the most important tools to ensure sound scientific and adaptive decision-making throughout the recovery process. The agencies have guidance for recovery planning which assists in developing plans that are consistent in the application of statutory, regulatory and policy requirements and builds on extensive experience with recovery planning and implementation. This presentation will review recovery plan requirements, process and key elements from the guidance to assist with effective recovery planning."

Small Stream, Urban Stream, and Intermittent Stream Outreach in the Upper Rogue Valley

Ryan Battleson, Oregon Department of Fish and Wildlife ryan.d.battleson@state.or.us

The upper Rogue River valley is one of the most quickly urbanizing basins in Oregon. The region is home to approximately 400,000 residents, as well as 4 native anadromous and resident species of salmonids including Chinook and Coho salmon, Steelhead trout, and Coastal Cutthroat trout. Small streams, urban streams, and intermittent streams are where these populations are most likely to come into contact with one another, often one unaware of the other's presence in their own backyard! ODF&W's Salmon and Trout Enhancement Program (STEP) utilizes the Small Stream, Urban Stream, and Intermittent Stream monitoring and outreach program utilizes volunteers to illustrate the importance of these streams to native salmonid populations. This effort focuses on the following: 1) Creating public awareness of fish using these streams, in order to promote stewardship and habitat protection and improvement 2) Help the ODFW Rogue Watershed District gain additional fish distribution and fish migration barrier information, and 3) Develop interest and support for restoration actions on individual streams with low cost, volunteer based initiatives. Volunteers from local sporting groups, the public, and schools operate upstream migrant “hoop” traps to survey for fish use during winter months. Since 2005, 34 streams have been sampled with “hoop” traps. Follow up to this monitoring, volunteers have worked to clear non-native vegetation, plant native riparian vegetation, and construct temporary fish passage improvements. These efforts have also identified fish passage barriers that previously were not known to ODFW. Following with the effort of creating community awareness of the Rogue Watershed’s Small Stream, Urban Stream, and Intermittent Stream program, 2016 will be the second year of our New Year’s Fish Counts. This program is patterned in part after the Audubon’s Christmas Bird count. Volunteers

receive training in fish identification and the operation of one person seines. Throughout each Saturday in January, volunteer crews and the STEP Biologist survey urban streams in Medford, Central Point, Grants Pass, and Ashland. The STEP program also utilizes volunteers to help complete a host of other district management objectives.

Variation in Early Male Maturation within and Among Releases of Columbia River Chinook Salmon: Environmental x Genetic Interaction

Brian Beckman, NOAA Fisheries brian.beckman@noaa.gov

Dina Spangenberg

Deb Harstad

Ryan Gerstenberger

Chris Brun

Don Larsen

Age of maturation in Chinook salmon is a trait regulated by Genetic x Environmental (GxE) interactions. Individuals and populations may be characterized as possessing a genetically determined "threshold" that relates to their predisposition to mature at a given age. The actual age at which maturation is initiated is regulated by environmentally-modulated physiological signals related to size, growth and/or adiposity. Columbia River spring Chinook salmon males commonly mature at age 1, 2, 3, 4 or 5. Males that mature at age 3 (jacks) are well described, these males spend 1 year in the ocean and return one year prior to the modal age of return for most males and females (age 4 in most Columbia River spring Chinook salmon populations). Age 1 or age 2 maturation in males has not been as thoroughly investigated. Recently, Harstad et al. (2014) documented that age 2 males (minijacks) may be common in hatchery releases of spring Chinook salmon. Furthermore, Spangenberg et al. 2014 demonstrated differences in minijack rate (the proportion of minijacks among smolts at release) for production release groups of Hood River (HR) stock spring Chinook salmon reared under different environmental conditions. Jacks from all release groups from this experiment have now returned, allowing us to further investigate variation in age 3 male maturation rates among these fish. In this talk we will explore relationships between minijack and jack rate within and among three release years of HR stock spring Chinook salmon reared at either Carson, Parkdale or Round Butte/Pelton hatcheries and subsequently released into the Hood River. These analyses will provide insight into how different environmental conditions may modulate age of maturation independent of genotype, within and among age 2 and age 3 males. In addition, we will include similar data from Carson stock spring Chinook salmon released from Carson Hatchery and Deschutes stock spring Chinook salmon released from Round Butte/Pelton Ladder facilities, allowing us to take a

reciprocal approach and examine how potential differences in thresholds for maturation may influence either minijack and/or jack rates among stocks.

Growth and Longevity of the Red Rock Crab, *Cancer productus* (Randall, 1840)

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Scott Groth

Red rock crabs, *Cancer productus*, are important components of Pacific Northwest nearshore communities and recreational crab fisheries. While an understanding of life history parameters is critical to fisheries management, few studies have been conducted on red rock crabs. The growth and longevity of the red rock crab was studied at two sites representing an unfished population in a marine preserve (Friday Harbor, WA) and a heavily fished saline estuary population (Coos Bay, OR). Growth in crustaceans is incremental and age classes are unevenly mixed, making these investigations difficult. An array of techniques was used including size distribution analysis, growth within confinements, and mark-recapture in describing the life history of *C. productus*. Carapace width increased from 20-30% with molt increment and intermolt period varied with size and sex. Maximum longevity is estimated to be around 5-6 years. Recreational fishing pressure in Coos Bay is linked to in a noticeable absence of large males at this site. Since only crabs > 115 mm were harvested by the recreational fishery, no adjustments in fishing regulations need to be made at this time.

Delineating Variable Width Riparian Zones by Mapping Floodplains, Wetlands, Wood Recruitment and Thermal Loading

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Daniel Miller

Kevin Andras

Spatially explicit riparian zone delineation and management require information on key riparian processes including (1) floodplains, (2) wetland areas or depth to water, (3) current vegetative shade effects on thermal energy to streams and (4) in-stream wood recruitment. Spatially explicit delineation of variable-width riparian zones provides a robust approach to riparian zone management that distributes protection based on site ecological processes and environmental settings that include fish habitats, hillslope erosion potential, channel migration zones, thermal refugia, wildfire risk and climate change.

Thinning & Stream Wood Recruitment in Riparian 2nd Growth Forests in Coastal OR & the Use of Buffers & Tree Tipping as Mitigation

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Sam Litschert

Gordon Reeves

Robert Pabst

A forest growth simulation model is coupled to a model of in-stream wood recruitment to explore riparian management alternatives in a Douglas-fir plantation in coastal Oregon. Alternatives included: (1) no treatment, (2) single and double entry thinning, without and with a 10-m buffer, and (3) thinning combined with mechanical introduction of some portion of the thinned trees into the stream (tree tipping). The predicted increases in in-stream wood that can occur during a thin with tree tipping may be effective for restoring fish habitat, particularly in aquatic systems that have poor habitat conditions and low levels of in-stream wood due to historic land use activities.

Sockeye Salmon Navigation in a Regulated River System

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Scott Hinch

Matt Drenner

Collin Middleton

Pacific salmon rely on directional cues as they navigate towards spawning grounds, and there are many factors that can affect the distribution of the cues. Among these factors are migration barriers, which can alter the release patterns of water originating from natal tributaries. Natal water contains imprinted chemical cues that are critical to successful navigation in all species of salmon, and alterations in the release of natal water can confuse migrating adults as they attempt to orient themselves towards spawning grounds. The Seton Dam is the only hydroelectric dam situated on the migration route of sockeye salmon in the Fraser River watershed, Canada's largest salmon-bearing system, and it diverts natal water to a power canal, creating a potentially confusing pattern of directional cues. There are two small sockeye populations that must navigate through this area, and preliminary research in the 1980â€™s indicated a negative effect of dam operations on the migration of both populations. As a continuation of this research, we have conducted a multi-year study that incorporates

telemetry and behavioral choice tests to characterize the effects of present operations on navigation behaviors. Our findings identify an operational regime that minimizes the impact of the dam on migrating sockeye, and subsequent changes to dam operations provide a positive example of adaptive management in regulated river systems.

Native Cutthroat Trout Persist in Timothy Lake

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Garth Wyatt

Nick Ackerman

Tim Shibahara

We analyzed 21 microsatellites to describe hybridization between native cutthroat trout and hatchery-origin rainbow trout in Timothy Lake, OR in the Clackamas River basin. In a sample of 86 individuals collected directly from the lake, we found that rainbow trout were most common (63%), followed by hybrids (21%) and cutthroat trout (16%), respectively. Although we detected extensive backcrossing towards both of the species, the sample did not suggest a completely admixed hybrid swarm. Specifically, we detected first-generation hybrids and a bimodal distribution of cutthroat and rainbow trout alleles. The pattern of hybridization suggests ecological/biological barriers to complete mixing and possibly local cutthroat trout populations in nearby tributaries.

Genetic-Based Estimates of Adult Chinook Salmon Spawner Abundance from Carcass Surveys and Juvenile Out-Migrant Traps

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Joseph Merz

Due to the challenges associated with monitoring in riverine environments, unbiased and precise spawner abundance estimates are often lacking for populations of Pacific salmon (*Oncorhynchus* spp.) listed under the Federal Endangered Species Act. We investigated new genetic approaches to estimate spawner abundance via genetic mark–recapture and rarefaction curves. The marks were the genotyped carcasses collected from the spawning area during the first sampling event. The second sampling event consisted of a collection of juveniles from a downstream migrant trap located below the spawning area. The parents that assigned to the juveniles through parentage analysis were considered the recaptures, which was a subset of the genotypes captured in the second sample. Using the Petersen estimator, we compared genetic mark–recapture spawner abundance estimates based on the binomial to

independently-derived spawner abundance estimates based on carcass tagging. We found general agreement between the genetic-based methods and the more traditional methods. We then estimated the number of successful breeders using a rarefaction curve approach, which required only the juvenile offspring sample. Our genetic-based approaches provide new alternatives to estimate adult Pacific salmon abundance in challenging environmental conditions or for populations with poor or unknown estimates of precision. Additionally, integrating carcass and juvenile sampling through genotyping has the added benefits of unifying the collection of viable salmonid population metrics into a single study design and quantifying recruitment related to habitat restoration.

Policy Patterns in River Networks: Riparian Management in the Oregon Coast Range

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Rebecca Flitcroft

Mary Santelmann

Sally Duncan

Environmental policies are ideas about natural systems projected onto a human defined landscape. A culmination of social, economic, and scientific factors, environmental policies result in baseline management requirements intended to affect ecological systems. In the case of riparian management policies in the Oregon coast range, requirements are based on human land uses (as mediated through site-specific environmental characteristics) rather than on ecologically defined criteria (such as the distribution patterns of specific species). This disconnect between human political structures and ecosystem-scale needs may result in gaps in the application of protective measures at broad spatial scales. For example, riparian buffers are intended to preserve cold water habitat for aquatic species, however, protections may not align with areas of concern. This is problematic in landscape-scale management of threatened anadromous fish species such as coho salmon (*Oncorhynchus kisutch*). The goal of this study is to explore the placement of riparian buffer policies with their intended goal of promoting cold water habitat for threatened coho salmon populations across the 84 HUC 10 watersheds the Oregon Coast Range. A geographic information system was created to map the spatial distribution of riparian management policies across river networks in the Oregon Coastal Coho Evolutionary Significant Unit (ESU) using the Oregon Department of Forestry stream layer. This stream layer provides the foundation for applied policy in the Oregon Coast Range, but was cobbled together from existing stream linework, resulting in varying stream densities across the region. A consistently derived stream layer (from NetMAP) was also attributed with riparian policies in order to evaluate the patterns of protection for coho salmon at a riverscape scale. Models of intrinsic potential for coho salmon habitat were used to identify river reaches with the capacity to support high quality habitat. Gaps in policy protection within stream reaches of high intrinsic potential were compared across the watershed and cataloging unit scales. Results

indicate that gaps in riparian protection of high intrinsic potential are ubiquitous across watersheds in the Oregon Coast Range. Further, watersheds vary in the distribution of gaps in protective measures.

Invasive Mussel Monitoring in the Columbia River Basin — Past, Present, and Future

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Gretchen Rollwagen-Bollens

Tim Counihan

Caren Goldberg

Jill Hardiman

Julie Zimmerman

Zebra and quagga mussels are native to Eurasia and have invaded the Great Lakes and several western U.S. water bodies, and threaten the Columbia River Basin (CRB). Enhanced monitoring and early detection of invasive mussels are now high priorities for the CRB. A project funded by the Bonneville Power Administration is supporting WSU and USGS to work collaboratively to address the following objectives: i) contribute to the coordination of regional early detection efforts, ii) summarize past efforts in the context of risk assessment data, iii) provide a framework for prioritization of boat cleaning stations, iv) assess the use of new technology (e.g., the FlowCAM and eDNA) to process veliger monitoring samples from the CRB, and v) conduct research that will help to assess the causes and effects of biological invasions in the CRB. We found that current monitoring efforts in the CRB are spread across sites with both high and low risk of establishment (based on Ca concentrations) and introduction, as well as sites of unknown risk. Our results suggest that reallocating future monitoring efforts and better understanding risk across the landscape may be desirable. Our results also suggest that the FlowCAM and eDNA have great potential to process veliger samples more rapidly and economically than traditional microscopy, and we are actively testing the efficacy of these new technologies, given the CRB's particular water quality, plankton composition, and hydrologic dynamics.

Wetland Recovery and Salmon Population Resilience: A Case Study in Estuary Ecosystem Restoration

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One of the most serious limitations to the recovery of at-risk Pacific salmon is the absence of intact ecosystems for tracking population responses to natural variability and for understanding the ecological processes that management programs should protect or restore. One exception is the small Salmon River basin on the Central Oregon coast. For forty years, Salmon River has provided a unique natural laboratory for evaluating salmonid population responses to changes in climate, habitat, and fish management. Since 1978 a series of restoration projects in Salmon River estuary has restored >175 ha of emergent marsh and tidal channels, reestablishing connections to >2/3 of the original wetland habitat that previously had been diked or filled. We initiated studies of Chinook and coho salmon in the basin in 2000 and 2008, respectively, to quantify life history variations and to evaluate each population's response to renewed estuarine rearing opportunities. Diverse juvenile life histories were expressed by each population and together accounted for at least 6 estuary-associated pathways that were rare or absent when the wetlands were fully diked. Otolith chemical analyses including 2 brood years of adult Chinook and 6 brood years of coho salmon further reveal that each of these pathways is now contributing directly to adult salmon production in the Salmon River basin. Small Chinook salmon fry and fingerlings that migrated to the estuary from early spring through summer and reared within the estuary for more than 30 days accounted for up to 75% of adults spawning in the basin in 2004-06. Similarly, juvenile coho with estuarine life histories contributed 20 to 35 % of the adults that survived to spawn in 2008-11. By re-establishing rearing opportunities in the Salmon River estuary, wetland restoration has expanded life history diversity and thereby, should strengthen salmon population resilience to future disturbance. A long history of protective management, restoration, and monitoring has established Salmon River as a key "model ecosystem" for understanding the demographic and life history responses of coastal salmon populations to climate change.

Getting Paid to Fish? Using a Tag-reward Model to Evaluate a Stocked Trout Fishery in Wallowa Lake, Oregon

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Each year over 7 million trout are stocked across Oregon, but fishery managers lack information on whether these efforts are meeting desired objectives. Catch and harvest data are traditionally obtained through creel surveys, which require an expensive investment in personnel costs. Utilizing a tag-reward model successfully implemented by Idaho Department of Fish and Game, a pilot study was conducted on Wallowa Lake to determine catch, harvest, and movements of stocked trout. During the summer of 2014, we marked 1,895 (out of a release of 38,000) legal and trophy-sized trout with a visually-identifiable tag. Ninety (90) fish were marked with 'reward' tags worth $50.00. Tags were distributed across multiple stocking events and locations within the lake from June to August. Anglers that caught a tagged fish voluntarily reported the date, location, fish size, and tag information. Of the 1,895 tags released, 486 (26%) non-reward tags were caught and reported in 2014. Of the 90 reward tags released, 50 were returned (56%) with $2,500.00 paid out to anglers. Additional tags were reported during the spring of 2015. On average, tagged fish were reported within 14 days of release. Most (75%) were caught in a location other than where they were released. We estimated that approximately 23,000 trout were captured during 2014, or 61% of the total trout stocked. Most of the legal (74%) and trophy-sized trout were harvested (79%). Using this tag reward model, we obtained valuable data that evaluated our current stocking strategy in a very cost-efficient manner. In addition the tag reward project was a positive way to connect biologists to anglers, who were overwhelmingly positive and supportive.

Here's to Making Good Decisions: Structured Decision Modeling and Bull Trout Reintroduction

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As a science, species reintroduction is in constant flux. Managers looking to use reintroduction strategies as a recovery tool for imperiled species such as threatened bull trout seek to maximize the benefit of a recovery action while minimizing the impact to existing donor stocks. Decision analysis is a method managers can use to evaluate the cost/benefit relationship of competing management decisions while transparently acknowledging and minimizing uncertainty through the iterative process of adaptive resource management. Our goal is to better understand the efficacy of competing bull trout reintroduction strategies (e.g., direct translocation, captive rearing, and artificial production) to support bull trout recovery efforts. To this end, we have created a working decision model for bull trout reintroduction actions and

tested the sensitivity of the model to perturbations of individual parameters. We will present the rationale behind the model, the model framework, and identify the parameters that are most uncertain. The model has been developed in such a way that it can be adapted to all bull trout populations or other species.

Morphological and Reproductive Divergence Associated with Habitat Shifts in Oligocottine Sculpins (Cottoidea)

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Successful invasion of novel habitats can lead to rapid evolution and speciation of the colonizer from its ancestral stock. When colonization leads to high rates of speciation and adaptive morphological evolution, the event is recognized as an adaptive radiation. Members of the cottoid subfamily Oligocottinae inhabit both subtidal and intertidal habitats and have been suggested to represent an adaptive radiation into the latter. Intertidal and subtidal environments are markedly different across a broad range of physical and biological characteristics, which can be expected to differentially select the traits of fishes in these contrasting settings. Although there are many ways in which differentiation could manifest, we selected a set of three fundamental biological aspects that we felt would be able to capture the different suite of putative selective pressures acting on each group and thus exhibit signatures of adaptive evolution across habitat types: 1) general morphology, 2) prey acquisition, and 3) reproduction. We used a likelihood-based ancestral state reconstruction of relevant morphological, ecological, and behavioral characters on a phylogeny of Oligocottinae to test our hypothesis that there would be differences between subtidal and intertidal species. Additionally, we performed a principal components analysis of 10 digitized landmarks for each species to test for differences in body shape. Our results show a clear separation in body shape between tidepool residents and subtidal residents. They also show that in general, tidepool residents copulate, but do not care for their eggs, while subtidal residents do not copulate, but do exhibit parental care.

Synchrony Emerges from Variability: Coho Salmon Phenology in Relation to Variable Thermal Regimes

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Species phenologies are often timed to capitalize on ephemeral resources to maximize growth in seasonal environments. Here we focus on the question of how environmental variability shapes salmon phenology in the Copper River Delta, Alaska- a complex landscape with thermally variable streams that sustain wild Pacific salmon (*Oncorhynchus* spp.) populations. We conducted a field-based comparative study to look at Coho salmon (*O. kisutch*) phenology during key periods of their life history including: spawning, egg hatch, and fry emergence in five streams. Streams varied from low thermal variability (1-5°C) in groundwater dominated streams to higher thermal variability (0-15°C) in surface-water dominated streams. We tested predictions relating the relative spawn timing among streams and the accumulated thermal unit (ATU) distributions during winter egg incubation to the timing of hatch and emergence the following spring. Despite differences in winter thermal regimes and ATU distributions among streams there were no significant differences in hatch ($p=0.790$) or fry emergence timing ($p=0.998$). However, spawn timing was significantly different among streams ($p<0.001$) with earlier run times in surface-water dominated streams and later spawning runs in groundwater dominated streams. Our work demonstrates that despite differences in thermal regimes, salmon emergence timing was synchronized in the early spring, allowing individuals to take full advantage of growth opportunities during the short Alaska growing season. As resources for salmon continue to shift due to climate change it is important to understand the role of phenology on life history strategies that allow species to persist across complex landscapes and thermal regimes.

USFWS Recovery Planning Process – REV

Grant Canterbury, U. S. Fish and Wildlife Service grant_canterbury@fws.gov

The U.S. Fish and Wildlife Service (Service) is developing a new recovery planning process we call REV – Recovery Enhancement Vision. The REV outlines a 3-part recovery planning process designed to optimize efficiency and effectiveness, leading to faster, more effective conservation on the ground for listed species. The three components of REV include a Species Status Assessment (SSA), the REV Recovery Plan (RP), and a Recovery Implementation Strategy (RIS). The SSA will contain the science - the life history and species ecological requirements, our analyses of the current condition of the species and its habitat, threats - both now and in the future, and potential conservation strategies. The RP will be a much shorter more concise document focused on the recovery criteria, recovery actions, and estimate of time and cost to recovery, as required under the Endangered Species Act. The more detailed activities that will implement the recovery actions in the RP will be outlined in a third, 'living' document: the RIS. This document will focus on the near-term, strategic implementation of the RP. All three are inter-related; they will be developed in tandem.

Guns 'N Skin Cream: The Science of Why We Don't Believe Science

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Climate change is real/a hoax, vaccines are effective/cause harm, nuclear power is safe/dangerous. For almost any issue that can be informed by science we see polarization in people's agreement with science. This raises the questions, why do people—often sharply and persistently—disagree about scientific consensus? One theory is that people just need to be better educated; if they only knew what scientists knew they would come to the "right" conclusion. This talk explores some of the psychological mechanisms that predispose individuals to selectively credit or discredit science based on their values. We apply fight or flight reflexes to predators, and data. We push threatening information away and pull friendly information close. The implications of this dynamic for science communication and public policy-making are discussed.

Lamprey Distribution in the Umpqua and Rogue River Basins

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Brian Mladenich

Pacific Lamprey (*Entosphenus tridentatus*) are a culturally important species, and a traditional first food source for the Cow Creek Umpqua Tribe. Due to the significance of the fish and the documented range-wide decline, the Tribe has focused on the research and conservation of lamprey throughout the Tribe's Ancestral Territory. In 2012, we began development of a GIS database of lamprey information for the Umpqua and Rogue Basins. We have continued to update the database as the Tribe and other partners have implemented targeted lamprey surveys and research. In addition, we have reached out to Tribal elders for traditional knowledge of the species. Our database includes scientific, traditional and local knowledge of documented lamprey occurrences. The database is intended to be a repository for information on all lamprey life stages and habitat, and includes information on Western Brook Lamprey (*Lampetra richardsonii*) as well. The database is a tool for planning in-stream projects, and will be updated as needed and shared with partners.

Oregon Plan Juvenile Monitoring in the SONCC and OCC; a tale of two ESUs

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As part of the Oregon Plan for Salmon and Watersheds, the Oregon Department of Fish and Wildlife has monitored coho parr in the Oregon portion of the Southern Oregon/Northern California Coho (SONCC) and Oregon Coast Coho (OCC) Evolutionarily Significant Units (ESU) since 1998. Monitoring has been accomplished by snorkel surveys; divers enumerated juvenile

coho, making a single pass through pools that meet size criteria in selected streams. Counts generated yearly estimates of abundance and distribution from 1998 - 2015. To provide a composite perspective on the status of the population, yearly data was pooled by three-year intervals into six successive brood groups. Comparisons of distribution and abundance were made among the brood groups and between the current year and the average of all years in each ESU. Results indicate the distribution of coho increased in both the SONCC and OCC subsequent to the first brood group (1998-2000) and then stabilized. In the OCC distribution remained stable, but it decreased in the SONCC following the 2007-2009 brood group and then continued to decline below 1998-2000 levels. Distribution for the SONCC in 2015 was the lowest estimate on record. Similar trends were observed for abundance. Abundance increased in both ESUs following the first brood group, and remained stable in the OCC, but declined in the SONCC after the 2007-2009 brood group. Abundance for the SONCC in 2015 was the lowest estimate on record. Our data suggest coho are progressing toward recovery in the OCC, but are declining in the SONCC. We speculate that drought conditions in recent years have been more pronounced in the SONCC and have contributed to the declines observed for the region.

Retrospective Analysis of a Natural-Origin Steelhead Population's Response to Exclusion of Hatchery Fish

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Garth Wyatt

We conducted a retrospective analysis with Upper Clackamas River steelhead population census data to determine the cause of a notable decline in natural-origin winter steelhead spawner abundance during adult return years 1972-1998. It was asserted that out-of-basin hatchery summer steelhead directly competed with native juvenile winter steelhead for rearing habitat, thereby causing the decline in winter steelhead abundance. If this casual mechanism were accurate, a population increase would be expected to occur following hatchery fish exclusion (1999). However, we were unable to detect an effect of hatchery summer steelhead on winter steelhead returns, and winter steelhead abundance in the Upper Clackamas River did not rebound to levels observed during the years preceding hatchery stocking. Instead, fluctuations in winter steelhead abundance were correlated with other regional winter steelhead stocks. There is strong covariation between productivity of contiguous steelhead populations, and this covariance declines with increasing distance between watersheds. Therefore, the decline in abundance of natural-origin steelhead in the Upper Clackamas River (1972-1998) was principally driven by survival rates common to steelhead populations in the Lower Columbia/ Willamette River region. Our analysis provides evidence that summer steelhead hatchery programs in the Clackamas Basin can coexist with natural-origin winter steelhead populations without impairing winter steelhead productivity.

Revisiting Historical Abundance of Oregon Coho: What Can We Learn About Their Decline and Recovery?

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The long-term data set for Oregon Coastal Natural (OCN) Coho had been assembled from data collected using differing methodologies through time. As a result, numerous ad hoc correction factors and adjustments have been implemented in order to align historical and contemporary data sets, and enable examination of abundance trends. Estimates of abundance extending from 1892 to present have been cited in the ESA Recovery Plan for Oregon Coat Coho as an indication that substantial restoration of freshwater habitat is necessary to prevent further declines in abundance. We assembled the data and methods used over the different eras of fisheries management since 1892 to evaluate estimations variances and possible sources of bias. OCN coho have been managed as one population of coho composed of all stocks on the Oregon coast north of Cape Blanco, and extending up the Columbia River and all its tributaries. This management approach applies many assumptions, including that all stocks in the OCN are equally productive and equally vulnerable to ocean fisheries. We assembled data from additional studies to test validity of several of these assumptions. We found evidence that the distribution of OCN stocks differs in the ocean, that distribution of fishing effort in the ocean has changed over time, that relative abundance of coho stocks has changed over time, and that the precision and accuracy of abundance estimates is substantially greater in recent decades. We evaluate the effect these differences on the interpretation of the apparent long-term trends and their likely causes.

Genetic Population Structure and the Relationship between Stream and Lake Ecotypes of Warner Suckers

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The Warner sucker (*Catostomus warnerensis*) is endemic to the Warner Valley, an endorheic subbasin of the Great Basin in southeastern Oregon. Two distinct ecotypes of Warner suckers exist; stream-type fish that are found in tributaries to the Warner Lakes and lake-type fish that are found in Hart and Crump Lakes. Lake-type fish attain larger sizes and presumably have increased fecundity, but risk increased predation, reduced access to spawning habitat, and periodic loss of habitat due to lake desiccation. Stream-type individuals inhabit a more stable environment with reduced risk of predation; however, they have a decreased forage base and stream habitat in the Warner basin has been extensively fragmented. Although it is presumed

that lake-type individuals originate in the streams, information regarding the relationship between the two ecotypes is limited. The recovery plan for the species recognizes the need for a functioning metapopulation of Warner suckers, where opportunities for genetic exchange among populations exist. Our objectives were to examine genetic structure among populations and to use genetic assignment data to examine the relationship between the two ecotypes. From 2007 to 2012 we collected Warner suckers from four tributary populations and Hart and Crump lakes and genotyped individuals at 16 microsatellite loci. We observed a high degree of variation among populations (global FST = 0.153), suggesting that there was minimal genetic exchange among populations. Leave-one-out tests of our baseline dataset indicated a high likelihood that individuals from the lakes would be assigned to their correct population of origin. Nearly all of the individuals collected from Crump Lake were assigned to Deep Creek, a tributary to Crump Lake. Individuals collected from Hart Lake were assigned to both Deep Creek and Honey Creek (a Hart Lake tributary), suggesting that fish were moving between the two lakes. These data provide important information for ongoing Warner sucker recovery efforts and will help to prioritize management actions such as increasing connectivity among tributary populations and reconnecting lake and stream habitat.

Olfactory Imprinting in Embryonic Salmon

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Many hatchery rearing and release practices can dramatically increase the rate of straying by adult salmon returning from the ocean to spawn. Homing is governed by the olfactory discrimination of home-stream water and exposure to the home stream during appropriate juvenile stages is critical for olfactory imprinting and successful completion of the adult homing migration. In particular, the parr-smolt transformation has been demonstrated as a critical period for olfactory imprinting and most hatchery programs use this as a guiding principal for designing release strategies that will return fish to targeted locations. Smolt acclimation and imprinting facilities have been developed as part of most hatchery supplementation programs and hundreds of millions of dollars have been spent for construction, operation and maintenance of these facilities. However, several recent studies have indicated that physical and logistical constraints on where these facilities must be sited relative to appropriate spawning habitat can result in a large percentage of fish spawning in non-target or

inappropriate locations. In this presentation, we examine the process of imprinting at earlier developmental stages and whether early imprinting may provide a new approach for achieving successful imprinting and homing fidelity to target spawning locations. Here, we describe initial experiments demonstrating that salmon embryos can learn and discriminate the olfactory signatures of natural waters and the importance of water source for normal olfactory development. Finally, we describe potential applications of this early imprinting paradigm for several ongoing supplementation programs in the Pacific Northwest.

Spatial and Temporal Overlap of Hatchery and Wild Spring Chinook Salmon Spawning: Effects of Hatchery Acclimation Sites

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Unwanted straying of hatchery salmon into spawning areas utilized by wild salmon can have major ecological and genetic impacts on wild salmon populations. To mitigate for potential negative consequences associated with these interactions, many hatchery reform measures have been proposed or implemented to segregate wild and hatchery adults. On the other hand, most supplementation hatchery programs are specifically designed to integrate hatchery-reared fish with wild adults on spawning grounds to increase the numbers of naturally spawning adults. Off-site acclimation and release facilities have been used extensively in Pacific Northwest hatchery programs to control the distribution of returning hatchery adults to achieve specific management and conservation goals. We examined the efficacy of acclimation facilities for returning salmon to specific locations within a watershed. Specifically, we examined the spatial patterns of homing and spawning by wild salmon and hatchery-reared spring Chinook salmon released from acclimation facilities in the upper Yakima River, Washington. For nine years, we comprehensively surveyed the spawning area of the Yakima River spring Chinook population and GPS mapped every carcass recovered (n=12,851). The results of this study indicated that site of acclimation and release significantly affected the distribution of adult spawning but a large percentage (55.1 %) of hatchery fish were recovered in areas far from their release sites in areas that overlapped with wild conspecifics.

Fish Diets in Upper Willamette Reservoirs

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As a part of a larger study examining impacts to reservoir ecology and food webs in Pacific Northwest reservoirs under modified drawdown regimes, we have been sampling gut contents from incidental mortalities at three high-head upper Willamette reservoirs: Hills Creek, Fall Creek, and Lookout Point, Here we present preliminary findings for the diets of Largemouth Bass, Chinook Salmon and Bluegill across a range of size classes at each reservoir. We then compare these results to those from isotopic analyses and suggest possible drivers of diet composition.

Salmon Behavior during Drought Conditions in Freshwater Creek, Mad River, and Mattole River, Humboldt County, California

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Terry Roelofs

Extreme drought conditions during the winter of 2013-2014 created an unusual situation in the coastal rivers and streams of northern California. Lack of rainfall resulted in extremely low turbidities, allowing for unique opportunities in underwater photography and videography. Under normal winter storm conditions high turbidity normally allows for a few inches of visibility under water. Nearly 60 consecutive days without rainfall created a rare opportunity to observe coho and Chinook salmon, and steelhead trout in conditions with gin-clear water. In addition, due to the prolonged nature of the dry spell, all three species sometimes occupied the same habitats for multiple weeks, resulting in a condition we called "species stacking." This collection of video clips provides a rare view of salmonid behaviors, including holding, cover utilization, competition and spawning.

Acquisition Lessons - Scholfield Creek Acquisition and Enhancement

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The McKenzie River Trust began as a land trust focusing work along the McKenzie River outside of Eugene (as our name implies). In the 26 years since we started, we have expanded our working area to include a number of other watersheds and communities reaching many miles from our home office. One place that we are beginning to work more is the Umpqua watershed. Partnering with the local watershed council (Partnership for the Umpqua Rivers), in 2014 we began working on an acquisition and enhancement project in the small town of Reedsport. The project will require partitioning off the wetland portion of land from three separate landowners including the City of Reedsport and Douglas County. If successful, we will protect over 200 acres of priority tidal wetlands and coho salmon habitat. In 2015, we were awarded USFWS Coastal Wetlands and Oregon Watershed Enhancement Board funding for the acquisition and subsequent enhancement. What our grant did not include was adequate funding to cover the many hours in the community working to build the local trust and support needed to make this project a success. For organizations like ours, seeking to protect and restore critical habitats, establishing a presence in local communities and building trust is critical. We may or may not succeed in completing this project within our grant cycle, however, the time spent in the community and the relationships built are invaluable as we continue with future projects and continuing efforts in and around the Reedsport area.

Who's Your Mama? Population Dynamics of Natural-origin Steelhead in the John Day River (Oregon)

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Ewann Berntson

Jim Ruzycki

Paul Moran

The John Day steelhead Major Population Group (MPG) is distinctive in that it is one of the few summer steelhead MPGs in the Interior Columbia Basin that has had no intentional influence from introduced hatchery steelhead. However, while there is no hatchery in the John Day basin, hatchery introgression has occurred as a result of straying from out-of-basin stocks. Observations of fin-clipped fish on spawning grounds, PIT tag interrogations at McDonald Ford (rkm 33 of the John Day River), and coded-wire tag recoveries suggest that out-of-basin strays make up a significant component of the John Day steelhead spawning population (Ruzycki and Carmichael, 2010). The John Day steelhead MPG was designated by the Interior Columbia Technical Recovery Team (ICTRT) in 2003. The ICTRT identified five putative steelhead populations within the John Day MPG (Upper Mainstem, Lower Mainstem, North Fork, Middle Fork, and South Fork). At the time these populations were identified, however, in-basin genetic information was limited and designations were based primarily on physical parameters, such as basin topography and distance from other spawning aggregates. The purpose of our analysis

was to determine what genetic support exists for the five-population scenario set out by the TRT, and to determine if a genetic signal is evident from the out-of-basin straying. The *O. mykiss* collected from Indian Creek emerged consistently as the only readily-identifiable discrete population in the John Day basin. Belshaw Creek clustered together most of the time; Belshaw Creek showed evidence of cutthroat alleles, indicating hybridization. While individuals with cutthroat alleles were removed from further analysis, their presence suggests that others in these sample groups may also be steelhead/cutthroat hybrids despite the lack of diagnostic alleles. Aside from the Indian Creek population and the Belshaw Creek cutthroat hybrid group, our analyses identified little population differentiation in John Day basin steelhead. Genetic data do not support the five-population system put forth by the Interior Columbia River TRT. While there is genetic structure evident within the John Day basin, the relationships do not correspond to those hypothesized by the ICTRT. When compared to the Columbia Basin steelhead baseline, we found good correlation between these samples and other John Day populations included in the baseline. John Day populations, however, exhibit close affinities with Upper Columbia and Snake River populations. These associations may be the result of Upper Columbia and Snake River fish successfully spawning in the John Day system.

Below the Liquid Line

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This presentation will contain video and still photography featuring juvenile delinquent Chinook, wild adult behavior, naughty *nerka*s, sculpins with attitude and some fish porn. Other highlights will include equipment used in “fish photography” and if I rob a bank what equipment I would buy.

A Warmwater Sampler - Underwater Videos and Pics of Bass+

Eric Engbretson, Engbretson Underwater Photography eric@underwaterfishphotos.com

Rich Grost*

Eric is a specialist in underwater photography of warmwater fish in Midwest lakes and rivers. Along with some surprise footage, he plans to show:
1) How walleyes relate to coarse woody habitat-Videos show how fallen trees in the littoral are used by game fish;
2) How Smallmouth Bass Eat-Amazing videos show the process of how bass catch and eat crayfish (and the circumstances when they refuse to.); and
3) Smallmouth Bass: The first Month-See it all from spawning, to eggs to young fry.

Conservation Decision Making: Integrating the Precautionary Principle with Uncertainty

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The precautionary principle suggests that more conservative actions are prudent when uncertainty is large. Decision-makers often rely on intuition rather than explicit methods to implement the precautionary principle. I demonstrate how Bayesian data analysis produces uncertainty metrics that can be easily blended with a mathematically explicit rendition of the precautionary principle. This results in decisions that are transparent, replicable, and exact. Societal values will often determine appropriate levels of precaution, so methods that elicit input from public stakeholder are needed.

Individual Age Assignment Using Age-length Keys for Small Populations with Overlapping Ages and Small Sample Sizes

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Tim Hoffnagle

One method to assess population age structure in salmonids *Onchorhynchus* spp. is to examine the relation between length and age. The best determination of length-at-age is a known-age (e.g., from scales, otoliths, coded-wire-tags). However, determining known-age for every salmonid is not always possible. Biologists often assign ages to fish that lack a known-age by using an age-length key (ALK). An ALK is developed from a subsample of individuals with known ages and a measured length. This ALK is then applied to the entire population of individuals for which only length is known. The data are grouped into length bins (e.g., 10 mm fork length) containing the numbers of unaged fish and those of known-aged fish, grouped by age. The ALK can then be used to estimate the percentage of individuals in each bin that are of each age, assign ages to individuals, and ultimately estimate population age structure. Problems with ALKs arise when sampling is not random, there is bias in sampling of aged individuals, ages that should be present in the population are missing from the sub-sample of aged-individuals, or known-aged individuals are missing or have insufficient sample size for a given length bin. A few solutions for filling in length bins with missing ages include obtaining a larger sample of aged individuals, increase bin width, use supplemental data (e.g., combine populations or incorporate prior-year's data), use inverse ALKs, or use maximum likelihood procedures to estimate age proportions in unobserved length bins. Our solution uses a finite mixture distribution model and an expectation-maximization algorithm to estimate the proportion, mean size, and standard deviation of each age class present in the population. We use model outputs for proportion-at-age, and the mean size and standard deviation at each age to construct an ALK that is weighted in proportion to the ages present in the population. The final ALK is then used to randomly assign ages back to individuals for any desired length bin. This method helps resolve problems with overlapping age structure and small known-age sample sizes and can be programmed to quickly and efficiently assign ages to any individual based on its length.

Fish Presence/Absence and Stream Habitat in Areas Affected by Sediment from Mount Saint Helens Eruption

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The 1980 eruption of Mount Saint Helens deposited over 3 billion cubic yards of sediment, volcanic ash and other debris in the upper North Fork Toutle River (NTFR) valley. To mitigate the impacts of continual debris loading in the NTFR valley, the U.S. Army Corps of Engineers constructed a sediment retention structure (SRS) soon after the eruption to prevent excessive sediment loads from entering the Toutle, Cowlitz, and Columbia River systems. Construction of the SRS blocked access to historic spawning grounds of coho salmon (*Oncorhynchus kisutch*) and winter steelhead (*O. mykiss*). A fish collection facility was constructed below the SRS to capture and transport these returning adult fish to Alder and Bear creeks, both tributaries of the upper NFTR. The Pacific Northwest National Laboratories evaluated spawning success and rearing in the tributaries during August 2013 through July 2014. Additionally, stream habitat and the migration corridors were evaluated. The current practice of capturing and transporting adult salmonids above the SRS appears to be successful in terms of production of juvenile offspring in the Alder and Bear/Hoffstadt drainages; however, uncertainty remains regarding the overwinter rearing and outmigration success of the juvenile salmonids in these systems.

Let the Fish Do the Talking: Linking Hydrologic Conditions to Fish Phenotypes

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Adaptation to environmental conditions is a cornerstone of population-level resilience. Stream discharge and temperature have long been recognized as key environmental drivers for aquatic biota. Predictable hydrologic conditions over time allow for the development of heritable life history strategies for aquatic species. Pacific Northwest salmonids demonstrate strong adaptive capacity to use available stream habitats, and heritability in the timing of life stage events, such as spawning migration. This adaptive capacity means that Pacific salmon may be able to respond to climate-driven changes in the regional hydrologic template including drought and changes in discharge and temperature. Further, the signal of this response may be detectable in the distribution of behaviors exhibited at a population-level. Here, we propose an empirically based framework of stream temperature and discharge that characterizes the hydrologic regime and through which we may consider life-stage behaviors of salmonids or other aquatic species. We illustrate the use of this framework using fish populations in the North Umpqua River Basin, Oregon. Predictions of future climate effects on aquatic species that do not consider life-stage specific behaviors in the context of the local hydrogeomorphic setting may overlook the importance of species-specific adaptive capacity. Our framework allows for behaviors to be considered within the context of the hydrologic regime, and can identify vulnerability of sections of the population or life stages based on phenology.

Sponsoring Large Scale Restoration Projects on Private Land: A Story of Complex Partnerships and Landowner Relations

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Joseph Smietana

Aaron Bliesner

The Union Soil and Water Conservation District (SWCD) was initiated in 1946 with a mission to assist landowners with voluntary conservation on private land while maintaining the viability of a working ranch. Over the last 70 years a variety of watershed based conservation practices

have been implemented including, spring developments, riparian fencing, grazing management and fish habitat enhancement. With the large scale habitat modifications of streams caused by human actions and the subsequent ESA listing of Chinook salmon, steelhead, and bull trout in the Grande Ronde Basin, the amount of landowners seeking assistance has grown dramatically. Pairing landowner erosion and land use concerns with the appropriate ecological approach and need for listed species recovery led to the creation of a multi-level partnership in the Grande Ronde Basin. This partnership seeks to develop and implement aquatic habitat enhancement projects on private land benefiting both landowners and natural resources. Within this partnership the District acts as a project liaison working to ensure that projects implemented on private land protect the viability of a working ranch while a positive ecological outcome is achieved. Many soil and water conservation districts have very limited resources which makes these partnerships imperative, yet challenging. In 2010, a large scale, multi-phased river restoration project, Catherine Creek 44, involving eight landowners and five regional natural resource partners began when two landowners contacted Union SWCD with streambank erosion concerns. During subsequent meetings concerns of adjacent landowners became apparent. The District hosted a series of outreach meetings involving all adjacent landowners and project partners and by 2011, eight landowners were involved and a 3.8 mile restoration project was underway. The overall goal of the Catherine Creek 44 Project was to restore natural channel function and processes that provide increased spawning and rearing habitat. Many agencies in the Grande Ronde Valley seek restoration opportunities on private land, including The Grande Ronde Model Watershed, Bureau of Reclamation, Oregon Department of Fish and Wildlife, and Confederated Tribes of the Umatilla Indian Reservation. This core group of partners began disseminating existing data and establishing project objectives. Project design was completed with all partners input and funded by the Bureau of Reclamation. Project implementation and monitoring funds have been provided by the above mentioned partners, Bonneville Power Administration, the Oregon Watershed Enhancement Board, and the Fish and Wildlife Service. The partnership continues to establish and implement projects throughout the Grande Ronde Basin and strives to improve and expand existing partner relationships. In order to achieve long term recovery goals on private land in the Grande Ronde basin it is imperative these partnerships continue to evolve and persist.

How to Set Watershed Restoration Priorities: The Importance of Using both Ecological and Socio-Economic Criteria

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A fish habitat restoration plan was developed for six coastal streams in Coos Bay, Oregon, U.S.A. using both watershed assessments and landowner involvement. A high level of public participation was a characteristic of this process, and a key to its success. Because stakeholders who own riverbank properties are extremely important to the successful implementation of a restoration plan, we took a “neighbor-shed” approach to public involvement. The targeted public involvement we used consisted of a series of “coffee klatches” designed to attract as many landowners as possible within each of the six basins. The initial meetings, used to present the “state of affairs” in each watershed, were followed by field trips to show habitat restoration projects. A second round of coffee klatches and a workshop with an expert panel were used to prioritize restoration actions. A restoration prioritization scheme was developed incorporating both an "ecological filter" (with 6 ranking criteria such as: watershed processes, limiting factors, etc.) and a "socio-economic filter" (with 7 criteria such as: cost of project, landowners concerns, likelihood of funding, etc.) to rank all possible restoration actions in each watershed. Depending on their combined priority scores, the various restoration actions were subsequently assigned to four categories: "go ahead", "proceed with caution", "interesting but…", and "not at this time". The resulting draft restoration strategy was presented to the landowners for their feedback. That ‘calibration’ helped developed a more advanced restoration plan that has been well received by many key stakeholders, as landowners indicate their willingness in signing up for restoration projects. Surveys indicated that landowners liked the targeted approach and supported restoration they would not have supported otherwise.

The Punctuated Seaward Migration of Pacific Lamprey: Environmental Cues and Implications for Streamflow Management

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We investigated emigration timing of juvenile Pacific lamprey (*Entosphenus tridentatus*) over a 10-year period in the Sacramento River, California, USA. Emigration was punctuated with 90% of macrophthalmia in daily catches of at least 50 individuals. Macrophthalmia were observed primarily between November and May, with among-year variation in median emigration date over four times that of sympatric anadromous salmon. Our best model associating catch and environmental factors included days from rain event, temperature, and streamflow. We found strong evidence for an association of catch with days from rain events, a surrogate for

streamflow, with 93% of emigrants caught during an event and the two subsequent days. Emigration was more likely during nighttime in subdaily sampling, after accounting for the effects of factors significantly associated with daily catch. These results emphasize the importance of natural variation in streamflow regimes and provide insight for management practices that would benefit emigrating lampreys, such as synchronizing dam releases with winter and spring storms to reduce migration time, timing diversions to avoid entrainment during emigration windows, and ensuring streamflows are sufficient to reach the ocean, thereby avoiding mass stranding events.

Willamette River Report Card: Challenges in Accurately Communicating Fish Community Information

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The Willamette River Initiative of the Meyer Memorial Trust released the Willamette River Report Card in December 2015. A team of natural resources practitioners and scientists collectively developed the Report card over 2 years. The Willamette received a grade of B- overall and a B, B, and C+ for the upper, middle, and lower reaches of the river, respectively. Data on fish provided 4 of the 15 metrics used to grade the health of the river. But how do you put a grade on fish data? How do you communicate accurately without being overly simple or confusing? Data from a 3-yr monitoring projects were used to describe native fish abundance and ratio of native to non-native fish. We faced challenges in scaling the observations of different reaches and making the information understandable to the public. Number of juvenile Chinook salmon captured in standardized seining by ODFW was used, but again there are challenges in interpreting presence information for a species that is migrating downstream. Number of fish consumption advisories was used as a metric, but social and regulatory nuances make the information difficult to use as a metric. In addition, water quality metrics were used, and temperature was one of the most important and potentially confusing metrics of the Report Card. The results and technical challenges of each of these aquatic metrics will be described. But one of the greatest challenges of the Willamette River Report Card was assigning a grade to quantitative data on fish communities. What is an A? Or F? Are we communicating effectively to a diverse public or are we simply confusing them? Is the Report Card accurate and defensible? Does it convey more hope than is warranted? What will be the outcome? If we are brokers of information in today's world of environmental issues, we must face the challenge of effectively brokering rigorous scientific information to diverse audiences of citizens and decision makers.

Fish Video from Soda Springs Fish Ladder Window and Tailrace Barriers

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Robyn Rice

For the past year, Soda Springs (North Umpqua River) Fish Ladder and Tailrace Barrier have been evaluated by Meridian Environmental (Seattle, WA) using video systems to document fish behavior. Video at the fish ladder was shot through a window (24/7/365), while that at the tailrace barrier was shot via submerged underwater cameras (340 hours of seasonal subsampling). This presentation will cut through the "dead tape" and show only the highlight clips of interesting fish, behaviors, predation, and ancillary critters. Discussion relating to video systems for other similar studies and at other fish ladders would be welcome.

Spawn Porn Videos - Steelhead and Chinooky

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Adults only. This entry into the Spawn Porn Contest includes sequences of egg fertilization and burial by wild naked steelhead and spring Chinook salmon in the North Umpqua River. [Insert your own joke about a pole.]

Regional Patterns in Spring/summer Chinook Salmon and Steelhead Freshwater, Ocean, and Smolt-to-adult Survival Rates

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Salmon and 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 will present mark-recapture estimates of in-river survival, ocean survival, and smolt-to-adult return rates for spring/summer Chinook salmon and steelhead populations from the Yakima, John Day, and Snake Rivers and examine how these survival rates vary over time and with environmental factors. Through simulation studies that characterize these patterns of variability, we will explore survival targets and environmental conditions that may be necessary to support population recovery.

Modeling Juvenile Spring Chinook Salmon Survival in the Middle Fork John Day River Basin

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James Ruzycki

Freshwater survival and productivity of spring Chinook salmon *Onchorynchus tshawytscha* is often influenced by both density dependence and abiotic factors. As part of an Intensively Monitored Watershed, we are identifying factors limiting freshwater survival of juvenile Chinook salmon and evaluating short-term effects of stream restoration in the Middle Fork John Day River. We collected and PIT tagged Chinook parr using an open population mark-recapture study design from 2011 to 2014. Each year, we incorporated four occasions with intervals from July through October at ten sites throughout the basin. Preliminary results show apparent survival varied by year, interval, and stream. Current analyses use recaptures of Chinook parr within the basin to estimate apparent survival between discrete capture occasions. We are testing multistate survival models that include covariates for brood year redds, stream temperature, and stream flow to determine which factors influence true survival of Chinook parr in the basin. Recaptures of PIT-tagged parr from repeated sampling occasions and detections of smolts throughout the Columbia River basin were used to estimate true survival rates of marked fish. Model fit based on AICc scores were then used to determine which models best described the true survival rates of Chinook parr in the basin.

Should I Stay or Should I Go Now? Resident and Migratory Life History Behaviors of Cutthroat Trout in the Long Tom River Basin

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Jed Kaul

Cutthroat trout (*Oncorhynchus clarki*) are ubiquitous to the rivers and streams of the Willamette Valley. While the basic life history of these fish is known, the details of their life cycle are not fully understood. In 2010, the Long Tom Watershed Council and Oregon Department of Fish & Wildlife (ODFW) initiated a study to examine the seasonal migration behavior of cutthroat trout in the tributaries to the Long Tom River downstream of Fern Ridge Reservoir. The goals of the study are to determine the proportion of fish exhibiting migratory or resident life-histories, to characterize the seasonal migrations (timing and duration) of these fish, to evaluate the effect of fish passage barriers on life history behavior, and to estimate the cutthroat trout population in the tributary watersheds. For our study, we captured cutthroat trout in multiple locations in Schafer, Rattlesnake, Amazon, Ferguson, and Bear/Owens Creeks, and at Monroe Dam on the Long Tom River. Fish were captured with stationary traps, seining, and electrofishing. Cutthroat trout over 12 cm were tagged with a 23 mm half duplex Passive Integrated Transponder (PIT) tag. In addition, a fin clip was collected from tagged fish for

genetic sampling. The fish were recaptured with traps, seining, and electrofishing, and re-sighted with PIT tag array stations. Using recapture and re-sight data, we observed cutthroat trout migratory patterns between tributaries. One major conclusion from our work is identifying tributaries that cutthroat trout are likely using for refuge and rearing verses primarily for spawning in the headwaters. This has allowed us to better focus habitat restoration work where it is most needed.

Translocation and Mobile PIT Tag Tracking for Effectiveness Monitoring of Road Crossings

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Low rates of passive movement by fish can limit the utility of PIT tags to evaluate fish passage through road crossings. To have an adequate number of detections for analysis, antenna arrays often need to be maintained for months. This requires regular maintenance of readers and antennas sometimes during high flow events. By using mobile tracking of fish above and below the crossing, stationary antennas and readers can be reduced or eliminated. By moving fish upstream of the crossing to below and downstream fish above the crossing (translocation), movement rates are dramatically increased; resulting in more detections and shortened study time. Significant results were achieved at a fraction of the time and cost. Are the manipulations of fish and relaxed assumptions for analysis a fatal flaw or can this methodology be used for simplified, cost effective monitoring?

Effects of Modulating Ration and Dietary Lipid on Smolt Quality and Adult Returns of Umatilla River Yearling Fall Chinook Salmon

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The Umatilla River yearling Fall Chinook salmon hatchery program produces approximately 900,000 smolts annually. An estimated 42 to 79% of all observed returning males from this program are minijacks, returning just months after being released as smolts. A production scale experiment was carried out to compare the standard feeding regime with other regimes incorporating modified lipid levels and feed rations in attempt to reduce minijack rates while maintaining acceptable adult returns. This 2x2 factorial experiment was conducted at Bonneville Hatchery, Oregon for brood years 2010-2013. Fish were fed High (18%) or Low (12%) fat diets at High (7days/week) or Low (4 days/week) ration levels from April through November, after which all groups received the standard High Fat-High Ration diet until release in March. Fish size, gill Na+/K+-ATPase activity, and percent solid (a surrogate for body lipid) were monitored routinely during the experiment. Early male maturation was determined just prior to release by measuring the reproductive androgen, 11-ketotestosterone. To evaluate post-release performance, all fish were coded-wire-tagged (CWT) and a subset from each rearing group received PIT tags. Non-standard feed treatments successfully altered growth, body lipid, smolt profiles (via ATPase) and early male maturation. Early male maturation was highest in the standard production (High-High) fish each year and lowest in the Low Lipid-Low Ration fish. High-High fish had highest body lipid and ATPase levels in the autumn and the lowest ATPase level in the spring. These data suggest that reducing growth rates and lipid accumulation through autumn reduced precocious male maturation and improved smolt development. Adult return data is incomplete for some release years but early trends show that diet manipulation reduced the numbers of minijacks and increased the proportion of fish returning at older age classes. In hatchery Chinook salmon there are tradeoffs between rearing large smolts to increase survival and decreasing size to reduce early male maturation. As more adult return data becomes available, we will have a better understanding of which rearing regime provides the optimal balance between these competing processes.

Hot Sex Isn't Always Good Sex: Decreased Reproductive Capacity in a Warmer Ocean

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Selina Heppell

Reproduction of iteroparous fish is often modeled to be an annual event for exploited stocks, but growing evidence demonstrates that this is not always the case; environmental variability, and in particularly energy (food) availability and temperature can have a substantial impact on the decision to spawn. The environment in the northeast Pacific is predicted to change substantially over the next several decades, with elevated temperature being one of the fundamental results; altered physiology in the form of increased metabolic rate will likely result in the need for energy allocation trade-offs, while altered phenology associated with temperature change may create mismatch between offspring and food. Of primary concern for fishes under a changing climate scenario is a potential reduction of or increased variance in reproductive capacity, with subsequent impacts on recruitment. Abortive maturation (a form of 'skip spawning') in rockfishes can be as high as 40% in some years, and experimental work has demonstrated that increases of as little as 1.5^{o}C can result in reduced reproductive output in other fishes both in terms of egg and sperm production and decisions to forego reproduction. While these impacts all occur at the level of the individual, all populations are collections of individuals and therefore these impacts can scale up to have population-level effects. Therefore, alterations of individual reproductive capacity may ultimately impact fundamental parameters of management importance such as age at maturity and the stock-recruitment relationship. If such negative changes are the norm for the future, then we have a direct need to understand the specific impacts that such changes will face. We are currently presented with an historic opportunity to conduct an event-for-time replacement study, where the El Niño in the northeast Pacific allows us to conduct a short-term in situ proxy evaluation of how long-term warming trends may affect marine species. In this talk I'll review the state of knowledge regarding skip spawning and the environment as well as our ongoing work to evaluate how predicted future ocean conditions may affect the reproductive capacity of an economically important nearshore species on the west coast.

Why Manage for Life History Diversity? What a Big Old Fat Female Can Do For You

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Linsey Arnold

Life history theory tells us that long-lived teleosts are "bet-hedgers"; each year they play the odds of environmental variability by producing large quantities of offspring with an expected low probability of reproductive success in any given year. When conditions are favorable, a small increase in the larval survival rate can result in a strong year class. Achieving these strong year classes may require larvae to be produced at a particular time or place that promotes survival. Biologists have argued for many years whether the age structure of long-lived species, such as Pacific rockfishes (Sebastes), has an effect on these productivity parameters and therefore the stability of populations. Older female rockfish have been shown to release their

larvae earlier and over a longer season than younger individuals, and may also provision their larvae with more energy reserves. If the optimal time and location are unpredictable, a diverse and well distributed spawning population may hold the key to successful, or at least, less variable, year class production. The value of life history diversity has long been recognized in salmonid management; now it is time to extend these concepts and recovery criteria to marine fish stocks. Management that promotes a diversity of age classes and spatial distribution of the stock may support populations with greater productivity and lower variance.

A Fish Inventory of Bull Trout Critical Habitat in Annie Creek, Upper Klamath Basin, Oregon

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Annie Creek, a tributary of the Wood River and the largest watershed in Crater Lake National Park, historically contained native bull trout and redband trout. The lowest eighteen kilometers of the stream, between the confluence with the Wood River on private ranchland and an impassable waterfall in the national park, were designated as critical habitat for ESA-listed bull trout by USFWS. We used a combination of electrofishing and environmental DNA analysis to characterize the fish community at sites distributed systematically throughout this reach. Native redband trout, Pit-Klamath brook lamprey, slender sculpin, and speckled dace were present, as were nonnative brook trout, brown trout, and fathead minnow. Large brown trout were observed in the stream during early autumn, presumably migrating from the Wood River to spawn. We did not detect bull trout anywhere in the system, and only nonnative salmonids occurred at sites inside the national park. All the native species occurred in the lower section of the reach on private cattle ranches, which were characterized by heavy grazing, highly degraded stream habitat, and little or no riparian vegetation. Multiple irrigation diversions in the lower watershed likely limit the movement and distribution of native fish, particularly redband trout. This exploratory work — the first systematic fish survey of Annie Creek since 1989 — suggests bull trout presently do not occupy critical habitat in the drainage and highlights opportunities for native fish restoration projects, including screening, passage improvement, fencing, and riparian planting on private land. Additionally, we found environmental DNA analysis for salmonids corroborated electrofishing results and required much less sampling effort, affirming the utility of this emerging method for studies of fish distribution in streams.

Copepod Effects on Swimming Endurance in Juvenile Chinook Salmon (*Onchorhynchus tshawytscha*)

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Juvenile Chinook salmon (*Onchorhynchus tshawytscha*) migrations through the Upper Willamette River Basin are interrupted by reservoirs and dams, where they are infected at high prevalence by parasitic copepods (*Salmincola californiensis*). This study aims to determine if being parasitized by these copepods reduces the fish's ability to survive their migration to the ocean. Hatchery fish were reared at the Fish Performance and Genetics Laboratory (FPGL) in Corvallis, OR. Hatchery fish were exposed to copepods multiple times over the course of two months. Fish were collected from the wild below Cougar Dam in the South Santiam River and transported to the FPGL. Infected and non-infected juvenile Chinook salmon were put through an endurance challenge to determine impact of infection intensity on swim time. Fish infected with copepods had significant areas of gill tissue damage and fin erosion. Infected fish performed poorer than fish without the infection in the endurance challenge. Mortality rates in naturally reared fish were exceptionally high over a two week holding period at the FPGL. Copepods impinge on the fish's health, ability to swim for long periods of time, and ability to recover after transportation.

Complete Watershed-Level Restoration Treatments of Camp Creek

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Camp Creek, a 13,489 acres basin located approximately five miles south of Scottsburg, Oregon, has been heavily impacted by past land-use practices. Camp Creek provides important summer and winter habitat for Chinook salmon, Oregon Coast coho salmon, steelhead, and cutthroat trout. However habitat is currently limited by large amounts of bedrock, lack of wood, poor riffle and pool ratios, and poor pool depths. Combined base-wide restoration efforts by the Partnership for Umpqua Rivers, Roseburg Resources Company, Coos Bay District Bureau of Land Management, Oregon Department of Fish and Wildlife, and the Umpqua Soil and Water Conservation District have accomplished 8.5 miles of stream restoration from 2013-2015 with 4 more miles of restoration scheduled for 2016. Phase 1 resulted in 185 logs and 150 boulders being placed into Buck Creek, a major tributary to Camp Creek. Phase 2 was implemented using a helicopter which placed 133 whole trees, 32 trees with root wads and fifty-six 30 foot logs in three tributaries of Camp Creek. The goal of the first two phases was to increase spawning habitat for coho salmon and steelhead. Phase 3 resulted in 46 sixty foot logs and 2500 boulders being placed into mainstem Camp Creek. If funded the final phase with be completed in 2016 where 60 logs and 3,500 boulders will be placed throughout 4 miles of mainstem, for a total of 12.5 miles and a total cost of $1,360,668.

A New Chapter in the Salmon River Story

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Estuaries provide critical habitat for many economically and culturally important species including Dungeness crab, pacific oysters, and all species of Pacific salmon. However, most estuaries have been significantly altered by humans over the past century, reducing the quantity and diversity of available habitats and compromising their long-term capacity to respond to climate change. An exception to this general rule can be found at the Salmon River Estuary, Oregon, where the Siuslaw National Forest has spearheaded restoration efforts, making this estuary the most restored on the Oregon coast. Multi-goal restoration of diked and ditched salt marsh habitat has occurred over decades and focused on restoring native plant communities, hydrologic connectivity, benthic ecosystems and fish habitats. The last significant restoration project was completed in 2015. While the Salmon River watershed is relatively small, it is large enough to support a diverse complement of anadromous salmonids, yet is small enough to allow for complete juvenile and adult population assessments basin-wide. This makes Salmon River an ideal location to evaluate how estuary restoration effects populations of salmonids. We will review the estuary restoration that has occurred at Salmon River, and the important research that has already been done there linking salmon life history to estuary habitats. We will also present ongoing research that is intended to evaluate fish response to restoration and contribute to our understanding of ecosystem resilience.

Trends in Age Composition and Correlations between Parental and Offspring Ages in Hatchery and Natural Imnaha River Chinook Salmon

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We examined age composition of hatchery- and natural-origin Imnaha River Chinook Salmon *Oncorhynchus tshawytscha* spawners and their offspring. We looked for trends in age

composition of hatchery and natural salmon from BY 1982-2010 and correlations between age and sex composition of parents spawned at Lookingglass Hatchery or in nature versus the proportion of age and sex at maturity of their offspring. For both origins, proportions of age 4 females increased ($P < 0.0014$) over the 29 brood years while those of age 5 females declined ($P < 0.0009$). We found no trend ($P > 0.1903$) in proportions of ages 3 or 4 males ($P > 0.185$). Age 5 natural males declined ($P = 0.024$) but not age 5 hatchery males ($P = 0.210$). For salmon spawned at Lookingglass Hatchery, proportions of age 3 spawners were not correlated with the proportion of any age class of recruits ($P > 0.058$). Proportions of age 4 male and female hatchery-origin spawners were negatively correlated with proportions of age 5 females ($P = 0.044$; $\rho = -0.399$) but proportions of age 4 natural-origin spawners were not correlated with those of any age class of recruits ($P > 0.097$). Proportions of age 5 spawners were negatively correlated with proportions of jack recruits ($P < 0.026$; $\rho > -0.435$) and positively correlated with proportions of age 5 recruits ($P < 0.024$; $\rho > 0.443$). For salmon spawning in nature, increasing proportions of hatchery-origin jacks were correlated with decreasing proportions of age 5 female recruits ($P = 0.016$; $\rho = -0.466$) and increasing natural-origin jacks was correlated with increasing age 4 female recruits ($P = 0.039$; $\rho = 0.408$). Increasing proportions of age 4 hatchery spawners were correlated with increasing jack recruits ($P = 0.002$; $\rho=0.589$) and decreasing age 5 recruits ($P < 0.023$; $\rho > 0.444$). Age 4 natural spawners were not correlated with age or sex of any recruits ($P > 0.193$). Increasing proportions of age 5 hatchery spawners were correlated with decreasing age 4 male recruits ($P = 0.045$; $\rho > 0.396$) and increasing age 5 recruits ($P < 0.049$; $\rho > 0.390$). Increasing proportions of natural age 5 spawners were correlated with decreasing jack recruits ($P < 0.003$; $\rho > -0.498$) and age 4 recruits ($P < 0.011$; $\rho > -0.493$) and increasing age 5 recruits ($P < 0.001$; $\rho > -0.648$). Overall, increasing proportions of hatchery salmon (all ages and both sexes) in the spawners was correlated with decreasing proportions of age 5 female recruits for both spawning at Lookingglass Hatchery and in nature ($P < 0.040$; $\rho > -0.406$). Age composition of the Imnaha River Chinook salmon population is becoming younger, as increases in jack and age 4 returns are at the expense of age 5 returns. This shift seems to be related to hatchery practices, which is counter to program goals and objectives. Management actions should be taken to correct this change and could include reducing smolt size, altering hatchery growth trajectories and/or re-using age 5 males in hatchery spawning.

Modeling Water Quantity and Depth as a Measure of Juvenile Salmonid Habitat Quality during Reduced Summer Flows in Catherine Creek

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Summer irrigation withdrawals from Catherine Creek, a tributary to the Grande Ronde River in NE Oregon, reduce stream discharge to levels below natural baseflow on an annual basis. This impacts suitable rearing habitat for ESA listed juvenile Chinook salmon and steelhead

downstream of the town of Union, OR. However, we have observed very high densities of those same fish during summer snorkel surveys in that stream reach. One proposed restoration action is to purchase instream water rights to improve summer rearing habitat in this reach. To assess impacts of stream flow on the amount quality rearing habitat, we utilized 10 cm digital elevation models from four reaches of Catherine Creek to model water quantity and depth at a variety of discharges (2-100 cfs). We considered depth to be the primary indicator of juvenile salmonid habitat quality for this exercise. Models from all four reaches showed a similar logarithmic-shaped curve for discharge vs. water quantity metrics, and best-fit regressions were very strong. At low flows common in summer (5 – 30 cfs), little change in overall wetted area was observed in our model. However, at flows 10cm deep, a low-end threshold for juvenile Chinook salmon habitat quality, was similar to wetted area, showing rapid declines below 6 – 7 cfs. Wetted area >20cm deep, a higher-end habitat quality threshold, declined significantly when flows were below ~30 cfs. Discharge below Union, OR is generally 4 – 5 cfs during late July and August. Discharge is closer to 15 cfs above a pair of irrigation diversions in town, and nearly 30 cfs above a diversion further upstream. If 10 cfs of this water could be conveyed downstream of Union, we would expect to see nearly a doubling of >20cm deep habitat (high quality rearing), and a trebling if all 30 cfs remained in the stream. Increased water volume and area would likely reduce crowding of juvenile salmonids in downstream reaches. It would also increase wetted areas for macroinvertebrate production (e.g. fish food) and may mitigate temperature stress during the hottest period of the year.

A Coast Wide Evaluation of Inter-annual Genetic Variation of Dungeness Crab (*Cancer magister*)

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While the effective management and long term viability of a marine fishery is often contingent on the precise delineation of population subunits and the connectivity among them, these characteristics are difficult to define by direct approaches. Using a population genetics approach has demonstrated to be a powerful tool in providing indirect estimates of connectivity in a variety of marine species. This paper provides the foundation for a multi-year study employing population genetic analysis to investigate inter-annual variation in population connectivity of the most valuable commercially harvested species on the west coast, the Dungeness crab (*Cancer magister*). We sampled adult crabs at 33 locations along the Washington, Oregon, and California coasts in 2012 and 2014, and 4 sites within Puget Sound in 2015. Individuals were genotyped at ten microsatellite loci to assess genetic differentiation between sampling locations. While overall genetic structure appears to be relatively weak (FST:

0 – 0.0099), a coast wide gradient of genetic connectivity strength was evident. A highly significant correlation of isolation by distance (p = 0.001) suggests that genetic connectivity is greater between neighboring sites than geographically distant sites. Taken together, our results provide sufficient evidence to indicate that the Dungeness crab population in the California Current System and Puget Sound is not panmictic, though we were unable to detect discrete population subunits. Through ongoing research, we will be able to examine inter-annual variation in genetic connectivity to provide a more complete ecological understanding of Dungeness crab. Our findings will also contribute to the continued sustainable management of this fishery and aid in marine spatial planning efforts, potentially including the implementation of ecosystem-based management.

Evidence of Parasite Associated Mortality in Shortnose (*Chasimistes brevirostris*) and Lost River Suckers (*Deltistes luxatus*)

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Shortnose Suckers (*Chasimistes brevirostris*) and Lost River Suckers (*Deltistes luxatus*) are endemic to the Upper Klamath Basin of Southern Oregon and Northern California. Upper Klamath Lake, the primary habitat of both species, is hypereutrophic and an important source of irrigation water. Populations of these fishes have been dwindling since the 1960s, and both species where put on the endangered species list in 1988. Poor recruitment of juvenile fish is thought to be a major factor for their demise and there is evidence that there has not been strong recruitment since the early 1990s. Pathogens are recognized as causes of mortality in many wild fishes, particularly in altered environments. In the summers of 2013 and 2015, we conducted histopathological examinations of age-0 and age-1 suckers. We saw heavy infections with trematode metacercariae (*Bolbophorus* in the skin and muscle and *Posthodiplostomum* in the viscera), but one of the most severe infections was a heart infection by L3 larval stage nematode *Contracaecum*. These worms are large and a single worm can fill most of the heart. We also found the worm in other fishes in the lake, particularly in the abundant Fathead Minnow (*Pimephales promelas*), which had about 20% prevalence in 2015. We suspect that this worm debilitates young fish, increasing the probability of predation compared to un-infected fish, but have yet to quantify the impact. We are also using genetics of 28s rDNA to identify intermediate and final hosts. Based on 28s rDNA sequence, the heart worm is likely *C. multipapillatum*, which has a copepod as an intermediate host and pelicans as definitive host. We have also found a huge diversity, about twenty species, of infectious trematode cercariae from snails including cercariae species of *Posthodiplostomum*, but not for *Bolbophorous*. We plan to conduct further PCR surveys of local snail and bird populations to complete the

lifecycles for these trematodes. We are also using our data to conduct well established methods to elucidate the role of these parasites with poor survival in these endangered fishes.

Effects from Dams on the Outmigration of Juvenile Chinook Salmon and Steelhead in the Upper Willamette River, Oregon

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Spring Chinook Salmon (*Oncorhynchus tshawytscha*) and winter steelhead (*O. mykiss*) from the Upper Willamette River are both listed as threatened species under the U.S. Endangered Species Act. Recovery plans for these species include reintroductions to habitat above high-head dams, and juvenile passage adequate to allow population growth and persistence. To evaluate the effects from existing dams and reservoirs on juvenile outmigration, we released large numbers of PIT-tagged juvenile Chinook Salmon and steelhead above and below Willamette Project dams during five consecutive years. Effects from dams and reservoirs on juvenile outmigration success and timing appeared to differ considerably between study sites, but were relatively consistent across years. We discuss our findings in the context of ongoing population recovery efforts.

Water Quality Monitoring Data as a Tool to Community Engagement and Habitat Assessment

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The Tillamook Estuaries Partnership (TEP) has developed a robust water quality monitoring program in the north coast of Oregon. TEP's monitoring effort focus on key pollutants of concern, many of which address native fish lifecycle requirement, such as temperature, dissolved oxygen, sediment, and toxics plus bacteria. TEP has found that providing this information to local land owners and natural resource agencies in an understandable format has been an invaluable communication tool. As the communities understand what is occurring in rivers, streams, and estuaries and how this impacts human health and aquatic life, TEP has found that participation and investment in solutions has increased. TEP's water quality monitoring programs is a long term effort, some components of which have been occurring for over a decade. An additional benefit from implementing long-term and sustained monitoring is the ability to communicate water quality changes over time. As communities and agencies beginning to wonder if the efforts and resources they've committed to restoration are making a difference, the water quality data once again becomes an extremely useful tool to keep partners engaged and moving forward. Another successful technique that TEP has employed in its monitoring program is the use of local volunteer to collect data. Using local volunteers lends

credibility to the information and results of the monitoring program in communities where even basic science can be suspect. TEP would like to present a summary of the type of data collected through their monitoring program and how it has been used to engage the local communities in salmon and other environmental restorations and management efforts.

An Expert Process to Evaluate Restoration Actions in the Lower Columbia River and Estuary

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Changes in the Columbia River (Pacific Northwest USA) basin, including hydropower development, have contributed to the listing of 13 salmonid stocks as endangered or threatened under the U.S. Endangered Species Act. Habitat restoration in the lower Columbia River and estuary (LCRE, from Bonneville Dam [head of tide at rkm 233] to the ocean) is part of a basin-wide, mandated effort to mitigate the effects of federal hydropower development on salmon survival. An Expert Regional Technical Group (ERTG) was established in 2009 to evaluate the potential response of juvenile salmonids and assign survival benefit units (SBUs) to proposed restoration actions. The ERTG standardized the process for restoration action evaluation to improve scientific integrity, repeatability and transparency. The SBU results are used to select restoration projects and assess progress towards mitigation. The SBU concept assumes restoration actions will increase juvenile survival and adult salmonid returns. However, estimating the survival benefits of habitat restoration actions is challenging. The ERTG adapted the conceptual framework of Simenstad and Cordell (2000) by developing an algorithm to integrate potential fish density as an indicator of performance with opportunity and capacity envisioned by the project design to assign SBUs. We also developed criteria describing how project attributes influence SBU scores. We have reviewed 55 proposed projects with a total of 181 restoration actions located across eight reaches of the LCRE. Most restore tidal inundation to emergent wetlands, improve riparian function, and remove invasive vegetation. Uncertainty of geomorphic and salmonid responses to restoration actions remain our foremost concerns. However, the ERTG process of reviewing and estimating SBUs has resulted in the funding of restoration projects that are more likely to benefit salmon survival. The ERTG process may be a useful model for others with similar goals and challenges.

Fine Sediment and Stream Temperature Controls on Larval Lamprey Habitat in the Umpqua Basin, Southwestern Oregon, U.S.A.

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Physical and biological interactions at multiple spatial scales shape the ranges of habitats, species, and life stages that a river can support. Understanding these processes within a hierarchical context for Pacific Northwest rivers may be helpful for proactive monitoring and restoration of native western brook lamprey (*Lampetra richardsonii*) and Pacific lamprey (*Entosphenus tridentatus*). To that end, our study had developed a preliminary landscape-screening framework to identify potential rearing habitat for larval lamprey in the Umpqua River basin, southwestern Oregon. This framework accounts for fluxes of suspended sediment that ultimately form larval burrowing habitat as well as current and projected stream temperature conditions and anticipated distributions of lamprey predators. Collectively, the results of this work aid in understanding the critical controls on habitat availability for larval lamprey within river networks and identifying strategic management and habitat restoration opportunities.

Migration Behavior of Hatchery Steelhead Smolts from an Integrated Broodstock: Implications for Ecological and Genetic Risks

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Hatchery steelhead migration behavior upon release can determine the type and magnitude of ecological and genetic risks posed to the receiving wild populations. To evaluate the success or failure of conservation hatchery programs, we determined the relationship between migration behavior and ecological and genetic risks posed by an integrated steelhead hatchery on the

lower Columbia River. Over the course of seven years, an average of 62% (range 50-78%) of released hatchery steelhead smolts were estimated to have migrated rapidly downstream upon release. Whereas, an average of 3% (range <1-7%) of released hatchery steelhead did not migrate and instead residualized over the summer. Of the residualized fish 72% were found in snorkel reaches just upstream and downstream of the release location. This migration behavior combined with evidence of behavioral interactions, habitat use overlap and diet similarities between hatchery and wild steelhead suggest negative ecological effects may be present near the release site. We recommend that hatcheries producing steelhead should assess migration dynamics of released steelhead. Risk reduction through the use of electrofishing to remove residuals, volitional release methods, and weirs to prevent upstream migration may be warranted.

Salmon Life Histories and Environment Effect Modes of Transmission of Pathogens

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Pathogens employ are variety of modes of transmission to optimize their survival and persistence within host populations, using optimal approaches for particular environmental conditions. The environment can be defined as both the conditions within their hosts as well as the external (outside) environments. Host/pathogen interactions in salmonid fishes provide many examples of this, given their anadromous and semelparous life strategies. The vast majority of our understanding of pathogen virulence and transmission has been gleaned from research of captive (e.g., hatchery) salmon during their freshwater development. Hatcheries have been around for only 100 years or so, but salmon have co-evolved with their pathogens much longer, perhaps millions of years. We will discuss examples of alternate modes of transmission and severity of disease, contrasted to their presentations in a hatchery situation. First, it is apparent that adult salmon that have returned to freshwater to spawn are often the primary, or at least a very important host, for certain parasites such as *Nanophyetus salminicola* and *Ceratonova shasta*. Second, some pathogens that can be easily transmitted directly from host to host under crowded conditions (e.g., hatcheries for fish, cities for humans), but in the wild or rural environments their transmission relies on invertebrate vectors – e.g., *Cryptobia salmositica* of salmon and the plague bacterium in humans. Also, we have preliminary evidence that *Aeromonas salmonicida* may use gill copepods *Salmincola californiensis* as vectors for this bacterium that is normally transmitted directly from fish to fish in captivity. Regarding virulence, predation is a primary cause of mortality in wild fish, but is seldom so in hatcheries. Hence, pathogens that may be considered only as an occasional nuisance in hatchery-reared fish (e.g., metacercariae of *Nanophyetus salminicola* and other metacercariae) may cause

significant parasite-associated mortality in certain populations of wild salmon in Oregon. In conclusion, much can be learned regarding transmission and virulence of salmonid pathogens based on data from captive fish, but these data are not necessarily directly applicable to wild fishes.

Investigating the Effects of Invasive Reed Canarygrass on Juvenile Chinook Salmon in the Upper Columbia River Estuary

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Thirteen native Columbia River salmon stocks are listed under the Endangered Species Act, impacting one of the Pacific Northwest's most important recreational, commercial, and subsistence fisheries. Both juvenile Chinook and coho salmon utilize wetlands for rearing habitat; therefore, many resource managers in Oregon and Washington are working, in compliance with the Federal Columbia River Power System Biological Opinion, to restore tidal wetland habitats. Reed canarygrass (*Phalaris arundinacea*) (PHAR) is a highly invasive perennial grass that affects a number of wetlands throughout the Columbia River estuary and is both difficult and costly to remove. PHAR is the most dominant species at the site of this study, Multnomah Channel Marsh, a restored wetland along Multnomah Channel. The presence of PHAR undoubtedly reduces plant diversity, but how it impacts juvenile salmonids is unclear. To better inform salmon recovery and estuary restoration, this study elucidates the role of PHAR and its effects on salmonid rearing habitat as indicated by invertebrate prey availability and salmon performance (i.e., feeding and growth). We compared relative growth potential and feeding success of hatchery-raised juvenile Chinook salmon placed in experimental pens on floodplain microhabitats dominated by PHAR and by natural emergent vegetation (i.e., *Carex aperta*). Invertebrate prey compositions from the 2015 (March-June) fallout and emergence traps were similar, but salmon growth during the net pen experiment differed significantly between the two vegetation types. The average density (per m2) of invertebrates in the emergence traps in the natural emergent vegetation and in PHAR was 995 (±369) and 1,415 (±825), respectively, and for the fallout traps was 3,574 (±1,085) and 4,133 (±1,599), respectively. Juveniles grew an average 6.4 mm in the natural emergent vegetation compared to only 4.7 mm in PHAR, and consumed more zooplankton and fewer dipterans in PHAR over the 10 days. Sampling will continue in the spring of 2016 to better understand the initial growth differences detected. Although restoration of tidal wetlands is important for improving degraded conditions in the Columbia River estuary, it is uncertain whether additional changes in the ecosystem (e.g. spread of invasive species) will limit the effectiveness of wetland restoration for juvenile salmon habitat and recovery.

Movement Variability and Fine Scale Morphological Differences within a Cave Dwelling Dwarf Arctic Charr Population in Iceland

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Quantifying the way individuals move around and utilize their habitat is important for understanding the early stages of diversification and speciation. Plasticity in movement among individuals within populations can result in different habitat use. Such differences may drive adaptive evolution as variable habitats likely exposes organisms to novel selection pressures. This can result in differential behavioral specializations among individuals, eventually leading to diversification of morphological, physiological, and life history traits. Such specialization is thought to be a critical early step in ecological diversification and speciation. Recent experimental evidence suggests that variability in behavior may precede morphological differences in the early stages of diversification in Icelandic Arctic charr (*Salvelinus alpinus*) populations. If morphological diversification is preceded by specialized foraging behavior, then we should be able to find evidence of divergent behavior among individuals displaying only fine scale morphological variability. Here we investigate this by repeatedly sampling the diet and quantifying the habitat use (movement) of individuals in a cave population of PIT tagged dwarf Arctic charr near Lake MÃ½vatn in NE-Iceland using a multi-antenna radio telemetry system. We conclude that: a) significant variation in behavior can be seen among individuals within the same population; b) this variability is correlated with fine scale differences in morphological features; c) these morphological features are related to foraging; and d) differences in these features correspond well to the different feeding strategies which are thought to be associated with each habitat type. This is the first record of such divergence within a dwarf Arctic charr population in Iceland. Studies such as this, which assess behavioral variability prior to the appearance of obvious morphological differences, may provide novel insight into the early steps of resource polymorphism and ecological speciation.

Characterization of Dissolved Free Amino Acids in Salmon Hatchery Water

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Straying of hatchery-reared salmon is of high concern to numerous agencies tasked with the protection of native salmonid populations. Hatcheries often utilize water for incubation and rearing purposes from the river these salmon return to, so efforts to imprint smolts to hatchery water as a target return location may be futile. Considerable attention has been directed towards dissolved free amino acids (DFAA) as a set of odorants salmon use to navigate and identify their natal rivers. Research has shown that salmonids possess the ability to distinguish between certain water sources based on their DFAA compositions and that DFAA compositions often differ significantly between watersheds. If salmon do indeed utilize DFAA for homing to natal spawning sites, alteration of DFAA composition in hatchery system water during key imprinting and homing periods may serve as a possible technique to improve return rates of hatchery reared salmon to their respective hatcheries. Our results show that hatchery and river water DFAA profiles can be highly similar. These observations might suggest some variability observed in the returns of hatchery-reared salmon to hatchery fishways may be due to an inability to distinguish between hatchery water and river water based on its chemical components.

Monitoring Anadromous Fish Population Dynamics using Environmental DNA

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Environmental DNA (eDNA) allows for the detection of organisms without requiring sampling of living organisms themselves. The first generation of eDNA science has shown that DNA from organisms can be extracted from many different sources in the environment and identified taxonomically. The next generation will use this information for environmental management. To do this, we need to test whether eDNA can give us quantitative information because it is very useful to know if a population of a species is large or small, and growing or declining. eDNA has yielded quantitative information in controlled experiments in the lab and in ponds, but whether eDNA can render reliable quantitative information in flowing streams and near-shore marine systems is still an open question. Fish excrete mucus, skin cells, gametes, urine and feces into water. DNA can be captured from the water using filters and quantified using species-specific PCR primers and probes with quantitative real-time PCR or digital PCR. We tested the ability of eDNA to produce useful quantitative information for monitoring eulachon and Pacific salmon populations in Northern Southeast Alaska anadromous streams. We quantified eDNA concentrations contemporaneously with a mark-recapture project to estimate

eulachon abundance in the Chilkoot River, and with daily weir counts of adult and juvenile salmon in Auke Creek. Our preliminary results from two years of monitoring suggest that eDNA not only reliably assesses species presence, but may be an affordable means to monitor culturally and biologically important aquatic and marine resources when researchers are interested in an index of abundance or information about phenology. Given adequate calibration, eDNA-based methods could be used on large spatial or long temporal scales to monitor fish populations at a fraction of the cost of traditional methods.

Seasonal and Spatial Differences in Diet of *Oncorhynchus clarkii clarkia* and *O. mykiss irideus* at Hinkle Creek, OR

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We examined spatial and temporal differences in diet of cutthroat trout, *Oncorhynchus clarkii clarkii*, and steelhead, *O. mykiss irideus*, at 8 tributary sites and 6 mainstem sites in the North and South Forks of Hinkle Creek, OR. Diet was obtained by gently lavaging about 15 fish per site on each sampling date, identifying and measuring prey under dissecting microscopes, and calculating prey biomass using length/weight regressions. In 2004 consumption rates of trout and steelhead were similar in spring and summer, then decreased significantly in fall. A higher proportion of terrestrial prey were eaten in summer (average 84%) compared to spring (average 36%); though prey consumption was low in fall terrestrial prey still made up 48% of diet. Trout ate aquatic mayflies, stoneflies, caddisflies and true flies plus terrestrial beetles and true flies in spring, primarily termites, ants, and true bugs in summer and only small springtails in fall. Based on coinciding replicate Surber samples for invertebrates at each site, benthic abundances remained the same over the year, and abundances in tributaries and mainstems were not different. The 15 replicate lavage samples from each of 14 sites per season were important for revealing not only seasonal differences, but also revealed spatial differences in trout life history strategies. In spring 2005, smaller trout in tributaries ate more than larger fish in mainstem sites. Compared to mainstem fish, tributary trout likely spent more energy feeding in high gradient, swiftly flowing streams which had smaller pools for refuge and feeding. Higher survival costs in tributaries and trout reliance on terrestrial invertebrates point to the importance of maintaining riparian vegetation that provide terrestrial prey for fish in small streams.

Recovery Planning Session: ESA Section 7 Regulation as a Recovery Tool

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How many landowners would be willing to voluntarily adopt management practices for the conservation of endangered species if those practices were supported by planning, education, technical assistance, or financial incentives, but in the absence of any Federal regulation? Social science suggests some but maybe not many, unless a financial incentive is offered that includes a very handsome profit. Similarly, how many Federal agencies will voluntarily "use their authorities" to carry out programs to conserve listed species, as required by the ESA, if those programs encounter institutional barriers related to the primary agency mission, decreasing Federal budgets, and ambitious production goals? Many will develop such a program, but the marginal benefits that species derive from those programs can fall into the range of small to undetectable. Regardless of people's motivation, aren't we already restoring our way to ecosystem health? One recent article suggests the impacts from development currently exceed the offsetting benefits of restoration by more than 10:1. So, is regulatory command-and-control based on ESA (or other Federal statutes) likely to result in a better outcome for conservation than more voluntary or self-directed approaches? Not without nuanced problem solving, and not in isolation from the other strategies mentioned above, but as Irwin Corey once said, "You can get more with kind words and a gun than you can with a kind words alone."

Water Project Grants and Loans: Supporting Instream and Out-of-Stream Water Needs

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In 2013, the Oregon State Legislature passed SB 839 creating a fund to provide grants and loans for water development projects across the State of Oregon that have economic, environmental and social/cultural benefits. All funded projects are required to have positive impacts on all three benefits. The Water Projects Grants and Loans fund, one part of the larger Water Resources Development Program, creates an opportunity for users of water both instream and out-of-stream to work together to address water management concerns basin-wide. A notable example of the program's support for the spectrum of water needs is the requirement that funded water storage projects operate in accordance Seasonally Varying Flows (SVFs). SVFs describe the duration, timing, frequency, and volume of flows that must remain instream for the protection and maintenance of natural ecosystem functions within a watershed (outside of the irrigation season and downstream of the point of diversion). SVF development requires scientific information collected through new or existing ecological flow studies. By addressing ecological impacts through SVF development and using instream releases to add environmental benefits, the fund creates a path forward for protecting aquatic ecosystems while still providing for the economic and social needs of the basin.

Comparison of Juvenile Coho Salmon (*Oncorhynchus kisutch*) Diet in a Freshwater and Brackish Water Habitat in Coos Bay, Oregon

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Loss of lowland estuarine and freshwater off-channel habitats along the Pacific Northwest coast is a contributor to the decline of salmonid populations. These habitats serve as nursery grounds for juvenile salmonids providing them with food, winter shelter, and transition zone from freshwater to saltwater. Until recent years, sub-yearling coho salmon found in lowland riverine habitats and estuarine marshes were assumed to have been displaced from optimal upland reaches by competition and high water discharge. Recent studies have concluded that this early estuarine migrant behavior is volitional and seems to represent a life history strategy present in 20-40% of returning spawners. The goal of this study is to document dietary differences of yearling and sub-yearling coho salmon foraging in lowland riverine habitats in the upper estuarine zone. We sampled stomach contents of fish by means of gastric lavage in three coastal lowland creeks in Coos Bay (southern Oregon). Prey found in the samples were sorted, counted, identified, and dried to obtain dry weight biomass. Our analyses show that total prey biomass consumed by both yearling and sub-yearling coho salmon did not differ between habitat types; however, prey composition, based on the Index of Relative Importance (%IRI) and non-parametric ordination, showed significant differences by habitat type and age-class. Insects were the dominant prey for sub-yearling fish in brackish waters as well as for sub-yearling and yearling individuals in freshwater. In both habitats, sub-yearlings preferred terrestrial insects (brackish: 57.8 %IRI and freshwater: 48.1 %IRI) while freshwater yearlings opted for aquatic insects (37.6 %IRI). By contrast, yearling individuals in brackish habitats relied predominately on crustaceans (88.9 %IRI), specifically *Americorophium* spp.

Challenges in Knowing How Many Species of Freshwater Fishes Live in Oregon

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By my count, there are 134 freshwater fish species and subspecies in Oregon in 25 families: 48 are non-native and 86 are native. There has been a tripling of non-native species in the last 75 years including a few that do not have sustaining populations. For the native species, there are numerous examples where ecological, physiological, behavioral or genetic information sometimes support and sometimes conflict with morphological taxonomy. For example, in *Lampetra richardsoni* and *L. ayersi*, there are differences in feeding type, myomeres and pigmentation, and evidence of size-assortative mating, but there are no known genetic differences. In others, such as Cutthroat Trout, differences that would be used to define species in Pikeminnows, are equated with subspecies. According to Aristotle, “Our discussion will be

adequate if its degree of clarity fits the subject matter, for we should not seek the same degree of exactness in all sorts of arguments alike". My solutions may or may not be adequate.

Estimating Recreational Salmon Harvest Using Angler Harvest Permits Available on a Smartphone Application

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Chinook salmon, *Oncorhynchus tshawytscha* harvest in Oregon is currently estimated using voluntary returns of angler harvest permits. The objectives of this study were to describe estimation methods and evaluate the accuracy of harvest estimates if anglers were given the option to record harvest on a smartphone application in addition to traditional paper harvest permits. Accuracy was evaluated via simulation using eight basins along the mid- and north-coast of Oregon as a case study. Harvest was estimated using data from supplemental on-site surveys in conjunction with harvest data recorded on smartphones. All harvest estimates were unbiased at the aggregate scale regardless of the rate at which anglers recorded harvest on a smartphone and the number of on-site surveyors. The maximum amount of bias at the individual fishery scale was -5%. Confidence intervals varied from 1.2% to 24.4% of actual harvest at the aggregate scale and 2.8% to 99.2% at the individual fishery scale. Precision increased as the percentage of anglers recording harvest on a smartphone increased. Although the methods described in this study likely need further evaluation, they have the potential to provide relatively efficient harvest estimates compared to the techniques that are currently applied.

Modeling Bull Trout and Brook Trout Coexistence: A Structured Decision Approach

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Over the last 100 years bull trout (*Salvelinus confluentus*) have experienced population declines in addition to reductions to their historic range throughout the Pacific Northwest. One factor believed to contribute to the decline of bull trout populations has been interactions with invasive fish species, such as the brook trout (*S. fontinalis*). The detrimental effects of brook trout on bull trout are well documented and include both resource competition and predation of juvenile bull trout. We developed a decision model to evaluate different management alternatives for populations of fluvial bull trout that coexist with brook trout. Management

alternatives we explored include brook trout removal, fish barrier installations, habitat enhancement, as well as bull trout translocations. Our fundamental objective was to identify the management alternative that would maximize the number of adult bull trout in population. We found that assumptions of how juvenile bull trout interact with brook trout (e.g. resource competition or brook trout predation rates) influenced optimal decision making. In addition, results from our model suggest management alternatives that support the fluvial life history strategy made bull trout populations more resilient to coexistence with brook trout. Future work with this model will include implementing it into an active adaptive management context to facilitate learning through implementing management alternatives.

Put that Cell Phone Down and Get Your Face in a Stream!

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The Roseburg BLM, Phoenix School, Cow Creek Tribe, and the Pacific Rivers Council have been getting high school students to put their cell phones down for the day and put their head in a stream. This effort is collecting real data on steelhead and cutthroat trout densities throughout the Canton Creek watershed. This data is being used to as pre-project monitoring data and to plan a watershed scale restoration effort which begins in 2016. This year we documented the effort with Go Pro cameras. The presentation will be the draft video we have put together as well as some information some of the innovative ways we used the Go Pro to get some unique footage.

Even Little Chubs Need Love - Underwater Photo & Video of the Umpqua Chub

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Cory Sipher

Steve Clark

The Umpqua chub (*Oregonichthys kalawatseti*) is a species endemic to the Umpqua basin of southwest Oregon. This small cyprinid species is found along the margins of large rivers and prefers slow water habitat with vegetation and small gravel habitat. Historically, the species' distribution was continuous throughout the Umpqua River however more recent surveys in the early 1990s and in 2006-2007 indicated that the species was segmented into distinct populations separated by large sections with no presence likely due to the presence of smallmouth bass (*Micropterus dolomieu*) which could be both a competitor as a juvenile and a predator on the chub as an adult. Fish biologists in the Umpqua Basin undertook a sampling effort to track population trends of the Umpqua Chub and to market their existence and plight to the community. Underwater video and photos of the effort will be shown, most of which was taken with a Go Pro Hero 4 camera.

Conservation Planning for Oregon's Native Fishes

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In 2002, the Oregon Fish and Wildlife Commission adopted the Native Fish Conservation Policy (NFCP), with the policy focused on ensuring the long-term sustainability of Oregon's naturally-produced native fish while providing for a broad range of societal, ecological and economic values to Oregonians. Implementation of the NFCP was through conservation plans for Oregon's native fish, with emphasis on the state's most imperiled fish species. The policy also encouraged integration of conservation plans into other planning processes such as the federal recovery plan as called for under the federal Endangered Species Act. Over the past dozen years, ODFW has completed twenty conservation plans across a range of species, with emphasis on ESA-listed salmon and steelhead species, with most being adopted as federal recovery plans as well. Integration of state plans into the federal planning process took significant collaboration between ODFW, state and federal agencies, tribal and local governments, along with diverse stakeholders, resulting in plans that were value-added to all parties involved. Critical to the success of these plans was the commitment to collaboration by the entities responsible for their management. While the state and our partners invested significant resources into plan development, we are now shifting our emphasis to the greater challenge of implementation, where sustained focus and continued collaboration is critical to ensuring that the actions critical to the sustainability of Oregon's native fish are implemented.

Temporal Variability in the Distribution and Abundance of a Desert Trout Associated with Stream Drying

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Shaun Clements

Desert fishes occupy habitats that can experience a large degree of inter- and intra-annual variation in environmental conditions. For example, drought conditions may substantially reduce the quantity of water available to stream fishes over large spatial extents, and portions of some streams may dry annually even under ideal or average conditions. As streams dry, habitat availability decreases and fish may respond by redistributing into wetted areas or they may become stranded and die, which has implications for how fish populations are monitored, assessed, and managed. We examined the distribution and abundance of redband trout in Rock Creek, Oregon, in relation to patterns of stream drying. We estimated that the wetted habitat available to redband trout in Rock Creek decreased from about 30 km on June 3 to about 8 km on September 2, 2015. During this time period, we sampled a total of 620 redband trout and uniquely tagged 481 redband trout. We observed movement of six tagged redband trout among samples sites (i.e., 100-m stream reaches) during the study; four fish were recaptured

about 100 m from their original capture location, one fish was recaptured about 200 m from its original capture location, and one fish was recaptured about 1,800 m from its original capture location. Additionally, we did not observe any redband trout among 24 sample sites in the lower 13.1 km of Rock Creek that were sampled prior to desiccation in 2015; despite the fact that redband trout have been observed in this area during previous surveys conducted in 2009, 2010, and 2011. Over the sample period we estimated that redband trout abundance decreased from 1,375 individuals (lower-upper 95% CL; 701-2,044) to 665 individual (124-908). These estimates represent about a 90% decrease in population abundance compared to previous surveys (i.e., surveys conducted in 2007 and 2009-2012); although some differences in methodology do exist. Combined, these data suggest that redband trout in Rock Creek are generally not redistributing in response to stream drying, but are likely becoming stranded and die as stream habitat fragments and dries. Additionally, the number of successive years of drought or near-drought conditions, and not just the magnitude of drought in any one year, may contribute the ability to redband trout to re-colonize previously dry habitats and may greatly influence the abundance of redband trout. Finally, understanding patterns of stream drying may aid in identifying drought-resistant refuge habitats that warrant special protection.

Southern Oregon Coast's New River, a Unique Coastal System

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New River is a coastal system which flows parallel to the ocean for more than ten miles. The current river configuration is a result from the introduction of European beach grass, which stabilized the foredune and caused the northern migration of New River's mouth. The Bureau of Land Management (BLM) manages several miles of New River under the designation of an Area of Critical Environmental Concern (ACEC). Management of New River involves carefully balancing the needs of the federally listed Oregon Coast Coho Salmon and adjacent habitat for Snowy Plover, a federally listed shore bird. Other management challenges at New River include invasive aquatic macroinvertebrates and plants, as well as water quality issues. The BLM strives to co-manage the New River ACEC with adjacent private landowners who are managing ranching land. Managing coho habitat in a river system formed by the invasive European beach grass is interesting especially considering habitat needs of other listed species and adjacent landowner needs. The BLM has over time worked cooperatively with adjacent landowners and non-profit groups and as a result coho habitat in New River has improved.

Causes and Consequences of Variation in Salmonid Migratory Behavior

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Salmonids display a remarkable level of variation in migratory behavior. Theoretically, populations have evolved in response to local conditions and changes in environmental

conditions or habitat availability can alter behavior and impact survival. However, it is challenging to generate adequate information at the individual-level to make meaningful inference within and across populations. An increasingly popular forensic approach, the examination of otolith structural and chemical analyses, can be used to collect such information. For example, otolith analyses has been used to identify the causes and extent of anadromy in *Oncorhynchus mykiss*, generate population-level information on migratory variation and mechanisms of mortality in Chinook salmon (*O. tshawytscha*), compare early marine residence of hatchery and naturally-produced Chinook salmon, and describe novel life histories in Alaskan populations of Dolly Varden, *Salvelinus malma*. For Columbia River Chinook salmon, we combined genetic stock identification with otolith elemental analyses to generate population-level information on migratory variation and regulatory mechanisms within and across populations. There is substantial variation in the age, size, and timing of marine entry that is related to apparent differences in mechanisms of mortality during early marine residence. Evidence for bottom-up effects on growth and survival is much stronger for yearling emigrants compared with subyearling emigrants, which appear to be more influenced by top-down effects, such as selective mortality or competition. Furthermore, size and timing of marine entry is related to migration rate and coastal residence times, which may also influence growth, exposure to predators, and ultimately survival. Hatchery populations often display less phenotypic variability than observed in natural populations, which has implications for migratory behavior, growth, and survival. Given evidence for lower fitness and reduced early marine survival in some hatchery populations, enhanced understanding of the causes and consequences of variation in migratory behavior of both naturally- and hatchery-produced populations is needed to guide management and restoration efforts.

Use of Accelerometers to Monitor Green Sturgeon Behavior After Gillnet Capture

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Steve Corbett

Green sturgeon (*Acipenser medirostris*) are of conservation concern throughout their range. The Southern distinct population segment spawns primarily in the Sacramento River main stem but ranges north to Oregon and Washington estuaries in summer. Listed as Threatened under the Endangered Species Act, these primitive fish are captured as bycatch in both estuarine and coastal gillnet and trawl fisheries. We tested the hypothesis that capture in gillnets would cause changes in adult sturgeon activity (i.e., that sturgeon would rapidly flee the capture area). Using inertial sensors, we documented tailbeat frequency and depth of swimming for sturgeon captured in commercial gillnets in Willapa Bay, WA. The data were transmitted acoustically to an extensive array of receivers positioned in the Bay. Transmitters were either surgically implanted (n = 2) or attached externally to the sturgeons' dorsal scutes (n = 2). In spite of the small number of fish tagged, we obtained over 4,800 data transmissions, with some fish detected over the course of several months and in estuaries up to 55 km from the release site. This information indicated that, contrary to expectation, green sturgeon recovered very rapidly

from gillnet capture and did not flee the capture area. Similar movement patterns and depth distribution were observed on the day of release and weeks to months after capture. This pilot work suggests that short-term handling associated with gillnet capture did not have lasting effects on adult green sturgeon behavior.

Responses of Adult Pacific Lamprey to Natural and Synthetic Olfactory Cues

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Methods to recover imperiled lamprey populations could include use of odors to attract or repel migrating adults. Assays with Pacific lamprey (*Entosphenus tridentatus*) in a two-choice maze were conducted to evaluate the response of adult females to introduced odors. First, we evaluated the reaction of pre-ovulatory females to odor from tanks containing pre-spawning conspecifics (males and females). We also tested whether ovulatory females were attracted to spermiating male washings or to a synthesized, male sex pheromone (3kPZS). We also conducted parallel tests to check for rheotaxis in ovulatory females. In all tests, the lamprey showed consistent nocturnal activity patterns, typically moving from sunset until sunrise and remaining inactive during daylight hours. The number of entries and the amount of time pre-ovulatory females spent in treatment and control arms of the maze were not significantly different ($P>0.89$). Ovulatory females also showed no difference in the number of entries into the arm receiving synthesized 3kPZS or spermiating male washings. However, they spent significantly less time in the arm containing the synthesized sex pheromone ($P=0.04$) than in the adjacent control arm. Conversely, the lamprey showed strong, positive responses to current velocity, indicating that the assays were capable of detecting positive effects. These results suggest that the response of lamprey to sex pheromones is species specific, in that Pacific lamprey are much less sensitive to these cues than sea lamprey (*Petromyzon marinus*).

The Ni-les'tun Restoration Project — Lessons Learned from Oregon's Largest Tidal Marsh Restoration

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In response to the agricultural conversion of 95% of the Coquille River basin's tidal floodplain in the last century, the US Fish and Wildlife Service at Bandon Marsh National Wildlife Refuge sought to reconnect 418 acres of diked and tide-gated pasture to the river's estuary, and begin the process of restoration to a fully functional and productive marsh. After 10 years of planning and preparation, tidal flow was restored in August 2011. The restoration was targeted to benefit migratory shorebirds and waterfowl, and juvenile salmonids, in particular. Refuge Manager Eric Mruz will describe how this complex project was completed, how a comprehensive monitoring program has documented its progress, and important lessons that have been learned that can inform future restoration projects. The talk will also present how adaptive management was applied to resolve an unexpected mosquito problem caused by the restoration.

Engineered Foodwebs: Altered Trophic Relationships in a Reservoir System

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Deep drawdown of reservoirs (defined as the drawdown below conservation pool) may induce highly variable and complex effects in fish communities and ecosystems. Here, we examined trophic relationships among fishes in two high-head reservoirs in the Willamette Basin under different drawdown regimes including Fall Creek (after a deep drawdown) and Hills Creek (reference site without deep drawdown) during late summer and early fall. To identify trophic relationships among consumers (e.g., dietary overlap and piscivory), we used stable isotopes ratios of nitrogen, carbon, and sulfur from primary producers, macroinvertebrates, zooplankton, and fishes. Our findings are consistent with expected overall reductions in fish densities after deep drawdown. Under such conditions, generalist predators may switch their diets from piscivory to the remaining and more abundant prey (e.g., invertebrates). This provides the foundation for food web manipulation through management alternatives which alter predicted cost-benefit ratios and influence the dynamics around species of concern. In this case, such alterations may have the potential to alleviate predation on ESA listed juvenile salmonids which have been found to regularly rear in such reservoir systems.

Introduction to Fish Orientation and Migration Session

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The responses of animals to their environment, especially orientation responses, are frequently the subject of research studies. Spectacular migrations of marine and freshwater fishes, such as the seasonal returns of salmon to our rivers have raised questions as to the mechanisms for the behavior. Some of the earliest contributions to our understanding of animal orientation and movements came about because people focused on relatively simple, fixed responses of species to single cues such as light or temperature gradients. Fishes present a combination of complex orientation responses that make them difficult subjects for controlled experimental studies. In my introduction to this special session I will provide some historical review of studies of the orientation responses of a variety of fishes, and details of what we have come to understand of some of the most complex behavioral responses of any animals. We will have presentations on freshwater, marine and anadromous species, ranging from lampreys to salmon that have led to our current understanding of orientation mechanisms and migration in fishes.

The Imitation Project: Wild and Hatchery Salmon

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We are studying Chinook salmon and steelhead to analyze the mechanisms that can create differences in life history patterns between wild and hatchery fish. The fish do not differ genetically, but the differences between them are genetically determined. Hatchery rearing results in smaller egg size in female steelhead. That difference in egg size produces differences in size at emergence and first feeding, and differences in size at one year of age. Those differences in size at age can have significant life history consequences. Small differences in temperature during embryonic development do not cause sex change in steelhead, but they can alter the timing of sexual development that can have life history consequences. Rearing Chinook salmon and steelhead in conventional hatchery conditions can significantly alter the orientation and migration behavior of juveniles and adults. All these differences between wild and hatchery rearing can affect behavioral traits that are apparent immediately following swim-up and significantly alter life history patterns.

Landtyping Work and how it relates to Riparian Areas and Fish Habitats

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Karen Bennett

Results of multi-year mapping of geoecology for all forests in Region Six using the USFS concept of Landtypes will be summarized with focus on implications for managers of riparian areas and fish habitat. Mapping includes new geomorphology, soils and vegetation layers now present and ready for use in the corporate GIS database.

Rainbow Have Higher Fitness than Steelhead; Impacts on Conservation and Management of *O. mykiss* Populations

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Dave Lytle

Coexistence among steelhead and rainbow trout is most often explained as a conditional strategy, in which some individuals must "make the best of a bad job" and adopt a life history that has lower fitness. It is generally assumed that those "making the best of it" become rainbow trout and are less fit than steelhead. We have found that this may not be true. Using fecundity, survival, and iteroparity data from a range of locations, we calculated the fitness of each tactic within a population and found that rainbows often have higher fitness than steelhead. In contrast to what is commonly assumed, it may be that steelhead are the individuals making the best of a bad job. We will show how this can be true even when steelhead are the dominant life history tactic in a population. Although these results most directly apply to theoretical work on coexistence, we argue that the notion of steelhead superiority acts as an underlying assumption in many conservation and management plans. This idea of steelhead superiority may ultimately influence research directions, predicted responses to habitat restoration or climate change, fishing regulations, and most importantly, the public's perception of this species.

Landscape Scale and Process Based: Expediting Aquatic Restoration on the Malheur National Forest

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Hazel Owens

Federally managed lands can be highly degraded systems as the result of numerous land management practices, including but not limited to grazing, mining, timber harvest, wildfire suppression, legacy restoration structures, and road network development. The needs for restoration within the Forest Service are wide-scale and hugely variable. Fortunately, aquatic restoration is recognized as being incredibly important and thus receives widespread support. Through headwaters restoration, floodplain reconnection, and riparian re-vegetation, we have the opportunity to make significant strides to improve habitat, water quality and resilience of

our ecosystems to climate change. Through numerous impressive partnerships, supportive leadership and driven field staff the Forest Service has enormous potential to make positive changes on a landscape scale. The Malheur National Forest is at the forefront of landscape scale restoration at a national level as a result of the Collaborative Forest Landscape Restoration Program. Additionally, at a regional level, the John Day River watershed is a priority basin for aquatic restoration. As a result of both the Forest's landscape scale restoration (Accelerated Restoration) and forest-wide aquatic restoration (Aquatic Restoration EA) analyses, forest staff must find opportunities to move from restoration concept to implementation as quickly as possible. We will provide a summary of how the Malheur is addressing aquatic restoration, including a review of landscape scale, process-based restoration planning and the tools, LIDAR for example, that allow us to determine restoration needs more easily and move to implementation more quickly. In regards to restoration on our federal lands, the potential is high, the opportunities are available and the biggest risk lies in taking no action.

Stream Buffers in West-side Forested Headwater: Objectives and Efficacy

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Aims of streamside riparian forest management approaches are protection and restoration of stream-riparian habitat, biota, and ecological functions and processes. Key concerns include temperature regimes, down wood recruitment, sedimentation, unique habitats, and sensitive species. The aquatic-dependent habitats and vertebrates component of the Density Management and Riparian Buffer study of western Oregon is contributing to our understanding of long-term buffer width effectiveness. In addition to understanding how aquatic vertebrates respond to alternative buffers with upland thinning over time, recent findings document down wood and stream flow patterns.

Salmon River: The Evolving Story

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The story at Salmon River Hatchery this year demonstrates the power of partnership to achieve multiple management and conservation goals. ODFW district, hatchery and research staff worked together with the public to form a 60-person volunteer group, coordinate with state and local food shares, and collaborate with anglers, activists, and area businesses. The fantastic recreational fishery was maintained, all surplus hatchery food grade fish went to those in our communities who need them most, and the rate of potential interaction between hatchery and wild fish on spawning grounds was reduced. The Salmon River Hatchery began releasing fall Chinook in the Salmon River in 1977 to supplement ocean and in-river fisheries. This stock supports a very popular fishery and also serves as the North Coast Aggregate exploitation rate indicator stock for the Pacific Salmon Treaty (PST). Annual production is set at 200,000 Chinook smolts, which are adipose fin clipped and coded wire tagged. Salmon River Hatchery has reduced all fish production except fall Chinook and reduced its staff this year, partly due to budget constraints. Implementation of the Coastal Multispecies Conservation and Management Plan (CMP), adopted in 2014, has also affected hatchery operations. The plan seeks to balance conservation needs and continued fishing opportunities, and the number of hatchery fish available for harvest above the hatchery was reduced. While the majority of effort has generally been low in the system, local concern was sufficient to warrant public outreach. Timely outreach succeeded in balancing previously conflicting interests and resulted in a wellspring of hands-on public support for hatchery operations and research efforts.

Calibrating Spawning Ground Surveys in Salmon River Using Mark-Recapture

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Stocks of Chinook salmon originating from Oregon through Alaska are harvested in fisheries managed in part by the Pacific Salmon Treaty (PST). Since 1986, Chinook Salmon at the Salmon River Hatchery have been coded wire tagged and adipose fin clipped (Ad+CWT) to serve as the PST exploitation rate indicator stock (ERIS) for Chinook stocks originating from the north Oregon Coast (NOC) aggregate. Estimates of age-specific ocean abundance, harvest, survival and maturity for the NOC aggregate are based in large part on age-specific spawner escapement and freshwater harvest of Salmon River Hatchery Ad+CWT fall Chinook. Estimates of Chinook spawning escapement in the Salmon River basin have been based on a statistical relationship between abundance in index areas and simultaneously measured estimates of escapement derived through mark-recapture study. Recent observations of escapement in these index areas have been outside the bounds of those values used to generate this statistical relationship. We've revisited these historical indices and their relationship to escapement by

conducting another mark-recapture field study during an escapement year that is outside the bounds of those that have been observed during previous examination.

Wy-Kan-Ush-Mi Wa-Kish-Wit: How Indigenous Knowledge has Shaped Modern Fisheries Management in the Columbia River Basin

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The Columbia River Inter-Tribal Fish Commission (CRITFC) was formed in 1977 to provide a unified voice in Columbia River fisheries management for the Nez Perce, Yakama, Umatilla, and Warm Springs tribes. Following extremely low returns of salmon in the early 1990s and regional inaction to reverse this trend, CRITFC and its four member tribes developed Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon), a 25-year comprehensive fisheries restoration plan. This plan holistically addresses the ecological needs of anadromous fish species in the Columbia River basin by focusing on the full life cycle rather than a single life phase. A guiding principle of Wy-Kan-Ush-Mi Wa-Kish-Wit is to integrate traditional ecological knowledge with Western scientific principles to modernize and better inform fisheries management decisions and restoration goals within the Columbia River. The tribes' guiding principles from Wy-Kan-Ush-Mi Wa-Kish-Wit has helped halt salmon declines and reshape management within the Columbia River basin. The goal of this paper is outline the goals, objectives, and principles of CRITFC and its member tribes towards recovery planning in the Columbia River basin.

Integrating Modeling, Monitoring, and Management to Reduce Critical Uncertainties in Water Resource Decision Making

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Lotic ecosystems provide multiple services to society. Managers need tools to assess the potential effectiveness of alternative management actions in the face of changing climate, land use and increasing water demands and often, under significant uncertainty. Formally integrating modeling with monitoring provides a basis by which managers can reduce uncertainties while managing, thereby improving the scientific bases for future decisions. We developed an adaptive framework that integrates a dynamic, multi species metapopulation model developed to assess effects of streamflow alteration on fish occupancy in a southeastern US stream system with an occupancy based monitoring protocol. Although the monitoring data were not extensive (collected over three years at nine sites), it allowed us to assess and update support for alternative ideas regarding the effects of streamflows on local extinction, colonization and reproduction dynamics of stream fishes. We believe that investment in more strategic monitoring, guided by a priori model predictions, could substantially improve the

information available to guide decision-making and management for ecosystem services from lotic systems.

Behavioral Response of Pacific Lamprey (*Entosphenus tridentatus*) to Predator Odors

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Pacific Lamprey (*Entosphenus tridentatus*), a species facing serious threats to their existence, experience a number of challenges in reaching their desired spawning grounds during the adult migratory phase, and predators are suspected to be one of these challenges. Although research exists on Pacific Lamprey response to attractant odorants, less is known about Pacific Lamprey response to predator odorants. Just as attractive odors guide lamprey to suitable spawning habitat, signs of predator presence may provide an important management tool for use in deterring lamprey from poor quality habitat. In our study, we tested Pacific Lamprey response to four predator odorants; White Sturgeon (*Acipenser transmontanus*), human saliva, dead lamprey, and river otter (*Lontra canadensis*). We conducted a two-choice maze test and measured the number of entries (count) and duration of time spent (occupancy) in the test arm during a control trial and an odorant trial. Results showed a significant ($P < 0.01$; t-test) response to the river otter odorant in both count and occupancy. However, the response was opposite from our expectations; fish spent more time and made more entries into the test arm with the river otter odorant than the test arm during the control period. This could be evidence of predator inspection and/or 'hiding' (remaining still). No significant difference ($P > 0.05$; t-test) was found in the response of lamprey to the other three odors. However, tests using the dead lamprey odorant ($P = 0.47$ for entries and $P = 0.14$ for duration; t-test) were indicative of a repellent response for duration. Results from this study indicate that Pacific Lamprey respond to some predator odorants and suggest that future testing may be valuable.

Ocean Migration: Navigating a Dynamic Geomagnetic Environment

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Migration in animals has evolved as an adaptation to environmental variability across space and through time. The availability of reliable sensory cues and guidance mechanisms to navigate among disparate locations is an essential component of this behavior. Accumulating evidence indicates that diverse animals use information from the Earth's magnetic field to navigate over a wide range of spatial scales. Studies in marine migrants demonstrate that a large-scale "magnetic map" is used to assess location and determine which direction to swim. This ability may underpin the life history of many marine migrants: transiting between disparate oceanic regions and ontogenetic shifts in habitat use. Due to high-frequency (e.g., storms) and longer-term (e.g., El Niño) processes, ocean currents experienced by an individual may vary considerably over time. Thus, complications arise in pairing geomagnetic information with optimal orientation responses in the context of dynamic ocean conditions. This is an even greater challenge when one considers that the "map" animals are attempting to pair with a variable ocean is, itself, gradually shifting across the globe and is prone to dramatic excursions and reversals. The complex interplay between ocean circulation and geomagnetic dynamics offers a unique conceptual setting to test hypotheses for how animals deal with environmental change. Moreover, recent analyses provide evidence for the important role (and predictive ability) of geomagnetic change on spatiotemporal variation in animal movement patterns. Such considerations are essential, as understanding the sensory basis of animal navigation enhances our ability to mechanistically predict distributions and successfully manage species in the face of global climate change and widespread habitat alterations.

Investigation of Fall-migrating Steelhead and Spring Chinook Salmon Juveniles from the Hood River

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The Hood River Production Program â€“ Oregon Department of Fish and Wildlife Monitoring and Evaluation project has been responsible for monitoring natural production of ESA listed steelhead and spring Chinook salmon populations in the Hood River since 1994 as part of the Northwest Power and Conservation Council's Fish and Wildlife Program. Rotary screw traps are being used to capture steelhead and spring Chinook salmon smolts to produce estimates of natural production within the subbasin. Data collected during trap operation has identified two distinct periods of steelhead and spring Chinook salmon migration: spring and fall. Historically, reporting of subbasin smolt production has focused primarily on spring migrants, as these were assumed to be actively migrating fish and represented the majority of the population. Fall migrants were assumed to be distributing themselves for over-wintering purposes, but the location and duration was unknown. To gain a better understanding of where these fall migrants are over-wintering and their contribution to the spawning population of returning adults, further investigations was needed. We estimated apparent survival and detection probability (CJS Model, Program MARK) using Passive Integrated Transponder (PIT) tag interrogation information from the Hood River and lower Columbia River. Fork length and mainstem Hood River flow at the time of tagging were included as individual covariates in the model. Interrogations of natural production juvenile steelhead and spring Chinook salmon tagged during the fall seasons of 2012 – 2015 and subsequently interrogated at the Hood River mouth PIT tag antenna array suggest that a high percentage are potentially leaving the Hood River subbasin shortly after they are released. Model results and adult PIT tag detections at Bonneville Dam (Columbia River) are compared to spring migrants to gain a better understanding of the populations of steelhead and spring Chinook salmon during the fall months.

An Initial Evaluation of a Potential Option for Managing Riparian Reserves of the NW Forest Plan (Aquatic Conservation Strategy)

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Deanna Olson* (presenter)

Norman Johnson

The Aquatic Conservation Strategy (ACS) of the Northwest Forest Plan guides management of riparian and aquatic ecosystems on federal lands in western Oregon, Washington, and northern California. We applied new scientific findings and tools to evaluate a potential option for refining interim riparian reserves to meet ACS goals and likely challenges of climate change while allowing other management goals, including timber production. Interim riparian reserves are retained in late-successional reserves and other special land designations in the option. In matrix, the area for aquatic conservation extends upslope one site-potential tree-height along all streams, divided into an inner zone devoted solely to achieving ACS goals, and an outer zone managed to achieve ACS and other goals. It is a context-dependent approach based on

ecological sensitivity of stream reaches to partition the zones. Based on simulations of the area of interim riparian reserves in six watersheds in western Oregon with lands managed by the BLM, approximately: (1) 72 percent remains intact; (2) 15 percent should meet ACS goals and provide opportunity for limited timber production; and (3) 9 percent would be returned to matrix. A large percentage of streams with high ecological sensitivity occurred on non-federal lands, a circumstance that merits further analysis in the context of landscape-scale considerations for biodiversity and recovery of ESA-listed species. Information needs remain with regard to application and effectiveness of these options and an adaptive management context is critical for continued improvement.

Recovery and Delisting of the Modoc Sucker

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The Modoc Sucker (*Catostomus microps*) occupies small streams in the upper Pit River drainage of southern Oregon (including Goose Lake Basin) and northern California. The species was federally listed under the ESA in 1985. Principal threats to the species included its limited distribution, habitat degradation, non-native predators, and possible hybridization with the more abundant Sacramento Sucker. Recovery of the species has included addressing specific threats, resolving perceived threats through research, surveying for additional populations, introductions to suitable secure habitat and community outreach. Private landowner cooperation has been and continues to be essential for securing access to populations, carrying out conservation actions and developing non-confrontational attitudes toward the Modoc Sucker and its conservation. At this time the distribution of Modoc Sucker is broader than at the time of listing, habitat conditions have improved, non-native species have been controlled, hybridization has been investigated with modern genetic methods not available at the time of listing and determined to not represent a threat, and landowner attitudes are generally supportive of conservation efforts. Getting there has involved collaboration between all parties, development of personal relationships and plenty of on-the-ground effort. The Modoc Sucker has also demonstrated its resilience over 30 years of climatic variation. In December 2015 U.S. Fish and Wildlife delisted the Modoc Sucker, and its stewardship is now the responsibility of the local community -biologists, agencies and private landowners.

Changing Forests, Changing Streams: Aquatic Responses to Riparian Thinning Across Seasons and Watersheds

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Dede Olson

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Silvicultural techniques like thinning are being applied to forested landscapes to shift successional trajectories and restore old-growth conditions in redwood ecosystems. Although most thinning treatments have occurred in upland forests, thinning may also have benefits in second-growth riparian forests. Before widespread thinning treatments are applied to riparian forests, however, it is essential that we evaluate the responses by stream-riparian food webs. To address this, we are evaluating the effects of thinning in riparian forests along headwater streams located in redwood ecosystems of coastal northern California. The objectives of our research include quantifying the influence of riparian thinning on: 1) Forest cover, light availability, and stream temperature; 2) Stream-riparian food webs; and 3) Stream amphibian and fish communities – primarily coastal cutthroat trout (*Oncorhynchus clarkii*) and coastal giant salamander (*Dicamptodon tenebrosus*). This research will attempt to understand how stream-riparian food webs function across entire watersheds by documenting the underlying mechanisms driving the responses by stream amphibian and fish communities to riparian forest thinning. To do this, we will integrate empirical data with stream network, food web, and bioenergetics modeling approaches. By evaluating the cumulative effects associated with riparian thinning on aquatic ecosystems across seasons and entire watersheds, we hope to guide riparian forest management in redwood ecosystems.

Describing Juvenile Life Histories of the McKenzie River Spring Chinook Salmon Spawning Population Using Otolith Microchemistry

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Dan Bottom

Jessica Miller

The natural-origin Chinook salmon (*Oncorhynchus tshawytscha*) population from the McKenzie River (Oregon) is critical for conservation of the Willamette River spring Chinook salmon Evolutionary Significant Unit. However, juvenile life histories of the McKenzie River population through the tidal-fluvial Columbia River estuary are poorly understood. The Columbia River estuary is a large river-dominated ecosystem with a vast complex of tidal-freshwater, or tidal-fluvial, habitats that extend ~200km from the brackish water interface (~rkm 20-40) to the tailrace of Bonneville Dam (rkm 233). Approximately 70% of vegetated tidal wetland and ~55% of forested upland habitat area have been developed throughout the Columbia River estuary and its historic floodplain. Habitat restoration projects are now underway in the Columbia River estuary with the goal of increasing survival benefits to juvenile Chinook salmon. However,

survival benefits of tidal-fluvial habitat restoration to Columbia River Chinook salmon populations are poorly understood and not easily measured. This study has quantified the importance of tidal-fluvial habitat for McKenzie River Chinook salmon. Using otolith micro-chemical profile analysis, juvenile size was back-calculated at the Willamette-Columbia River confluence and at the Columbia River fresh-brackish water interface. Net growth in the tidal-fluvial Columbia River was then estimated for 92 natural-origin McKenzie River Chinook salmon from outmigration years 2005 and 2006. All otoliths were sampled from McKenzie River adult salmon to draw inferences about the juvenile life histories of surviving spawners. Mean ± SD net growth in the tidal fluvial estuary for all years was 5.48 ± 5.81 mm for subyearlings and 7.43 ± 8.32mm for yearlings. Differences in mean net growth by juvenile life-history type were not significant despite a prevailing assumption that subyearlings rear longer in estuary habitat than yearlings. Growth conditions were generally faster in 2005 than in 2006. Sixteen percent (15 of 92) of fish analyzed grew between 10 and 43 mm over approximately 30-100 days in the tidal-fluvial Columbia River. Extended rearing in tidal-fluvial habitat provided an alternate life-history pathway for some yearling (12), fingerling (one), and fry (two) migrants. These results suggest tidal-fluvial habitat supports McKenzie River Chinook salmon life-history diversity and growth, and therefore likely contributes to population resilience. Further analysis is underway to increase sample sizes and to refine understanding of the McKenzie River population's juvenile life histories in the Willamette River basin. The additional analysis is focused on estimating residency in the McKenzie River, the upper and the lower Willamette River areas, and on estimating juvenile sizes at these transitions.

Dean Creek Spruce Swamp Restoration

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Spruce swamp, while historically abundant in Oregon, has been disproportionally impacted by human activities. Logging, diking, and tidegate installation has resulted in an approximately 90-95% reduction of spruce swamp acreage south of the Columbia River (Brophy, 2005). The habitat structure that these swamps provide is vital to a number of fish and wildlife species, and conservation and restoration of this habitat type is of very high priority. The Dean Creek Spruce Swamp restoration project took place on 20 acres of former spruce swamp in the Umpqua River Estuary. While the site was logged in the 1940's, the tidal channel network remains intact and functioning. Partnership for the Umpqua Rivers staff, in conjunction with ODFW, placed 125 logs in 20 sites with a helicopter. Most logs were placed in tidal channels; however some were placed in low areas of the wetland to act as nurse logs. 50 Sitka spruce (*Picea sitchensis*) were planted in holes cut in the logs. An additional 40 trees were planted in higher areas of the wetland. Log retention has been excellent, and spruce survival has been very good. More than 75% of all spruce trees have survived and are growing well. It is believed that this planting will jump-start the natural process of spruce swamp regeneration and will result in the restoration of the site.

Comparison of Magnetic Orientation Responses of Native and Introduced Salmonid Species in the North Pacific Ocean

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Recent studies suggest that Pacific salmon (*Oncorhynchus* species), steelhead trout (*O. mykiss*), and trans-located Atlantic salmon (*Salmo salar*) use spatial variation in the Earth's magnetic fields to navigate while at sea. When juvenile Chinook and steelhead with no prior migratory experience were exposed to simulated magnetic fields that exist at the latitudinal periphery of their oceanic foraging range, they elicited orientation responses that would lead them back to their oceanic foraging grounds. We also tested whether juvenile Atlantic salmon that were trans-located from Maine to Oregon for a recreational fishery possessed similar magnetic orientation responses. These fish were exposed to the same simulated magnetic fields found at the boundaries of their introduced range in the North Pacific. Our findings suggest that there is a family trend of deriving positional information from the Earth's magnetic fields, and this ability is influenced by genetic and environmental factors. This work establishes the basis for future homing and straying studies, including additional information regarding the resolution of magnetic maps, which may explain variations in homing and straying patterns.

An Evaluation of the Efficiency of Minnow Traps for Estimating the Abundance of Minnows in Desert Spring Systems

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It is important to accurately quantify population parameters for native desert fishes of special conservation concern. We evaluated the efficiency of baited minnow traps for estimating the abundance of two ESA listed species, Foskett speckled dace (*Rhinichthys osculus* ssp.) and Borax Lake chub (*Gila boraxobius*) in desert spring systems in southeastern Oregon. We estimated capture and recapture probabilities using the Huggins closed-capture estimator and compared

the abundance estimates with the commonly used Lincoln-Petersen estimator. We evaluated alternate sample designs using simulation. Trap capture probabilities averaged 23% and 26% for Foskett speckled dace and Borax Lake chub, respectively, but differed substantially among sample locations, through time, and nonlinearly with fish length. Recapture probabilities for Foskett speckled dace were, on average, 1.6 times greater than first capture probabilities, suggesting trap happy behavior. We found the Lincoln-Petersen estimator underestimated Foskett speckled dace and Borax Lake chub abundance by 48% and 20%, respectively comparing to the Huggins estimator. These biases were due to variability in capture and recapture probabilities. Simulation of fish monitoring that included the range of capture and recapture probabilities observed indicated that bias and error decreased with increasing capture occasions and that variability in these probabilities over time of +/-10% greatly reduced the ability to detect annual decreases in abundance using raw catch data. Failure to account for this variability in capture and recapture probabilities can lead to poor data quality and study inferences. Thus, we recommend employing sampling designs and estimators that can account for this variability.

Using Bioenergetics to Estimate Nonnative Smallmouth Bass Predation of Larval Lamprey in the Umpqua River Basin

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Nonnative fishes have been increasingly implicated in the decline of native fishes in the Pacific Northwest. Our study focused on nonnative smallmouth bass introduced into the Umpqua River in the early 1960s. Spread of smallmouth bass there coincided with a steep decline in counts of adult Pacific lamprey in the Umpqua River. To better evaluate potential interactions between these two fishes, we sampled diets of smallmouth bass and used bioenergetics models to estimate predation on larval lampreys in a single pool in Elk Creek, a tributary to the lower Umpqua River. We estimated smallmouth bass abundance in this pool to be 618 (339-897, 95% CI) individuals, with a mean mass of 147 g. Sampling of stomach contents indicated smallmouth bass consumed larval lampreys, which comprised about approximately 2% of their overall diet by weight. We used information on diet and other parameters (temperature, body size, growth) in a bioenergetics model to estimate consumption of larval lamprey by smallmouth bass. Our estimates indicated that smallmouth bass consumed 1921 larval lamprey (1053-2788, 95%CI) in

this single pool. Although the precision of these estimates is low, the magnitude of potential predation clearly demonstrates that smallmouth bass are a major threat to larval lampreys.

Looking for Water in All the Wrong Places: Measuring and Mapping Stream Intermittency and Thermal Regimes in Southeast Oregon

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Headwater streams in the Willow and Whitehorse watersheds support the strongest remaining local populations of threatened Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) in the state of Oregon, and rank among the strongest local populations across the entirety of the species' range. The 2012 Holloway wildfire severely burned the majority of these watersheds and resulted in an almost complete loss of riparian and upland vegetation. We deployed a network of stream temperature and desiccation loggers in 2014 to understanding the effects of the Holloway Fire on fish habitat and water quality. We used a modified generalized random tessellation stratified (GRTS) sampling design to allocate 100 sampling sites to natural stream channels across the Willow and Whitehorse watersheds in southeast Oregon. Sixty-seven sites were located in National Hydrography Dataset (NHD)-classified "perennial" streams, and 33 were located in streams classified as "intermittent". Our sample design allowed us to examine thermal regimes and stream desiccation inside/outside the fire perimeter, inside/outside the known distribution of Lahontan cutthroat trout, and inside/outside livestock grazing exclosures. In addition to these 100 sites, we also included data from 6 supplemental sites (all classified as perennial) that were fortuitously established by crews in 2011. These supplemental sites allowed us to directly evaluate pre- and post-fire conditions. Preliminary results show that of the 73 sites classified by NHD as perennial, 27 displayed signs of intermittency. Conversely, of the 33 sites classified by NHD as intermittent, 3 appeared to be perennial during the 1 year we monitored. Further analyses will examine spatial and temporal patterns of stream temperature and desiccation across the post-fire landscape.

Lake Sturgeon Movements after Passage Upstream of Two Hydroelectric Dams on the Menominee River, Wisconsin-Michigan

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Lake sturgeon (*Acipenser fulvescens*) populations in the Great Lakes have declined dramatically over the last two centuries. Their recovery in the region is thought to be hindered by the presence of dams on Great Lakes tributaries. Dams deny these fish access to riverine habitat needed for spawning and survival during early life stages. We will attempt to mitigate this effect on the Menominee River by using a specifically designed elevator to pass 120 mature lake sturgeon upstream of the first two hydroelectric dams over a two year period. Our research objectives are to determine if: 1) lake sturgeon passed upstream return downstream within 1 or 2 years of passage; 2) lake sturgeon have the opportunity to spawn at least once above Park Mill Dam within 1-2 years after passage; 3) spawning opportunity, downstream return rates, and use of the downstream fishway at Park Mill Dam are related to biotic and abiotic variables; and 4) the number, length, sex, and timing of passage can be manipulated to maximize the number of eggs deposited above Park Mill dam by fish that were passed upstream. Each lake sturgeon passed will be surgically fitted with a VEMCO® V16 acoustic transmitter and their movements monitored with an array of VR2W receivers and a VR100 portable receiver. A total of 60 of the 120 lake sturgeon have been passed upstream to date. Preliminary results indicate most lake sturgeon return downstream within 1 year, however, number of spawning opportunities and individual movement patterns are variable.

Using Environmental DNA to Detect Invasive and Cryptic Aquatic Species

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Genetic monitoring methods provide a means to obtain population metrics from cryptic (visually-evasive), rare, and hard to study aquatic organisms. Environmental DNA (eDNA) is emerging as an effective tool for detecting the presence of such species without direct observation. It is easy to deploy, cost effective to use over a large survey area, and unambiguously identifies target species. The presence of target species is ascertained by using molecular genetic assays to detect within water samples DNA that has been shed into the

aquatic environment. Two eDNA case studies are presented, one concerning an invasive species of non-native char and the second a cryptic amphibian that is a candidate species for listing under the Endangered Species Act. In Eastern Oregon, recovery of the ESA-listed bull trout (*Salvelinus confluentus*) is contingent upon minimizing the threats posed from interactions with the invasive brook trout (*S. fontinalis*). The remote nature of the study area makes comprehensive surveys impractical, resulting in the distribution of brook trout not being well-characterized. We developed qPCR assays for brook trout and investigated the potential for using eDNA methods to detect brook trout within a remote high-altitude lake known to contain the non-native char. The eDNA method proved sensitive under controlled laboratory settings and was capable of detecting spatial trends in brook trout occurrence; however, the detection probability was heavily influenced by field collection strategies. The second study investigated the use of eDNA to detect the presence of Oregon Spotted Frog (*Rana pretiosa*), a medium-sized aquatic frog endemic to the Pacific Northwest. The species distribution is believed to be substantially reduced from its historic range, but a species inventory is hampered by difficulties in detecting the species in the field, likely resulting in unrecognized populations. In the initial phase of this project, qPCR assays were developed and eDNA methods were investigated as a less intensive and invasive means to survey species distribution relative to available habitat.

Multiple Monitoring Programs' Sample Locations on One Map: Who is Monitoring What, Where, When, and How?

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Making management decisions over a large spatial scale requires a comprehensive understanding of conditions. A single monitoring project or program cannot tell the full story due to shrinking budgets, extensive spatial scales, complex life histories of anadromous fish, and the patchwork of land ownership such as we have in the Columbia River Basin. To help practitioners discover and learn about monitoring activities, the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) has developed a suite of online tools to map the locations of monitoring sites. Monitoring Explorer is an online map viewer designed to allow users to see multiple monitoring programs' sample sites and associated sampling protocol and design. The sharing of location data is achieved using a data exchange standard and web services. Each sample site is linked to PNAMP's online data documentation tools, thus allowing users to link locations to associated metadata such as protocols, sample designs, and methods. Viewing monitoring sites from multiple programs helps users identify opportunities for collaboration in data collection or to find data that allow analyses across large spatial and temporal scales.

The Effect of Experimental Hatchery Manipulations on Wild Broodstock Steelhead (*Oncorhynchus mykiss*) Growth and Behavior

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One of the biggest hurdles for a juvenile salmonid is migrating downstream from freshwater spawning grounds to the ocean. In our attempt to successfully recover a wild winter run of *Oncorhynchus mykiss* to the dammed North Santiam River in western Oregon, juveniles from wild broodstock were reared for more than 1 year at the Oregon Hatchery Research Center (OHRC) in Alsea, OR. The fish were reared for 9 months on two treatments: conventional tanks and tanks with a scalable complex structure that is easy for hatchery staff to implement and clean. Both groups were reared at densities below conservation hatchery standards and fed low-lipid experimental diets. Fish were assessed using morphometric measurements, behavioral assessments, and conducting growth rate analyses. Dorsal and caudal fins were compared using fin morphometrics of fish reared in conventional hatchery tanks and in tanks containing complex structure. Behavioral assessments, including predator-avoidance and foraging behavior, were used to compare fish across rearing treatments. In addition, a separate component tested fish growth rate related to individuals' egg size at spawning. Fish were raised in duplicate tanks containing small-egg origin fish, large-egg origin fish, and a mixture of the two. The goal of this project is to improve on current hatchery practices to produce a wild "surrogate" fish for downstream passage studies when a wild run is not large enough to provide experimental animals. Results of these analyses are in preparation and will be presented at the annual meeting.

Effectiveness Monitoring of Tidal Juvenile Salmon Habitat Restoration Projects

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The Columbia River Estuary Study Taskforce (CREST) implements multiple juvenile salmon habitat restoration projects annually. These projects range from estuarine to freshwater tidal, from the mouth of the Columbia River Estuary upriver through Reach F. A key component of successful restoration is pre- and post-project monitoring. Once limiting factors have been identified, appropriate metrics are selected to evaluate the short and long term impacts of restoration treatments. Selecting the right metrics is critical to measuring the success of project objectives (habitat opportunity, forage potential). Years of experience and integration of a standardized set of protocols has resulted in identifying key metrics that can be used across sites, and some metrics that can be implemented by general biologists. Utilizing these standardized protocols creates the opportunity to share data across sites throughout the tidal reaches of the Columbia River.

An Urban Stream Can Support a Healthy Population of Coastal Cutthroat Trout

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Urbanization presents numerous challenges to aquatic species. For fish, common threats are altered flow dynamics, poor water quality, and degraded food webs. These threats can be detrimental to fish and bring into question whether urban environments can support healthy populations. Tryon Creek is one of the largest urban watersheds in Oregon. Located in southwest Portland, its headwaters flow through urbanized neighborhoods where developed land of low, medium, and high intensity accounts for 55.6 % of the total land use. The U.S. Fish and Wildlife Service's, Columbia River Fisheries Program Office used demographic, life history, disease, and genetic indices to assess the overall health of the coastal cutthroat trout population in Tryon Creek. Results of these population health indicators were compared to coastal cutthroat trout populations that are not impacted by urbanization and considered healthy. Preliminary results indicate an estimated abundance of 1.9 ± 0.2 individuals per m2 with a mean condition factor of 1.26 (range 0.80-2.42). The population tested negative for 10 different pathogens and results were equivocal for *Renibacterium salmoninarum*. The population did not exhibit excessive deviation from Hardy–Weinberg equilibrium. Expected heterozygosity and allelic richness were 0.76 and 6.6, respectively. The FST between putative generations approximated 0.00. All of these results are similar to characteristics found in populations not impacted by urbanization and suggest that an urban stream can support a healthy fish population. However, it should be noted, that Tryon Creek may be an exceptional urban watershed, protected in large amount by surrounding public land, and located in an area with support from multiple local programs and a strong environmental ethic. Future comparison of the health of fish populations in other urban watersheds to Tryon Creek may be warranted.

The Efficacy of Using Various Electrical Waveforms to Kill the Embryos of Invasive Common Carp

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Common Carp can be skilled and devastating invaders due to their tolerance to a wide range of environmental conditions and because they can act as ecosystem engineers. Habitat degradation caused by invasive carp at Malheur Wildlife Refuge, a major stop for waterfowl on the pacific flyway, has triggered population control efforts that focus on removing adult carp. Solely removing adult carp has not successfully controlled the population, and as a result the refuge is considering the expansion of control efforts to include the electroshocking of young carp because vulnerable spawning areas are often localized in shallow, vegetated areas. Very little is known about what voltage gradients and waveform types are the most deadly to fish embryos and larva, so we exposed the embryos of Common Carp to two waveforms types commonly emitted by boat electrofishers (alternating current, square pulsed direct current). Fish were shocked at five different developmental stages (Blastula, Gastrula, Organogenesis, Active Movement, and Pigmentation) and under four different voltage gradients (10, 15, 20, and 25 V/cm); but the shock frequency, duration, and pulse width were held constant among treatments. Results from both shocking Common Carp and a pilot study that shocked steelhead indicate that the vulnerability of embryos and larvae to electricity differs among developmental stages, voltage gradients, and waveform types.

Distribution and Abundance of Umpqua Chub and Smallmouth Bass in the Umpqua River Basin

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The Umpqua chub (*Oregonichthys kalawatseti*) is endemic to the Umpqua basin of southwest Oregon. This small cyprinid is found along the margins of large rivers and utilizes slow water habitat with emergent vegetation and small gravel substrate. Historically, the species' distribution was continuous throughout the Umpqua River however more recent surveys in the early 1990s and in 2006-2007 indicated that the species was segmented into distinct populations separated by large sections without presence. Four populations are found in the Smith River, Elk Creek, Calapooya Creek- Olalla Creek, and Cow Creek-South Umpqua River. A number of variables have been suggested for this divergence ranging from salinity barriers in the estuary to the presence of smallmouth bass (*Micropterus dolomieu*) which could be both a competitor as a juvenile and a predator as an adult. The Roseburg Bureau of Land Management and the US Forest Service worked with the Oregon Department of Fish and Wildlife in 2015 to develop a sampling protocol to survey Cow Creek and the South Umpqua River for Umpqua

chub and smallmouth bass. We selected sampling sites that overlapped historic survey sites and attempted to spatially bracket the known distribution based on those historic surveys. We used an N-mixture model analysis to estimate population and confidence intervals and used habitat covariates to describe presence and abundance. We present the results of this population and distribution analysis and provide recommendations for species conservation through habitat and occupancy relationships.

Stock Difference in Growth, Smolting, and Early Male Maturation in Hatchery Spring Chinook Salmon

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For three consecutive brood years (2008-2010), both a Hood River and a Carson stock of spring Chinook Salmon, *Oncorhynchus tshawytscha*, were reared at Carson National Fish Hatchery under a common-garden experimental regime to assess the effects of stock on smoltification, early male maturation, and smolt-to-adult return rates. Juvenile fish were monitored for size, smolt development, whole body lipid, and early male maturation. Despite identical rearing conditions, the Hood River stock was smaller, had lower whole body lipid and gill Na+ K+ ATPase levels, and higher rates of early male maturation. Additionally we found that the threshold size for initiation of early male maturation was lower for the Hood River stock than for the Carson stock, suggesting a genetic basis for this life history difference. This study highlights the importance of understanding how specific genotypes may respond differently to the unique environmental conditional in a given hatchery. The different responses may in turn influence physiological and life history pathways that affect smolt-to-adult return rates and the demography of returning adults.

The Complex Line between Science and Resource Management Decisions

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In order to manage natural resources, decisions must be made to identify courses of action. Science and the information it produces is ideally and often used in decision-making processes. However, this application can be varied and is quite complex. This talk will provide one perspective, from management experience, on the different ways in which science fits within a system of natural resource decision-making. Improvements that can be made to the relationship between science and decision-making will also be discussed.

SDrawGUI: A Graphical User Interface for GRTS Sampling and Analysis

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Spatially-balanced sampling is a popular design for ecologists who want to use probabilistic sampling and avoid selecting locations that are close in proximity. Generalized random tessellation stratified (GRTS) sampling is a spatially-balanced sampling approach that provides an efficient and flexible alternative to simple random sampling. I will demonstrate a new tool for drawing and analyzing data from a GRTS sample of points in a stream network. The graphical user interface of the SDrawGUI package combines elements of existing R packages with new features for sample selection, data analysis, mapping, and R code archival. This work is funded by Western Region networks of the National Park Service.

Census and Lake-stream Movements of Spawning Bull Trout Obtained Using an Underwater Video Station in an Odell Lake Tributary

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Small population size has been identified as a primary threat to bull trout in many core areas and across all six recovery units. Abundance monitoring is needed to assess population status, trend, and response to management actions; but it can be costly and often requires capturing individuals for counts or population estimates, which can subject a substantial proportion of a population to increased mortality risks. Redd counts are used as a proxy for abundance, but

observer error and the relationship to actual abundance are rarely quantified. We monitored a small bull trout population during the 2012 spawning period using an underwater video station in Trapper Creek, which contains the only documented spawning ground in the Odell Lake Core Area. The station (located 10 m upstream of the lake) consisted of a picket-style weir, passage chute, and submersible video camera and lighting in the stream; and motion-sensitive DVRs and 12-volt batteries in a steel lockbox on the streambank; powered by a solar panel. Bull trout (range, 45-90 cm) accounted for 340 video records. Each fish had at least one distinctive physical characteristic and 43 unique bull trout (21 females, 22 males) were identified passing through the station. Individual males passed through the fish chute on average 5 times (maximum, 18). Females only passed on average 2 times (maximum, 3). This movement pattern suggests that access to the lake during spawning was important to bull trout as either cover or for courtship. Brook trout, present in Trapper Creek, were not recorded at the station. These results suggest that in certain situations this video station can be a useful monitoring tool by providing census, biological, and behavioral data for spawning bull trout, calibrating redd counts, and assessing brook trout threats, without handling fish or restricting movement.

Evaluation of Upstream Migration and Dam Passage by Adult Pacific lamprey in the Lower Snake River, 2104-2015

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Pacific lamprey declines in the Columbia River basin appear most dramatic for interior populations such as in the upper Snake River. While causes of decline are not well understood, it is hypothesized that dam passage may limit adult escapement to upstream locations throughout the Columbia River system. To test this hypothesis, we evaluated adult lamprey passage through adult fish ladders, monitored passage behavior and potential bottlenecks, and estimated dam conversion rates at four USACE Dams on lower Snake River. During 2015, 373 adult lamprey were captured at John Day Dam on the Columbia main stem, surgically implanted with radio transmitters and transported for release to Ice Harbor Dam on the lower Snake River. Monitoring of the radio-tagged sample is on-going. As of 15 October 2015, 243 radio-tagged fish had been detected at Ice Harbor Dam (65%), 66 were detected at Lower Monumental (18%), 30 were detected at Little Goose (8%) and 10 were detected at Lower Granite dams (3%). Preliminary passage ratios by project are 49% for Ice Harbor Dam, 70% for

Lower Monumental Dam, 44% for Little Goose Dam and 67% for Lower Granite Dam. Preliminary passage ratio from Ice Harbor tailrace to Lower Granite Dam exits is 3%. These represent minimum estimates which do not account for late-fall 2015 or spring 2016 movement. However, 2015 preliminary estimates are broadly similar to rates observed in 2014. Additional passage metrics including percent approach, relative entrance and fishway use, entrance and fishway passage success, passage times for fishway segments, and fallback rates at each dam were also examined. These metrics were used to locate primary entrances, fishways, and turn around zones used by fish that do not successfully pass each dam. Findings allow managers to identify potential passage impediments and opportunities for future fishway improvements in the lower Snake River.

Reductions in Smolt Transportation Correlate with Decreased Straying of Hatchery Steelhead into the John Day River, Oregon

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Interactions between donor and recipient populations can influence the productivity of locally-adapted salmonid populations. The John Day River basin in Northeast Oregon supports a wild population of summer steelhead *Oncorhynchus mykiss*, which receives stray wild and hatchery steelhead from the upstream Snake River basin. We monitored the proportion of hatchery origin spawners present in the John Day River basin from 2004â€“2012, and estimated that despite no hatchery steelhead releases in the John Day River basin, up to 38% of the natural spawners were hatchery-origin strays. The proportion of hatchery origin spawners decreased through our monitoring period. Information theoretic model selection identified the percentage of hatchery steelhead smolts barge transported from Lower Granite Dam on the Snake River as the most plausible explanation for this decline. In-stream detection of PIT tagged adult steelhead indicated that hatchery and wild steelhead which were barged as smolts through the Snake and Columbia rivers were 38 and 51 times more likely, respectively, to be detected as adults in the John Day River as compared to those not barged downriver. To minimize the proportion of non-natal spawners (of both hatchery and wild origin) in Columbia River tributaries, less than 40% of Snake River steelhead smolts should be barge-transported.

Sink or Smolt Part II — Lower Elevation John Day River Steelhead Populations

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Several lower elevation tributaries in the John Day River basin experience intermittent stream flows during critical summer rearing periods for ESA-listed Middle Columbia River summer steelhead *Oncorhynchus mykiss*. Rock Creek, a tributary of the Lower Mainstem John Day River (LMJDR), is one stream that experiences intermittent summer flows. Steelhead redd surveys indicate redd densities in lower Rock were greater every year than mean redd densities across the John Day basin. In the summers of 2011 and 2012, juvenile steelhead surveys were conducted in Rock Creek to estimate abundance, condition metrics, and age structure. Age 0 juvenile steelhead were the most prominent age class captured with few older juveniles based on length histograms and scale data. The lack of fish > age 0 in lower Rock Creek raised concerns about juvenile recruitment and stream productivity. In 2012-2015, we implanted Passive Integrated Transponder tags into juvenile steelhead in lower Rock Creek. Our data suggest growing conditions may favor age 1 smolts in comparison to other John Day River populations dominated by age 2 smolts.

Effects of Rearing Density and Vertical Sorting on Adaptation to Captivity in Steelhead

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Steelhead that are reared in hatcheries rapidly adapt to captive conditions. Two main questions exist in determining if adaptation to captivity can be reduced in hatchery salmonids. (1) What traits are under selection for high performance (large body size) in hatcheries? (2) What aspects of hatchery culture exacerbate the rate of adaptation? Using 13 families of Alsea River steelhead we test whether rearing fish at low density reduces differences in mean body size between families and thus, reduces the opportunity for selection. We also test whether families position themselves differently in the water column and if early positional differences correlate with growth in both high and low density treatments. There was a significant family effect on position in the water column at first feeding. Multiple families were surface oriented, while other families associated with the bottom of the tank. We will correlate surface/bottom orientation with growth data from siblings in the rearing density experiment that are approximately half-way through the one-year smolt rearing process. By identifying traits and rearing environments that influence domestication we may be able to change the hatchery environment to produce captively-reared fish that are less adapted to novel, hatchery conditions.

Assessing Potential Effects of Riparian Forest Thinning on Stream Temperature: Conceptual and Modeling Approaches

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We developed a conceptual model to describe basin- and reach-scale processes and factors that influence stream temperature, and we provide a decision framework for understanding direct and indirect effects of land use on stream temperature. The conceptual model shows how five functionally related variables (climate, organisms, relief/topography, parent material, and time) drive basin hydrology and sediment transport, and channel and valley reach morphology to influence stream temperature. The decision framework addresses multiple stream sizes and environments (e.g. rangelands, prairies, forests, urban areas, and agricultural areas). We present an approach for assessing land management risks using the decision framework. As an example, we use this approach and process-based modeling to evaluate potential effects of riparian forest thinning on stream temperature in a mountain stream in the western Cascades, Oregon (USA).

Effects of Dietary Lipid Source and Ultraviolet Radiation on Growth and Fatty Acid Profile of Steelhead, *Oncorhynchus mykiss*

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The primary lipid source used in hatchery salmonid feeds is marine fish oil which is characterized by high levels of polyunsaturated fatty acids (PUFA). As PUFA are highly susceptible to peroxidation, it is thought the high marine fish oil content of hatchery salmonid feeds is a contributing factor in a disease called steatitis which is an ongoing issue at some Pacific Northwest hatcheries. Signs of steatitis include inflammation of adipose tissue, fin

erosion and skin lesions. Skin lesions are often observed when affected fish are moved from the hatchery to outdoor culture systems that are exposed to sunlight. There have been few studies designed to cause steatitis through dietary manipulation and we are not aware of any that have altered both diet and UV radiation. Therefore we conducted a two-factor study to determine the effects of dietary lipid source and artificial UV radiation on growth responses, histology and tissue fatty acid profile of juvenile steelhead (*Oncorhynchus mykiss*). Results of the study will be presented.

Physiological Mechanisms of Imprinting and Homing Migration in Pacific Salmon

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The amazing abilities of Pacific salmon to migrate long distances from the ocean to their natal streams for spawning have been investigated intensively, but there are still many mysteries because of difficulties to follow their whole life cycle and to wait their sole reproductive timing for several years. In my laboratory, we have tried to clarify physiological mechanisms of imprinting and homing migration using anadromous chum salmon (*Oncorhynchus keta*) in the north Pacific Ocean as well as lacustrine sockeye salmon (*O. nerka*) and masu salmon (*O. masou*) in Lake Toya and Lake Shikotsu, Hokkaido, Japan, where the lakes serve as a model "ocean". Three different approaches from behavioral to molecular biological researches have been conducted using these model fish. First, the homing behaviors of adult chum salmon from the Bering Sea to Hokkaido as well as lacustrine sockeye and masu salmon in Lake Toya were examined by means of physiological biotelemetry techniques, and revealed that salmon can navigate in open water using different sensory systems. Second, the hormone profiles in the brain-pituitary-thyroid (BPT) and brain-pituitary-gonad (BPG) axes were investigated in chum salmon and lacustrine sockeye salmon during their imprinting and homing migration by means of molecular biological techniques, and clarified that thyrotropin-releasing hormone and salmon gonadotropin-releasing hormone play leading roles on imprinting and homing migration, respectively. Third, the olfactory functions of salmon were studied by means of electrophysiological, behavioral, and biochemical techniques, and made clear that dissolved free amino acids, that are released mainly from biofilms in the riverbed, compositions in natal streams are crucial for olfactory imprinting and homing in Pacific salmon. We also suggested that olfactory memory formation during juvenile imprinting and memory retrieval during adult homing of chum salmon may be controlled by the BPT and BPG hormones, respectively, and can be clarified using N-methyl- D-asparate receptor's essential subunit NR1 as a molecular marker. These findings are discussed in relation to physiological mechanism of imprinting and homing abilities of Pacific salmon.

Environmental and Natural Life History Determinants of Migratory Phenotypes in Juvenile Spring Chinook Salmon

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There is considerable variation in downstream-movement life history tactics displayed by Chinook salmon *Oncorhynchus tshawytscha* in the Willamette River, Oregon, USA. However, it is unclear if juvenile migratory phenotypes are determined in response to environmental stimuli or if they are established naturally much earlier in life. At the same time, there is a growing need for juvenile wild fish surrogates to conduct fall and spring migration studies to evaluate passage efficiency and survival through the Basin's reservoirs and dam projects. We conducted rearing trials to experimentally determine the effects of environmental variables on the developmental trajectories and expression of migration phenotypes in juvenile Chinook. We found that temperature, density, tank substrate, diet lipid content, and feeding strategy can be manipulated to produce surrogate wild fish that follow targeted growth trajectories, resulting in the expression of specific movement phenotypes: fall and spring smolts. Analyses of morphology of wild juvenile Chinook salmon in the Upper Willamette River revealed that body shape variation is correlated with these two migratory pathways and that our wild surrogates more closely resemble their wild counterparts compared to conventionally-reared hatchery fish. In addition, we have documented fish sort into distinct surface- and bottom- oriented groups at the start of exogenous feeding and this orientation persists after separation. At 2 months post-swim-up, surface and bottom phenotypes differed morphologically and reflect the wild fall and spring migrant morphology, respectively. Our results suggest that vertically sorted phenotypes may reflect different juvenile life history tactics and by manipulating various environmental variables we can influence the developmental trajectories and migration phenotypes juvenile Chinook salmon express.

Introduction to Forest Management of Riparian Reserves in Regards to Thinning and Prescribed Fire

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Within federal Riparian Reserves (west-side) and Riparian Habitat Conservation Areas (east-side), public land managers are required to assure that vegetation management activities (thinning or prescribed fire) are beneficial to the ecology and function of these areas. Either

due to ESA salmonid extinction risks and/or catastrophic fires, there is a desire of some to step up vegetation restoration where others prefer to refrain from this type of management in riparian reserves. As such, there is a need to better identify appropriate ecological factors that would indicate whether thinning or prescribed fire activities could be effective in aiding the restoration of riparian function and resilience, especially at the landscape level. Often there is insufficient science to provide managers the confidence to support these activities. This is especially true in regards to the understanding of recovery rates and risks. Through the following presentations, it is hoped that this session will aide in improving and supporting science based recommendations to management.

Oregon Coast Coho Salmon: Recovery under the ESA

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NOAA Fisheries released a proposed recovery plan for Oregon Coast coho salmon in October, 2015 and received comments from agencies and the public. After considering comments received, NOAA Fisheries will publish the final the plan. Compared to most other listed salmon and steelhead species, the basic strategy for recovering OC coho recovery is elegantly simple: increase rearing habitat by increasing the quantity and quality of stream and estuarine complexity. This presentation will include an update on the recovery planning process including scientific and policy developments.

Conservation Planning for Pacific Lamprey

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Howard Schaller

Pacific Lamprey along the West Coast of the United States have declined in abundance and become restricted in distribution throughout Washington, Oregon, Idaho, and California. Threats to Pacific Lamprey occur in much of the range of the species and include restricted mainstem and tributary passage, reduced flows and dewatering of streams, stream and floodplain degradation, degraded water quality, and changing marine and climate conditions. The Pacific Lamprey Conservation Initiative is a regional strategy to improve the status of Pacific Lamprey throughout their range by helping implement research and conservation actions. A clear understanding of Pacific Lamprey life history expression is important in guiding lamprey restoration actions. We evaluated relative risk of extirpation and vulnerability to climate change. Both of these approaches were life stage based. To systematically characterize the conservation risk of Pacific Lamprey across its range, an assessment was conducted with a diagnostic tool adapted from NatureServe by using existing demographic and threat information. We applied a tool for consistently scoring the vulnerability of Pacific Lamprey to future climate change. We identified downscaled environmental exposures that influence

Pacific Lamprey vulnerability and characterize Pacific Lamprey life-stage sensitivity to direct exposure for these specific environmental metrics. The findings of both the risk and climate vulnerability assessments were informative for guiding future restoration activities for Pacific Lamprey.

Fish Passage Banking: An Innovative Approach to Fish Passage Waiver Mitigation

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Fish Passage Banking is an innovative new concept being tested in a pilot project on Oregon's North Coast by the Oregon Department of Transportation (ODOT) and the Oregon Department of Fish and Wildlife (ODFW) with assistance from the Willamette Partnership and The Nature Conservancy. This presentation will describe what fish passage banking is, why it's a good idea for Native Migratory Fish (NMF), and maintaining ODOT's infrastructure, and how banking will work under this pilot project. Oregon's fish passage law (ORS 509.580 through 910) requires that fish passage be addressed whenever a culvert is replaced or there is a significant repair. Applicants may pursue a waiver for fish passage if providing full passage at the project location is problematic and they can demonstrate a net benefit to Native Migratory Fish (NMF) by implementing mitigation at another location. Fish Passage Banking will facilitate the removal of the highest statewide priority fish passage barriers in a watershed by allowing ODOT to mitigate multiple culverts project waivers with limited habitat for NMF by addressing a high priority barrier instead. The two main project components being tested during the fish passage banking pilot project are the policy framework for banking and the method of calculating bank credit. The Net Benefit Analysis (NBA) Tool is a methodology for quantifying habitat quantity and quality at both the bank (mitigation) site to determine credits, and the waiver (impact) site to determine debits. The NBA tool uses ODFW aquatic survey data and the ODFW HabRate model to generate habitat scores for every salmonid species and life stage. The tool generates quality weighted habitat acres as the unit of credits and debits. The pilot will also test the policy issues around mitigation banking for fish passage. The Fish Passage Banking framework is documented in the Mitigation Bank Instrument (MBI). The MBI contains the requirements and procedures to establish a fish passage bank, and to debit a waiver site against the bank to ensure a net benefit to NMF.

The Role of Recovery Criteria in the Federal ESA Reclassification Process

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A common misconception with recovery plans for species listed under the federal Endangered Species Act (ESA) is that recovery criteria within a final recovery plan must be fully achieved prior to developing a proposal to downgrade or remove federal protections (i.e.,

reclassification). The ESA however, does not require all criteria be met. For one, recovery plans are not regulatory documents; they are, for all intents and purposes, guidance documents. Moreover, given the long timeframes often required to recover species, threats for which recovery criteria were developed may have abated without recovery actions being implemented or new threats not identified at the time of listing and recovery plan development may have arisen. For these reasons the U.S. Fish and Wildlife Service and National Marine Fisheries Service - the two agencies implementing the federal ESA - may legally consider reclassifying a species even if recovery criteria have not been fully met. Logically it follows there may also be instances where new threats arise and a species' listing status may remain unchanged (or worsened) despite all recovery criteria being met. While recovery criteria are the cornerstone of any recovery plan, determining whether they have been fully achieved, or achieved "enough", and if a species should be reclassified as a result, is ultimately determined by a five-factor threats analysis, the same process that guides a determination of whether a species' should be listed as threatened or endangered. This presentation will explore this topic conceptually with application to species in Oregon that have been recently delisted (e.g., Oregon chub) and several that are currently under consideration for downlisting or delisting.

Escapement Estimates for Coho Salmon Using Genetic Mark-Recapture

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Coho salmon (*Oncorhynchus kisutch*) have declined dramatically in the southern part of their geographic range. Monitoring of coho salmon populations is needed to determine the status of populations and mitigate future losses, but coho often spawn in small, remote coastal streams where limited visibility and restricted access make redd count surveys challenging. As a result, estimating escapement abundance from such redd counts is likely highly inaccurate, and alternative approaches are therefore needed. Here, we use a genetic analogue of the traditional mark-recapture method (Genetic Mark-Recapture, GMR) to estimate escapement of adult coho salmon in two Northern California streams, Freshwater and Mill creeks. In GMR abundance estimation, the first sampling event consists of collection of tissues from adult fish (typically from traps and/or carcasses), with tissue collected serving as the marks (M). The second sampling event consists of juveniles (some of which are progeny of parents in (M) captured in out-migrant traps. Sibship reconstruction inferred by genetic analysis is used to determine the number of unique parents contributing to the juvenile sample of size (C). Recaptures (R) are the number of parents from the first sampling event (M) that were assigned at least one offspring from the second sampling event with genetic parentage analysis. Escapement abundance is then estimated using a modified version of the simple Peterson

estimator, Nc=M*C/R. Application of this approach resulted in abundance estimates of 603 for Freshwater Creek, which is larger than the current abundance estimate of 318 in 2013. No current abundance estimates are available for Mill Creek, but our approach estimated 548 in 2012 and 242 in 2013. This GMR approach may provide a more precise and less invasive alternative for monitoring coho salmon populations in small remote streams.

Journey's End

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This 18 minute video captures underwater behavior and spawning activity of wild chum salmon (*Oncorhynchus keta*), fall Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and Pacific lamprey (*Entosphenus tridentatus*) in natural habitats on the northern Oregon coast. Filmed with a GoPro Hero and Hero3 camera and edited in iMovie 11.

Integrating Surface Water Solutions to Meet Evolving Regulations

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Nicole Czarnomski

Surface water is regulated by a multitude of local, State, and Federal regulations each with its own set of priorities and rules. Oregon is facing increasing surface water regulations related to the recent FEMA NMFS BiOP which will require stricter regulations for floodplain development including stormwater management, buffers, and setbacks. Meeting surface water regulations requirements on a piecemeal basis is increasingly complex, expensive, and has a high risk of failure. This is because ecosystem services operate as interdependent processes that cannot be parsed out and accounted for in isolation. The need to integrate watershed context and function is broadly applicable to habitat, species, and water quality management planning and restoration actions in streams. The challenge is demonstrating accountability to regulators and documenting the ecosystem benefits of particular actions within a watershed context over time. Navigating this maze of layered and overlapping compliance measures is increasingly challenging for surface water management agencies and regulators alike. This presentation will explain potential unintended consequences of adopting continuous simulation flow control tools and policies that do not take into account local conditions. Some detention policies that could potentially increase stream erosion include; minimum orifice size, matching existing development hydrology, and presumed channel forming discharge thresholds. We will also describe stream resilience strategies that can integrate surface water goals with watershed functional uplift. This method evaluates functions at the site-level and considers these within the broader watershed context. This is an opportunity for jurisdictions to step back and assess ecosystem function and processes and apply restoration and conservation actions that document benefits in a way that complies with multiple regulations. Understanding ecosystems

as a network of interdependent systems that support diverse services such as water quality, habitat, and flood control enables us to focus on restoring the overall network. This approach is more cost effective, self-sustaining, and resilient while meeting multiple compliance goals as opposed to adding more layer local code and regulations.

Timothy Lake Brook Trout and Kokanee Spawning Disruption Program: Effective Management Tool or an Exercise in Futility?

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On February 22, 2011, after consultation with the Clackamas Fish Committee, PGE filed with the Commission a plan to disrupt brook trout and kokanee spawning and evaluate the effects of the disruption program. Brook trout and kokanee are nonnative to the Clackamas River basin, and following their introduction into Timothy Lake have established naturally self-sustaining populations. It is hypothesized that negative ecological interactions are occurring and may be adversely impacting native cutthroat trout in Timothy Lake and its tributaries. The objective of this program is to bolster the native coastal cutthroat trout population by utilizing tributary weirs to reduce the spawning success of brook trout and kokanee.

Biological and Physical Ocean Indicators Predict the Success of the Invasive Green Crab, *Carcinus maenas*

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An introduced population of European green crabs *Carcinus maenas* was established in San Francisco Bay prior to 1989. Subsequently, their larvae were carried northward into the embayments of Oregon, Washington, and British Columbia by the unusually strong Davidson Current during the winter of the El Niño of 1997 – 1998. Since this colonizing event, green crabs in Oregon and Washington have persisted at low densities. In this study, we show that after the arrival of the strong founding year-class of 1998, significant recruitment to the Oregon and Washington populations has occurred, but only in 2003, 2005, 2006, 2010 and 2015. Warm winter water temperatures, high positive values of the Pacific Decadal Oscillation (PDO) and Multivariate ENSO (El Niño Southern Oscillation) indices in March, weak southward shelf currents in March and April, a late biological spring transition, and high abundance of subtropical copepods are all strongly correlated with strong year-classes. We hypothesize that northward transport of larvae from California by coastal currents during warm winters is the mechanism by which the larvae are delivered to Oregon and Washington. Among the best

indicators of northward flow (and green crab recruitment) were the date of "biological spring transition", the sign of the PDO, and the biomass of southern copepod species, which indicate (1)stronger northward flow of coastal waters during winters, (2) relatively warm winters (sea surface temperature >10°C), which enable larvae to complete their development in the near-shore, and (3)coastal circulation patterns that may keep larvae close to shore, where they can be carried by tidal currents into estuaries to settle.

Bull Trout (*Salvelinus confluentus*) Life History and Parasite Associations in the Upper Willamette Basin

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Bull trout are known to exhibit substantial life history variation, and an understanding of population-specific aspects of life history can be useful in developing effective measures to improve population status. In the Upper Willamette Basin, studies using radio telemetry, PIT tag interrogation systems, and trapping have indicated a predominantly migratory life history in bull trout populations. Although migratory behavior may provide access to habitats conferring relatively high growth opportunity, it is also possible that increased movement can expose bull trout to high rates of mortality. Bull trout populations in the Willamette Basin substantially declined by the late 1900s, prompting a coordinated multi-agency effort to recover bull trout. One element of this has been a reintroduction program consisting of direct translocation of bull trout fry to recipient spawning and early rearing streams in 1993 – 2005 and a head-start captive-rearing program in 2007 – 2013. In 2013, exceptionally high mortality (82%) and a high incidence of deformities occurred among captive-reared fry. We used radiography, necropsy, and histology to assess factors adversely affecting these fish and found a strong association with infection by metacercariae of the trematode parasite *Nanophyetus salmincola*. To assess implications of parasite infections for juvenile bull trout in the wild, we conducted surveys for the Juga spp. snail host of *N. salmincola* in the basin and conducted fish health examinations on incidental bull trout mortalities and surrogate fishes. Bull trout spawning areas occur in colder stream reaches upstream of the snails, but fish in downstream reaches may acquire relatively heavy loads of metacercariae. Infections of *N. salmincola* commonly occur without associated obvious skeletal deformities in other salmonid species in watersheds that are warmer and endemic for the infection in Oregon, and it is plausible that the infection is more pathogenic to early juvenile bull trout, which apparently have not co-evolved with the parasite. Moreover, parasites such as *N. salmincola* may contribute to higher mortality among juvenile bull trout that move downstream too early, and this may become increasingly important if changes in

habitat conditions bring earlier onset or increased intensity of contact between juvenile bull trout and parasites.

POSTERS

Life History and Population Dynamics of the Jenny Creek Sucker

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The Jenny Creek sucker (*Catastomus rimiculus* sp.) is a dwarf form of Klamath smallscale sucker endemic to the Jenny Creek Watershed in the Cascade-Siskiyou National Monument and Soda Mountain Wilderness Area of southwest Oregon. This unique population is one of the primary aquatic resources protected by the national monument. A BLM conservation plan identified the need to improve understanding of the life history of this species, with specific recommendations to identify spawning and rearing habitats. In 2013, BLM initiated a multiple year study of Jenny Creek suckers to better describe the distribution, movement, growth, and population dynamics of the species. To date, we have conducted three years of electrofishing surveys, including a quantitative effort to estimate population abundance in 2015. We PIT-tagged approximately 1000 individual suckers, and deployed five PIT antenna arrays in suspected spawning tributaries. Preliminary results indicate that Jenny Creek suckers are patchily distributed within Jenny Creek, are found in relatively low abundances, and that the population structure is dominated by younger age classes. No indications of seasonal spawning migrations have been detected. Multiple tagged individuals have been recaptured during the study, providing the first empirical measurements of individual growth rate for Jenny Creek suckers. Future plans include continuing to recapture tagged fish and developing environmental DNA as a tool to characterize spawning distribution in tributaries. New understanding obtained from this study will guide future management of the watershed by the BLM, and may help prioritize areas for restoration, conservation, or future land acquisition.

Examining Diversity Inequities in Fisheries Science

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A diverse workforce in science can bring about competitive advantages, innovation and new perspectives, skills, and experiences for understanding complex problems involving the science

and management of natural resources. In particular, fisheries sciences confront exceptional challenges due to complicated societal-level problems from the overexploitation and degradation of aquatic ecosystems worldwide. Here, we examine the status of gender and race/ethnicity that comprise the U.S. fisheries science workforce based on a survey of 498 faculty members from 56 institutions of higher education and 1,708 federal employees. Our findings show that minorities and underrepresented groups are still a small portion of tenure-track faculty and federal government professionals likely due to systematic biases and cultural barriers.

Evaluation of Gastric Lavage for Quantifying Stomach Contents of Lake Trout from Odell Lake, Oregon

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Gastric lavage provides a nonlethal means to sample the stomach contents of fishes. With some exceptions, published studies that have evaluated this technique have focused on species that prey on relatively small diet items that are effectively removed by gastric lavage. Piscivorous species such as lake trout may prey on fishes that exceed 50% of their own length. The size of these prey items may make removal using gastric lavage more difficult. Therefore, we compared the dietary composition of lake trout sampled using gastric lavage with lake trout sampled by whole stomach removal. Secondarily, these data were used to identify the general food habits of lake trout in Odell Lake, Oregon. The majority (73%) of the lake trout sampled during this study were ≥ 600 mm. Gastric lavage removed > 90% of the stomach contents of lake trout sampled during the summer and autumn of 2014 in Odell Lake; including prey fish up to 50% of the length of individual lake trout. We observed > 98% overlap in dietary composition (measured as percent by weight) between gastric lavage and whole stomach removal for lake trout sampled during the summer and autumn of 2014. The percent of stomach contents removed and percent overlap in dietary composition were less for lake trout sampled during the spring of 2014; however, this may have been a result of field crew experience or slight differences in gastric lavage methodology. Kokanee, mountain whitefish, tui chub, and unknown salmonids and other fishes made up the greatest composition by weight of lake trout stomach contents. However, lake trout also used seasonally abundant food sources such as fish eggs and Dipteran pupae. Overall, gastric lavage appears to be a viable, non-lethal method for accurately characterizing the food habits of highly piscivorous lake trout that can consume relatively large prey items.

Stream Restoration in West Fork Cow Creek: A Strategic Approach to Accomplishing Watershed-scale Work

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West Fork Cow Creek (WFCC) is a 55,914 acre 5th field watershed located at the southwestern tip of the South Umpqua Sub-basin. This watershed has received little attention to address known limiting factors to threatened fish populations, including the lack of quality fish habitat, fish passage barriers, and poor riparian conditions. In 2012, Medford District Bureau of Land Management (BLM) began a new partnership with the local watershed council, Partnership for the Umpqua Rivers (PUR), to raise funds for stream restoration project work. Since that time, PUR, BLM, and all streamside landowners in the basin, as well as other stakeholders, formed a planning team to direct restoration prioritization and monitoring across the entire watershed. This planning and coordination effort resulted in significant leveraging of state and federal funds. Funds are secured to complete surveys of restoration suitability, fish passage through culverts, and fish species presence/absence. These surveys along with water quality monitoring data will be used to create a prioritized restoration action and implementation plan for the watershed. Funds are raised for instream enhancement in four WFCC tributaries and are slated to begin in summer of 2016 on two of these tributaries. Although project work has not yet started, over $644,000 is in place to target four streams for fish habitat enhancement work and pre-project survey and monitoring data collection. Another $516,000 is in place to deal with legacy road issues. The ambitious goal to restore stream and riparian habitat at this scale is only possible through the efforts of the well-coordinated team members and partners.

Umpqua Basin Beaver Working Group Project: Goals and Objectives

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Historically, beaver (*Castor canadensis*) dams in the Pacific Northwest (PNW) were prevalent; forming complex wetland habitat to which numerous species such as coho salmon (*Oncorhynchus kisutch*) and Pacific lamprey (*Entosphenus tridentatus*) are uniquely adapted. Since then, anthropogenic reduction of beaver populations and past land management has led to a riverine landscape largely void of beaver and nearly inhospitable to their natural establishment due to decreased availability of forage and increased stream power. In recent decades, PNW land managers have invested considerable effort to enhance instream habitat and riparian vegetative conditions while abiotic processes rebound more slowly over time. While some beaver response to such efforts has been observed in the Umpqua River basin, beaver populations are typically isolated to headwater reaches or are present in urban areas where their behaviors often cause conflict with land owners. As a result, the Umpqua Basin

Beaver Working Group (UBBWG) made up of federal and non-federal agencies as well as non-governmental organizations was formed in 2013. The UBBWG has developed four primary objectives which are listed in the forthcoming discussion. As a result of past management of federal lands in the basin, openings in riparian canopies vital to survival of palatable forage species are rare or non-existent in some subbasins. Subsequently, one objective of the UBBWG is to encourage beavers dispersing from source populations, to naturally establish in riparian openings recently created and strategically planted by UBBWG members and volunteers. Where high quality habitat is available, but un-used, beaver reintroduction may be important to accelerate establishment. For this reason, a second objective is to capture known "nuisance" beaver which would be released to previously selected and vetted stream reaches in the basin. A third objective is to provide land owners in the basin with cost sharing opportunities to allow persistence of beaver colonies, where termination would have otherwise been likely. The fourth objective addresses what is potentially the greatest challenge limiting beaver/human coexistence- the overall lack of public knowledge regarding beaver behavior and related wetland ecology. To fill this knowledge gap, we plan to use a multifaceted approach to public education and outreach, including outdoor learning events for children, and outreach to adults through public meetings, watershed council involvement, and the media.

Developing a Non-invasive Method to Assess Green Sturgeon (*Acipenser medirostris*) Condition

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Non-invasive methods to determine sturgeon condition are needed for both aquaculture and sturgeon conservation. Our aim was to determine whether a Distell fish fatmeter could be used for reliable assessment of green sturgeon condition. There is no documented use of this technology with sturgeon species. To establish the relationship between lipid content and fatmeter reading, we conducted a laboratory experiment on green sturgeon held in captivity at the Conte Anadromous Fish Research Center. Thirty sexually-immature sturgeon (age 8, total length 75.1 - 114 cm, weight 1.9 - 7.4 kg) were held in Connecticut River water at 14ºC, and under five different feeding rates: 0.1%, 0.25%, 0.5%, 1.0%, and 1.5% of body weight/d. All experimental sturgeon carried a previously implanted Passive Integrated Transponder (PIT) that provided unique identification. We conducted proximate composition analysis on muscle tissue of sacrificed animals, along with fatmeter readings, after 167-169 days. Muscle fat content was determined via supercritical fluid extraction (SFE) using carbon dioxide and an ethanol modifier. Five fatmeter measurements were taken at each of three different sites along the dorsal flank above the lateral line. Four sturgeon died of causes unknown. One sturgeon from the 0.25 %

body weight/d treatment died on day 89, and 3 from the 1.0 % body weight/d treatment died on days 147, 149, and 149. These fish were excluded from the analysis. For all treatments, mean total length increased between the initial sample and the end of the experiment. However, fish fed the lowest ration decreased in mean weight and condition factor. As expected, hepatosomatic index (liver weight /body weight x100 %) increased with feeding ration. Additionally, muscle protein content was positively correlated with ration, and inversely correlated with muscle moisture content. In spite of a wide range of resulting individual muscle lipid levels (0.5 – 3.4%), the fatmeter readings did not accurately reflect flesh lipid content, regardless of the position on the sturgeon body where they were taken. The readings may have been affected by the presence of scutelets, on the skin or lack of a sturgeon-specific instrument calibration. Further refinement of this technology is needed if it is to be used on sturgeon either in aquaculture settings or in the wild.

Heat Shock Proteins Expression in Summer/Fall Chinook in a Changing Thermal Regime

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Summer/fall run Chinook in the Deschutes River are a wild stock that is used as an indicator for the Pacific Salmon Treaty. The Confederated Tribes of Warm Springs Reservation of Oregon (CTWSRO) and co-managers, Oregon Department of Fish and Wildlife (ODFW) have been monitoring this stock since the 1970s. With the installation of the select-water withdrawal (SWW) tower at Round Butte Dam by Portland General Electric Company in 2009, water temperatures in the Deschutes River have been managed to mimic the historic thermal regime. This has resulted in warmer temperatures in the spring when juvenile fall Chinook are preparing for seaward migration. Since 2011, the CTWSRO has been PIT tagging 25,000 juvenile fall Chinook in an effort to advance understanding of this stage of development, migration patterns and survival rates. In 2016, the CTWSRO will begin collecting tissue samples from juvenile fall Chinook for geneticists at Columbia River Inter-Tribal Fish Commission to investigate whether expression of heat shock proteins (HSP) in fall Chinook post-SWW have returned to frequencies prior to when the Pelton-Round Butte Hydroelectric Complex was constructed in the 1960s. HSPs are induced in response to high temperatures indicating a change in environment over generations and may confer differential survival. A comparison of allelic frequency in HSP of fall Chinook that return compared with those that fail to return as adults may prove useful for managers faced with complaints in the change in management of the thermal regime of the Deschutes River. This poster will inform AFS attendees on developments in fall Chinook research in the Deschutes River including trends in adult escapement, what has been learned in recent juvenile studies, migration patterns of juveniles and adults, and recent genetic results, as well as what is planned in the future.

Riparian Areas = A River Runs Through Them

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Loss of key habitat and degraded water quality (TMDLs) affect many of our coastal regions. One of the key components of most restoration projects is re-vegetating the site. Whether we are restoring riparian areas, wetlands (tidal and freshwater), or floodplains, a healthy riparian area strong re-vegetation plan is essential to the long-term success and resource value of these projects. The Tillamook Estuaries Partnership (TEP) and others have developed extensive riparian planting programs. As an example, TEP manages two such programs and coordinates a third: 1) The Backyard Planting Program (BYPP); 2) the Northwest Oregon Restoration Partnership (NORP), a native plant nursery); and 3) the Tillamook County Partnership for Invasive Species Management (TCPRISM). These projects focus on maintaining healthy riparian areas through voluntary efforts by landowners on both private and public lands. With a strong emphasis on native plant stock (provided by NORP) and invasive species removal and monitoring, riparian areas are being restored and conditions are being improved throughout watersheds in the northwest.

Middle Fork Willamette River Sub-Basin Lamprey Occupancy Survey

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Pacific lamprey (*Entosphenus tridentatus*) were added to the U.S. Forest Service (USFS) and Bureau of Land Managements' (BLM) Interagency Special Status / Sensitive Species Program (ISSSSP) in 2015. In addition, the phylogeny of brook lampreys (*Lampetra* spp.) remains unresolved. Additional data is needed evaluate potential impacts to lamprey populations from USFS/BLM resource management and habitat restoration activities. Our objectives are to: (1) determine the distribution of lampreys across federally managed lands within the Middle Fork Willamette sub-basin, Oregon, USA; (2) develop a protocol to assess reach-level occupancy of larval lampreys; (3) identify landscape-level and reach-level variables associated with lamprey occupancy at the sub-watershed level; and (4) describe the morphological and genetic variability of lampreys across the project area. Using a general random tessellation stratified (GRTS) sampling regime, we targeted perennial fish-bearing stream segments between 30-50m and less than or equal to 2.5% slope. We used a backpack electrofisher to assess lamprey occupancy at three reaches (20 x bankfull width) within each sub-watershed. Up to 15 lamprey specimens (larval, transforming, or adult Lampetra spp.) were retained from each site for genetic and morphological characterization. In 2015, we surveyed 56 reaches from 25 sub-watersheds and 9 watersheds in the MFWR sub-basin. Lamprey occupied 30% of all sampled reaches. We collected 113 specimens for morphological and genetic analysis (results pending further analysis). We will complete our assessment of the MFWR sub-basin in 2016, and expand our effort to include the rest of the Willamette National Forest in 2016.

Analytical Tools to Support Hatchery Reform in the Pacific Northwest

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Hatchery reform is an important focus of recovery efforts for salmon and steelhead populations in the Pacific Northwest. Analytical tools are needed to track status and trend data, document population assumptions, and implement adaptive management strategies. We illustrate this with three examples of hatchery reform and discuss the different management strategies developed for each program. The Redfish Lake sockeye program is designed to prevent population extinction, conserve the genetic identity and diversity of the population, and increase the abundance of natural-origin adult returns. The Chief Joseph Hatchery program has both conservation and harvest objectives for Okanogan summer/fall Chinook, and has made strong progress toward its conservation goals. Finally, the Willapa Bay salmon hatchery programs have harvest as the primary objective, but must also be managed consistent with conservation goals for natural spawning populations. We will highlight some of the issues with managing these programs and also explore solutions.

Salmonid Life Cycle Models for Dynamic Hatchery and Harvest Management

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The All-H Analyzer (AHA) model, which was developed as part of the Columbia Basin Hatchery Scientific Review Group (HSRG) review, predicts population outcomes in terms of natural production and harvest for management policies implemented over a long period of time. We developed a new salmonid life cycle model (LCM) with several novel features:

1. the model predicts annual outcomes for natural and hatchery populations in terms of abundance and fitness. It predicts annual catch and escapement, and results are sensitive to the initial population status.

2. it allows for implementation of dynamic harvest and hatchery policies based on annual abundance.

3. it presents annual outcomes as a range, rather than as a point estimate, placing more emphasis on uncertainty and variability. It accounts for variability in freshwater and marine survival and management imprecision.

4. it incorporates multiple populations and accounts for population interactions.

When hatchery reforms are first implemented, fitness benefits may not be immediately observable. In fact, abundance may decrease initially before fitness improvements increase survival and abundance. The new LCM paints a more realistic picture of what may happen under different management scenarios. We use models developed for the Willapa Bay Chinook populations as a case study.

Relating Transportation Associated Stress with the Immune System in Juvenile Chinook Salmon (*Onchorhynchus tshawytscha*)

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Transportation of hatchery reared fish from the hatchery to a separate site has been associated with oscillating cortisol concentrations in the fish's plasma for days post transportation. Cortisol may trigger stress responses in the immune system, such as oxidative burst, a process used by the immune system to destroy invading bacteria. In this study, juvenile Chinook salmon (*Onchorhynchus tshawytscha*) were raised at the Oregon Hatchery Research Center in Alsea, Oregon. To simulate transportation, fish were first netted and moved to a separate holding tank to simulate transport. After three hours, these fish were then netted again and moved to a new recipient tank. At times zero, three, six, and 24 hours post treatment, spleens were collected. The following day, spleen neutrophils were excited with Phorbol 12-myristate 13-acetate (PMA) and flow cytometry was used to detect oxidative burst. Results show that stress associated with transporting juvenile Chinook salmon can be detected in the immune system. Fish immune system activation did not return to background levels for more than 24 hours after initial

transport stress. There is evidence to indicate that heightened immune function reduces energy available for growth. The results of this study, combined with other findings, leads us to believe that transportation of hatchery reared fish to a separate site can hinder overall performance of fish post-release.

Development of a Water Sampling Protocol for Monitoring and Managing the Abundance of *Ichthyophthirius multifiliis* (Ich)

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Ichthyophthirius multifiliis (Ich) is a ciliated protozoan that infects freshwater fishes. These infections can lead to mortality, and have resulted in mortality events of pre-spawning salmon in the Klamath River, CA. In this project, I will develop an improved monitoring protocol for Ich, with the intent of describing and mitigating the occurrence of Ich outbreaks in the Klamath River. Ich has a waterborne infective stage, and so molecular quantification (qPCR) of the parasite in water samples could be an effective method for early detection of disease-threshold parasite levels. I will establish the relationship between the levels of Ich detected in water samples and observed salmon mortality, by comparing parasite levels in archived water samples with recorded observations, in collaboration with Yurok tribal biologists and the Ca/NV Fish Health Lab. Interpretation will be refined by determining the genetic contents of each parasite life-stage, identifying the genotypes of Ich present in the Klamath River, and characterizing exotic isolates. If effective, water sampling will be used to gain insights into the relationships between Ich levels, water temperatures, water flow rates, fish behavior and infection severity in migrating salmon. These insights will help optimize disease management in the Klamath River, and could be applied throughout the region.

Thinking Long Term on the Long Tom: Looking Back at 120 Years of River Management and Developing a New Path Forward

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Euro-American management of the lower Long Tom River starts with the story of the steamship Ann, who made her way upriver 10 miles from the Willamette to the town of Monroe in 1869. The journey was so challenging that it would be 31 years before another vessel attempted the trip. To improve conditions for ship traffic, Captain Fish of the U.S. Army Corps of Engineers (USACE) worked with the Oregon State Legislature to develop an ambitious plan to improve navigation on the river from the Willamette to Monroe that included the removal or alteration of bridges, several teams of horses, and most importantly, 3,800 pounds of TNT. Gravel bars were blasted, snags removed, and sections of the channel straightened. Despite these efforts, only three ships ever made the journey to the mills in Monroe. Since this initial work to improve navigation on the river, USACE's principle management goal of the Long Tom River from Fern Ridge Dam downstream to the Willamette River has been to reduce flood risks to floodplain landowners. Fern Ridge Dam was the first dam completed by the USACE as part of the Willamette Valley Project in 1941. The dam did not reduce flooding of downstream properties sufficiently so the USACE developed and completed the Long Tom Channel Rectification and Improvement Project from 1943-1951. This project involved the channelization of the river, reducing its length from 36 to 23 miles, the construction of three low-head dams, the installation of rock revetments along 40% of the channel upstream of Monroe, and the installation of 144 culverts to drain water from disconnected oxbows. In the 64 years since the project was completed, vegetation has established along the channel, increasing roughness and sediment deposition rates and reducing the capacity of the channel to convey flood waters. To sustain the conveyance capabilities of the channel, USACE has devoted significant but steadily declining resources to the maintenance of the channel, including mechanical and chemical brush removal, dredging, and bank protection. While there is broad community support for the flood control mission of the project, its impacts on the river and its fish and wildlife resources are significant. Fish passage for ESA-listed Juvenile spring Chinook salmon, coastal cutthroat trout, and Pacific lamprey is impeded by the low-head dams. Aquatic habitat is reduced in quantity and quality, water quality is impaired, and fluvial processes are disrupted. In 2012, the Long Tom Watershed Council, USACE, and the University of Oregon began to explore an alternative future for the management of the river, one that would continue the mission of flood control but also improve fish passage and habitat conditions. With the input of technical advisors from state, federal, and university scientists, we developed a plan to engage local stakeholders, model fluvial conditions, and design restoration projects that will help accomplish community and ecosystem goals for the river.

Cutthroat Trout and Coastal Giant Salamander Responses to Drought in Cascade Mountain Streams

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Changing climate conditions in Oregon are expected to reduce winter snowpack prompting earlier and lower summer low-flow conditions. In 2015 highly reduced snowpack combined with limited precipitation resulted in the lowest recorded summer flows (1950-2015) at the HJ Andrews Experimental Forest located in the western Cascade Mountains, OR. We compared coastal cutthroat trout (*Oncorhynchus clarkii clarkii*) and coastal giant salamander (*Dicamptodon tenebrosus*) abundance, biomass, condition factor, and age distribution between 2014 and 2015 in sites within and adjacent to the HJ Andrews Forest. Cutthroat trout abundance and biomass were significantly lower in 8 of 9 streams in 2015 (paired t-test; $p = 0.007$ and $p = 0.037$, respectively). On average, total trout biomass in 2015 was reduced by 29% relative to 2014 (range: +2% to -62%). Trout condition factor was lower in 7 of 9 streams, however the magnitude of the change was highly variable and not statistically significant. Juvenile cutthroat trout abundance was higher in 5 streams but lower in 4 streams compared to 2014, however, juvenile mean length was greater in all 9 streams in 2015 (paired t-test; $p = 0.002$). Coastal giant salamander abundances and biomass varied in response with no clear trend. However, salamander mean condition factor was lower in all 9 streams in 2015 (paired t-test; $p = <0.001$). Streams ranged in mean daily August temperature from 9-15 degrees C, but there were no trends in fish or salamander response associated with temperature. These results highlight that even in relatively cold streams, adult cutthroat trout in Cascade Mountain headwaters are susceptible to impacts of a drought.

Is There Evidence for Competition Between Bull Trout and Lake Trout in Odell Lake, Oregon?

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Bull trout abundance has declined in a number of western lakes where nonnative lake trout have been introduced, and competition for food resources has been suggested as a mechanism to explain this pattern. We examined patterns of relative abundance, spatial overlap, and trophic characteristic of bull trout and lake trout in Odell Lake, Oregon, to evaluate the potential for competition between these species. Early reports (i.e., 1946-1950) suggest that bull trout were once abundant and provided a valuable sport fishery, and that lake trout were poorly represented in the sport fishery, but that they were becoming more common. Trap net and gill net surveys conducted in 2013 and 2014 indicated that lake trout currently outnumber bull trout by about 27 to 1. During our sampling, lake trout were detected in littoral, limnetic, and profundal zones during the spring and autumn, but were absent from the epilimnion during the summer; consequently, lake trout and bull trout likely overlap in space during most of the year in Odell Lake. Stable isotope analysis indicated that bull trout and lake trout are both apex

predators in Odell Lake, and these species likely prey extensively on forage fishes. Bull trout and lake trout differed in δ15N; however, the magnitude of this difference (< 0.8‰) is considerably less than what is commonly referenced as a one trophic-level difference (e.g., 3.4‰). Bull trout and lake trout also differed in δ13C, which may result from use of different prey species or similar prey species in different proportions. Overall, spatial overlap and trophic overlap (although incomplete) suggest the potential for competition between these species in Odell Lake, and patterns of relative abundance are consistent with theoretical predictions associated with competing species that coexist at a stable or unstable equilibrium. Therefore, competition with lake trout should be considered a plausible mechanism currently influencing the abundance of bull trout in Odell Lake.

Dealing with Drought: A Case Study at Leavenworth National Fish Hatchery

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In 2015 many hatcheries in the Pacific Northwest experienced one of the worst droughts to hit the region in almost a century. This left many facilities without the water resources necessary to successfully rear fish. Leavenworth National Fish Hatchery was no exception to this situation. Here we present how the utilization of cool water reservoir storage, the ability to reduce raceway densities, and the implementation of a novel well recharge system essentially saved the facility from catastrophic loss. Additionally, we suggest how proper contingency planning is essential for providing the tools and options necessary to guard against future loss if drought conditions continue.

Pilot Study: Auction and Raffle Items Available in Seaside, Oregon

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Through conference calls, begging and bartering we procured a multitude of high quality donations from local Oregon artists and businesses who support the goals and continued achievements of the Oregon Chapter of the American Fisheries Society. Our sampling efforts in 2015-2016 confirmed acquisition of artwork and photographs from Heather Fortner, Bruce Koike, Jan Roberts-Dominguez, Jeremy Monroe and Mary Edwards to name a few (google names for examples). Seven guided fishing trips for albacore tuna *Thunnas alalunga*, Pacific halibut *Hippoglossus stenolepis*, Chinook salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss* were also accrued. Contributions from LaCrosse, Danner, Englund Marine, Wildlife Safari, Wildhorse Casino, Mt. Bachelor, Simms, breweries from around the state, pottery and rafting trips should be carefully considered as motivation to start saving money prior to attending the meeting. Results suggest a high correlation between the amount of money contributed at the raffle and the quality of the items available. This year there may be a Benelli shotgun and/or Bowtech bow. Overall, we recommend attending the annual meeting to monitor the outstanding scientific research, but if the heady scientific presentations aren't your bag you should still attend the banquet and auction to seize the opportunity to consume good food in great company and donate to ORAFS.

Smallmouth Bass Movements in the Menominee River, Wisconsin-Michigan

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Several segments of the Menominee River that borders the states of Wisconsin and Michigan support exceptional fisheries for smallmouth bass. Fishery managers would like to know more about the seasonal movements of these populations in order to make more informed management decisions. Specifically, there is some concern that smallmouth bass congregate in relatively small areas during fall and winter months, making them more susceptible to harvest when compared to other portions of the open-water fishing season. We used acoustic telemetry to determine if smallmouth bass in the Menominee River between Grand Rapids and Park Mill dams all moved to the lower, more lacustrine section of the river during fall or if bass generally remained in the segment of river where they were tagged (i.e., upper, middle, lower). During May 2014 and May 2015, smallmouth bass â‰¥ 15 inches were collected by electrofishing and implanted with acoustic transmitters and their movements were monitored using both active tracking and fixed receivers (n=60). Preliminary results indicate some

smallmouth bass inhabit the lower segment year-round, however many others utilize the full extent of the impoundment.