Abstracts

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Oregon Chapter of the American Fisheries Society

Poster Session Abstracts

Efficacy of Extended Protection Against Salmincola californiensis for Juvenile Hatchery Spring Chinook for a Reintroduction Program in Oregon.

Stacy Strickland
Oregon Department of Fish and Wildlife
stacy.a.strickland@odfw.oregon.gov

A reintroduction program began in the upper Deschutes Basin in 2008 for spring Chinook salmon (Oncorhynchus tshawytscha) and summer steelhead (O. mykiss). Initial fish passage data was fairly good for outmigrating Chinook and not as successful for steelhead. As adults started returning however, the steelhead had higher smolt to adult return ratios (SARs) than the Chinook. Research into why the Chinook weren't returning focused on possible pathogens causing low juvenile survival. We began monitoring the freshwater copepod (Salmincola californiensis) load on juvenile spring Chinook reaching the Selective Water Withdrawal tower in Lake Billy Chinook in 2015. Initial data showed that nearly half of the mortalities examined had lesions from copepods on gills and fins and up to 30% of the live fish examined also had these lesions. It was theorized that fish with lesions would have lower chance of surviving to the ocean due to increased disease susceptibility and poor smolting capability. In 2021, a medicated treatment was initiated to reduce this copepod load post-release from the hatchery and acclimation sites. We present the first two years of treatment results.

Characterizing the effects of environmental variability and individual biological characteristics on green sturgeon recruitment success.

Erin Lunda
Oregon State University
erin.gilligan@oregonstate.edu
Co-Authors: James Peterson, Adam Duarte, Todd Swannack

Environmental variables during early life stages for sturgeon can have a great influence on recruitment success through survival, growth, and additional physiological processes. Failure to recruit has considerable impacts on relative year class strength and ultimately can lead to population declines. Thus, survival and growth of juvenile green sturgeon in the Central Valley of California has become a key information need for management decision making. This research will aim to understand how environmental variability, individual behavior, and biological characteristics impact recruitment success

of juvenile green sturgeon, all while accounting for the great uncertainty regarding the species. An individual based model will be used to simulate how individuals might respond to their internal and external environments. Using this framework, we can evaluate fine-scale processes and identify key patterns and tradeoffs of how individuals interact with each other and their environment under different ecological hypotheses. Green sturgeon are known to be particularly sensitive to water quality stressors and contaminants in the Central Valley. Because of this, there will be an emphasis on exploring individual level responses to these factors and extrapolating those effects to evaluate population-level impacts that are useful for management. By identifying and providing mangers with the greatest impediments to recruitment success, informed decisions can be made that will aid in the recovery of this species.

Reintroduction of anadromous summer steelhead above McKay Dam. Restoration of Tribal First Foods near Pendleton, Oregon.

Jerimiah Bonifer
Confederated Tribes of the Umatilla Indian Reservation
jerimiahbonifer@ctuir.org
Co-Author: Craig Contor

During the springs of 2021 and 2022 we radio tagged and released a total of 33 endemic hatchery summer steelhead into the McKay Reservoir pool and upper McKay Creek to evaluate the ability of steelhead to navigate the reservoir pool, distribute throughout upper McKay Creek, and find and use suitable spawning habitat. Observations of successful spawning in 2021 represented the first summer steelhead redds observed (n=2) in upper McKay creek in 94 years. 2022 produced similar results with summer steelhead successfully navigating the pool and spawning in the stream (n=5). 2023 will represent the third and final year of this pilot study.

Understanding the effect of fine-scale habitat characteristics on steelhead abundance in Oregon Coastal streams.

Katherine Kennedy
Oregon State University
kennkath@oregonstate.edu
Co-Author: Melanie Davis

My research seeks to describe the suitability of freshwater habitat for Oregon Coast steelhead trout (Onchoryncus mykiss) by integrating empirical, remotely sensed, and modeled data with community knowledge in a next-generation species distribution model. Findings from this research will contribute to a broader scientific understanding of how complex landscape mosaics promote population persistence in the face of climate-mediated disturbance, and will help guide targeted conservation actions.
The impacts of climate change are cascading and numerous in aquatic ecosystems. Changes in temperature, precipitation and runoff regimes are all examples of how these habitats will change, and it is essential to uncover how aquatic ecosystems will respond to these compounding effects. Climate change along with other anthropogenic factors have compromised these ecosystems, causing the

extinction rate for freshwater species to equal or exceed that for species in any other ecosystem type. Given this reality it is becoming increasingly important to create clear conservation strategies, informed by system-scale research. Steelhead inhabit Oregon stream systems, and are both culturally and economically significant to native American harvests, sport fishing, and Endangered Species Act considerations (i.e. commercial fishing of steelhead is prohibited.) The goal of this proposed work is to develop a model to identify critical juvenile habitat in need of protection and better inform conservation strategies for aquatic ecosystems.
This research plan will be executed in three discrete steps: 1) characterizing fine scale and spatial scale habitat-species relationships through multivariate variable selection, and the comparison of generalized mixed linear models (GLMM), generalized linear additive models (GLAM), and quantile random forest models (QRF), 2) developing habitat and species distribution models (SDMs) based on carrying capacities of what has been identified as suitable habitat, 3) utilize predictive climate data to forecast impacts of climate changes on access to these key habitats.

UPRLIMET: Upstream Regional LiDAR Model for Extent of Trout in stream networks.

Brooke Penaluna
USDA Forest Service, PNW Research Station
brooke.penaluna@usda.gov
Co-Authors: Jonathan Burnett, Kelly Christiansen, Ivan Arismendi, Sherri Johnson, Kitty Griswold

Predicting the edges of species distributions is fundamental for species conservation, ecosystem services, and management decisions. In North America, the location of the upstream limit of fish in forested streams receives special attention, because fish-bearing portions of streams have more protections during forest management activities than fishless portions. We present a novel model development and evaluation framework, wherein we compare 26 models to predict upper distribution limits of trout in streams. The models used machine learning, logistic regression, and a sophisticated nested spatial cross-validation routine to evaluate predictive performance while accounting for spatial autocorrelation. The model resulting in the best predictive performance, termed UPstream Regional LiDAR Model for Extent of Trout (UPRLIMET), is a two-stage model that uses a logistic regression algorithm calibrated to observations of Coastal Cutthroat Trout (Oncorhynchus clarkii clarkii) occurrence and variables representing hydro-topographic characteristics of the landscape. We predict trout presence along reaches throughout a stream network, and include a stopping rule to identify a discrete upper limit point above which all stream reaches are classified as fishless. Although there is no simple explanation for the upper distribution limit identified in UPRLIMET, four factors, including upstream channel length above the point of uppermost fish, drainage area, slope, and elevation, had highest importance. Across our study region of western Oregon, we found that more of the fish-bearing network is on private lands than on state, US Bureau of Land Management (BLM), or USDA Forest Service (USFS) lands, highlighting the importance of using spatially consistent maps across a region and working across land ownerships. Our research underscores the value of using occurrence data to develop simple, but powerful, prediction tools to capture complex ecological processes that contribute to distribution limits of species.

Quantifying the response of Coastal cutthroat trout to wildfire in the Oregon cascades.

Jansen Ivie
Oregon State University
iviej@oregonstate.edu
Co-Authors: Dana Warren, Kevin Bladon, David Roon

The occurrence of large, high severity wildfires has increased in many regions, including the Western United States, in the past few decades. Shifts in the wildfire regime have increased interest in the effects of wildfires on a range of ecosystem components, including water quantity, water quality, and aquatic ecology. Past studies have found a range of fish responses to wildfire. However, a lack of pre-fire data in most systems affects our ability to explicitly quantify the magnitude of wildfire impacts on abundance, condition, and distributions of fish populations. In 2020, the Archie Creek Fire burned the forests of the Hinkle Creek Paired Watershed Study (HCPWS) in the in the Umpqua River basin of the Western Cascades of Oregon. The original HCPWS quantified forest harvesting effects on water quantity, water quality, and fish populations from 2002–2011. These earlier data provided the rare opportunity to quantify fish responses to wildfire. In the second year after the fire, we used the same methods as in the HCPWS (single-pass electrofishing in stream pools) to estimate relative fish abundance through ~2.7 km of South Fork Hinkle Creek. We made a longitudinal comparison of cumulative mass of age 1+ Coastal cutthroat trout (Oncorhynchus clarki clarki). By quantifying fish in every pool through the mainstem of South Fork Hinkle Creek, this study provides a whole river (rather than reach-scale) assessment of how fish populations respond to wildfire disturbance in headwater streams on managed forest land in the Pacific Northwest. Relative to the most recent two years of the HCPWS (2010. 2011), our preliminary data suggests limited effects of fire on fish condition.

Decreased mortality rates during PIT tagging of salmonids with inexpensive recovery tank improvements.

Julie Huff
Coquille Watershed Association
jhuff@coquillewatershed.org
Co-Author: Morgan Davies

Although PIT tagging is stressful on juvenile salmonids, it is a useful technique in tracking their behavior and movement. These juvenile salmonids are administered anesthetics prior to tagging and then recover in a freshwater tank or bucket with aeration. Although the water is highly oxygenated with the help of a bubbler, there is typically little flow in the bucket. When a freshly tagged juvenile salmonid is first placed into the recovery tank the water is manually stirred to allow the oxygenated water to pass through the gills of the anesthetized salmonid. This decreases the amount of time it takes for the anesthetized fish to recover and improves incidental mortality rates due to tagging. A low-tech improvement has been made to further improve recovery tanks in the Coquille Basin causing incidental mortality rates to drop to near zero. A USB powered water pump paired with a waterproof power bank provides constant flow to the recovery tank keeping oxygenated water flowing over the gills of recovering salmonids without the need for stirring the water. The combination of constant water flow

and decreased handling of the salmonids significantly decreases the time until full recovery and incidental mortality.

Oregon Department of Fish and Wildlife Native Fish Investigations Job Opportunities.
Chris Derrickson
Oregon Department of Fish and Wildlife
derrickc@oregonstate.edu
Co-Author: Alex Harrison

The Native Fish Investigations Program at ODFW conducts research and monitoring projects on native freshwater fish species, and the things that affect them, across the state. Data and research collected in these projects can help guide managers in their decision-making process. In the coming year, we are recruiting seasonal employees to help with several projects, such as monitoring Bull Trout spawning in the Clackamas, suppressing Brook Trout populations in the South Fork Sprague, conducting surveys for Bull Trout and Westslope Cutthroat Trout in the Upper Mainstem John Day, and sampling floodplain fish communities in the Willamette, among others. We are seeking motivated individuals to serve as field staff for these projects; positions vary in length, location, and level of experience required. This poster will summarize ongoing and upcoming projects and highlight opportunities for students, recent graduates, and others to join our team.

Diet and Philonema infections in reservoir-rearing juvenile Chinook Salmon.
Marina Larson
Oregon State University
larsomar@oregonstate.edu
Co-Author: Claire Couch, Christina Murphy, Michael Kent, James Peterson

Juvenile Chinook Salmon hatched above Willamette Valley Project dams often rear in reservoirs from mid-February until smolt outmigration and grow significantly larger than their stream rearing counterparts. Understanding the feeding ecology of juvenile Chinook salmon in reservoirs is important for understanding growth rates, survival, migration timing, and disease dynamics. The purpose of this study was to analyze dietary patterns of wild juvenile Chinook salmon from Lookout Point Reservoir. Our main objective was to assess relationships between prey consumption, surface temperature, and fish size. We opportunistically evaluated parasitism, as there was a significant presence of the parasitic nematode, Philonema. Our results reveal high rates of piscivory from July through the end of September. Piscivory decreased as surface temperature decreased, beginning in late September and continuing through December. Zooplankton and arthropod consumption increased significantly in November and December, corresponding with the dramatic decrease in water surface temperature. To our knowledge, this is the first description of widespread piscivory in sub-yearling reservoir juveniles. This finding is important as fish represent a high-quality dietary component that could contribute to meeting the energetic demands of large juvenile Chinook Salmon observed in reservoirs. In addition to describing dietary patterns, we found Philonema infections in 42% of the fish we sampled, which is a much higher prevalence than the infection rates previously described in juvenile Chinook salmon. The

dietary consumption patterns we identified in this study may contribute to explaining mechanisms of growth and survival in reservoir juveniles, but our study also elucidates a previously understudied risk of reservoir rearing in the form of heavy nematode infection.

Assessing the Consistency of Stream Ecosystem Characteristics in Accounting for Variation in Trout Abundance Between Summer Flow Conditions.

Nicole Miller
Oregon State University
milleni4@oregonstate.edu
Co-Author: Ashley Sanders, Ashley Coble, Dana Warren

Mediterranean climates are characterized by wet and relatively mild winters, and hot, dry summers. This precipitation pattern is the primary driver of the flow regimes of streams within the Pacific Northwest, which experience annual low flows in the summer and periods of high flow and flooding in the winter. Summer low-flow conditions can vary greatly depending on the previous winter's precipitation and snowpack (which commonly fluctuates up to 30% away from multiannual mean amounts), and the effects of climate change are expected to further exacerbate variability in environmental conditions that affect stream flows. Therefore, understanding how natural variation in flow regime affects the relative importance of different stream characteristics is important for informing future forestry and fishery management strategies. Focusing on summer low-flow conditions, we analyzed data from 20 streams in the Oregon coast range in the summers of 2021 and 2022. These two summers represent flow conditions that encompass the lower (25th percentile) and upper (75th percentile) ends of natural variation in streamflow in this region (based on long-term data from the Siletz River in coastal OR). We evaluated which abiotic and biotic factors best predicted the abundance of coastal cutthroat trout (Oncorhynchus clarkii clarkii) in each of these two years and investigated if and to what degree the best predictors of fish abundance changed across years with different summer low-flow levels. Preliminary analyses indicate that positive correlation between percent pool area in a stream and salmonid biomass density was much stronger during the drier year (2021) than the wetter year (2022), suggesting that as droughts become more common and more severe, adequate habitat (rather than basal resource production) may be increasingly important to the persistence of strong populations of cutthroat trout in headwater streams.

ORAFS Legislative Committee

Troy Brandt
River Design Group
tbrandt@riverdesigngroup.net

The Oregon Chapter of the American Fisheries Society's Legislative Committee is coordinating with the Oregon Chapter of The Wildlife Society to retain a legislative liaison for the 2023 legislative session. The ORAFS Legislative Committee will be tracking and responding to legislation that has the potential to affect fisheries and aquatic resources. The Legislative Committee invites ORAFS members to participate in the committee and get involved with representing the Chapter in Salem.

Prospective Students: New Opportunities with the Integrated Marine Fisheries Lab at OSU

Cheryl Barnes
Oregon State University
cheryl.barnes@oregonstate.edu

The main objective of the Integrated Marine Fisheries Lab is to conduct science that informs marine resource management. Much of our work focuses on better understanding population and community dynamics of groundfishes in the North Pacific. We rely on field sampling, lab-based research, and statistical modeling to inform data-poor stock assessments and support ecosystem-based fisheries management. We value collaboration among academic and agency scientists, resource managers, and fishery stakeholders because of its benefit to both process and product. Some common research themes include evaluating effects of scale on ecological inferences, enhancing scientific lessons through cross-regional comparisons, and using multiple metrics to improve our understanding about processes of interest.

Over the next few years, we will be recruiting MS/PhD students and postdocs who are interested in working on highly collaborative projects that are specifically designed to answer management-relevant questions. Topics may relate to marine spatial ecology, food web dynamics, climate change impacts, and improving commonly-used statistical tools. We intentionally seek out diverse identities, backgrounds, and perspectives, which enhance the quality of our work. Thus, we strongly encourage those from underrepresented and/or historically marginalized groups to apply.

The Integrated Marine Fisheries Lab is in the Department of Fisheries, Wildlife, and Conservation Sciences at Oregon State University and part of the Coastal Oregon Marine Experiment Station based at the Hatfield Marine Science Center. We are supported by and work in close collaboration with the Oregon Department of Fish and Wildlife's Marine Resources Program.

What long-term aquatic monitoring can offer fire science and management in the Northwest Forest Plan area

Christine Hirsch
U.S. Forest Service, Aquatic and Riparian Effectiveness Monitoring Plan
christine.hirsch@usda.gov
Co-Authors: Joe Ebersole, Rebecca Flitcroft, Marcia Snyder, Sara Wall

Wildfire is a broad-scale disturbance process that helped form complex terrestrial and aquatic habitats over the millennium. Wildfire suppression coupled with changes in climate have important, but poorly understood, effects for aquatic habitats. Long-term monitoring programs that cover vast areas are well poised to answer important landscape-scale questions related to wildfire using empirical data. The Aquatic and Riparian Effectiveness Monitoring Program (AREMP) has been collecting ongoing monitoring data on Federal lands under the Northwest Forest Plan (NWFP) (a plan covering 24.5 million acres) in Western Oregon, Washington, and Northern California. Data collection for this program began in 2002 and includes 219 randomly selected watersheds with at least 25% federal ownership that are surveyed on an approximately 8-year return interval. During the operating time-period of this monitoring program, increases in the intensity and severity of wildfires have occurred throughout western states. Extensive entry of wildfire into AREMP long-term aquatic monitoring sites has occurred

in the past few decades. Of the 219 AREMP watersheds, 120 (55%) have burned at least once since 1984, and of these, 61 have experienced multiple wildfires. This project will analyze the extensive pre- and post-wildfire data collected by the AREMP program (e.g., physical stream habitat, large wood, benthic macroinvertebrates, and riparian stand conditions) to describe and compare wildfire effects on in-stream aquatic habitat among ecoregions, across wildfire intensities, and at varying burn extents. Before- and after-fire paired surveys are available from 131 sites within 38 watersheds. Analysis will explore the role of stand age, wildfire return interval, high intensity precipitation events, and time since wildfire to better capture the response of aquatic habitat to wildfire.
The views expressed in this presentation are those of the author(s) and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency or U.S. Forest Service.

Monitoring Trends in Native and Non-Native Piscine Predator Dynamics below Bonneville Dam and in Bonneville Reservoir

Kelsey Anderson
Oregon Department of Fish and Wildlife
kelsey.r.anderson@odfw.oregon.gov
Co-Authors: Grant Waltz, Kevin Rybacki, Parker Chambliss, Art Martin

The Northern Pikeminnow Management Program (NPMP) was implemented in 1990 to reduce the predation on out-migrating juvenile Pacific salmon and steelhead (Oncorhynchus spp.) by applying targeted removal fisheries for Northern Pikeminnow (Ptychocheilus oregonensis) in the Columbia and lower Snake rivers. The program also monitored and evaluated for evidence of compensatory responses by Smallmouth Bass (Micropterus dolomieu) and Walleye (Sander vitreus) to Northern Pikeminnow removals. Monitoring and evaluation included standardized electrofishing and laboratory techniques to estimate indices of abundance, consumption of juvenile salmonids, and predation on juvenile salmonids from these three piscine predators. We examined trends in these indices below Bonneville Dam and in the Bonneville Reservoir from efforts during 1990 – 2021. There was evidence of a decreasing trend in the Northern Pikeminnow abundance index and an increasing trend in the Smallmouth Bass abundance index in these areas. Walleye continue to be rarely captured there. Additionally, trends in Smallmouth Bass indices of abundance, consumption, and predation were all elevated in 2021 relative to the historic mean, while trends for the same indices from Northern Pikeminnow were lower than the historic mean. These trends should be monitored continually, as they could be signaling a predator compensatory response to the removal of Northern Pikeminnow or changes due to other natural or anthropogenic factors in the Columbia River Basin.

Do we need to change the way we collect landings data for recreational fisheries?

Mee-ya Monneedy
Oregon State University
mee-ya.monneedy@oregonstate.edu
Co-Author: Scott Heppell

Harvest data are collected to aid fisheries management decisions. Real time monitoring of quota-managed fisheries (including both catch and discards, i.e. bycatch) is vital to avoid exceeding quota. The Oregon Department of Fish and Wildlife's (ODFW) Oregon Recreational Boat Survey (ORBS) currently utilizes 26 port samplers to collect these data for recreational fisheries along the Oregon coast, primarily through in-person interviews when boats return to port. Catch can be measured directly, but accurate monitoring of bycatch requires (1) anglers accurately identify released species and (2) remember what they released. Due to event recall biases and variability in species ID skills, this can introduce a high degree of uncertainty in recreational fisheries data. Electronic monitoring, which exists in the commercial fleet, may increase accuracy and decrease labor for recreational fisheries monitoring. We aim to test the feasibility of electronic catch monitoring for the recreational charter fleet as well as determine whether current average bycatch values are accurately represented in port sampler collected interviews. Our objectives are to (1) compare size and species composition from manual data collection (identifying species composition in-person and manually acquiring standard length measurements) to data collected via stereo-video monitoring; (2) compare 'true' values collected via at-sea observers (ODFW Sport Groundfish Onboard Sampling Program) to port sampler collected data (ORBS); (3) provide ODFW with an analysis of the appropriateness of this alternative form of monitoring recreational fisheries. We tested the stereo-video system during fall recreational charter surveys conducted via our collaborators, the ODFW Marine Reserves Program. During these surveys, we recorded all fish caught during the charter trips via stereo-video. We then compared the accuracy and total effort of the stereo-video methodology against traditional methods of collecting size, length, and species composition data.

Adaptability and persistence results in reduction of hatchery Chinook Salmon spawning in the McKenzie River above Leaburg Dam

Martyne Reesman
Oregon Department of Fish and Wildlife
martyne.j.reesman@odfw.oregon.gov

The Leaburg Dam Fish Sorter was implemented to sort and collect ESA listed Upper Willamette River spring Chinook salmon in the McKenzie River. Specifically, we needed to 1) collect adult spring Chinook salmon for broodstock and outplanting and 2) remove hatchery fish to decrease the percentage of hatchery origin spawning (pHOS) in the upper McKenzie River. The pHOS target is <10% as written in the NOAA approved Hatchery Genetic Management Plan. The McKenzie Hatchery water supply of 50 cfs has been eliminated by a mandate from the Federal Energy Regulatory Commission (FERC) to cease diverting flow into Leaburg Canal. Because McKenzie Hatchery can only pull a small amount of flow from Leaburg Canal to attract spring Chinook salmon into McKenzie Hatchery, the fish are bypassing the hatchery and residing elsewhere in the McKenzie Basin.
After nearly 20 years of pHOS above Leaburg Dam in the 15 to 50 percent range, a fish sorter installed in 2020 succeeded in holding the level to 3 %. The salmon/steelhead exclusion grate we placed in the right bank fish ladder while keeping it operational successfully excluded all but 9 salmon jacks and facilitated passage of other native fish species (mountain whitefish, rainbow trout, large scale suckers) including a record number of Pacific lamprey (n=244)!

West Coast Nearshore Fish Habitat: Standardized Spatial Data and Distribution of Fish Assemblages and Selected Invertebrates

Steve Rumrill
Oregon Department of Fish and Wildlife
Steven.s.rumrill@odfw.oregon.gov
Co-Authors: Kate Sherman, Jamey Selleck, Joan Drinkwin, Leif Rasmuson

The Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) completed a Nearshore Project in 2022 to expand its spatial data system and programmatic focus from estuaries into the nearshore ocean. PMEP's Nearshore project included three components: 1) defining and mapping boundaries for delineating nearshore zones along the West Coast; 2) compiling and standardizing spatial data on biotic and substrate habitats within defined nearshore zones; and 3) producing a State of the Knowledge report on U.S. West Coast nearshore fish and invertebrate habitats. This poster summarizes and highlights the nearshore habitat data compilation and standardization and the published State of the Knowledge of U.S. West Coast Nearshore Habitat Use by Fish Assemblages and Select Invertebrates.

Lake and Reservoir Management Session

Response of kokanee DVM to inter-annual variation of daphnia abundance in Crater Lake.

Jonathan Armstrong
Oregon State University
Jonathan.Armstrong@oregonstate.edu
Co-Author: Mark Buktenica, Scott Girdner, Eric Ward

Diel vertical migration (DVM) is among the most ubiquitous movement behaviors on the planet and has important implications for ecosystem functions and fisheries management. A large body of research has characterized variation in the expression of DVM within and among taxa, across water bodies or regions of the ocean, and through the annual cycle. Despite this large volume of work, our understanding of how DVM varies across longer time scales, such as years, remains extremely limited. We explored how kokanee DVM in Crater Lake responded to cyclical dynamics in prey availability over a 23-year period including three periods of high daphnia abundance. Specifically, we analyzed long-term data on zooplankton community composition, fish diets, and fish depths to test whether episodic periods of resource abundance led fish to select for shallower depths with warmer temperatures. In years with abundant daphnia, night habitats selected by kokanee were shallower (~15 m vs. ~35 m) and warmer (~10°C vs. ~7°C). A bioenergetic foraging model found that this behavioral plasticity would strongly reduce digestive constraints on growth. Our work shows how the expression of DVM can change in response to inter-annual variation in food abundance. Other factors driving DVM, such as predation risk, also vary inter-annually. This implies that DVM may be far less consistent than currently assumed.

Heart Lake Rotenone Treatment for Unwanted Fish Species.

Justin Miles
Oregon Department of Fish and Wildlife
justin.p.miles@odfw.oregon.gov

Heart Lake, a small 18-acre lake located in the Fishole Creek basin of the Fremont-Winema National Forest was treated with rotenone to eradicate brown bullhead and fathead minnow in September of 2022. The stocked rainbow trout fishery was experiencing declines in catch rates and trout condition factors were suffering in response to an illegal introduction of brown bullhead and fathead minnow. The goal was to successfully eradicate all fish in Heart Lake and reestablish a viable recreational fishery for the future.

Nine ODFW employees safely and successfully conducted the piscicide treatment utilizing both powder and liquid rotenone. One boat applied powder rotenone into pelagic waters using a siphon pump while the other boat applied liquid rotenone into littoral zones using a spray pump. Other employees were stationed on the shoreline to restock the working boats with rotenone and supplies to ensure the operation was running as planned.

Two days after the rotenone treatment, staff sampled the shoreline and estimated that 13,700 brown bullhead and 51,000 fathead minnow were removed from the lake. No fish were found 22 days post treatment in five gill nets and two hoop net sets dispersed throughout the lake. At this point, the treatment appears to be a success, additional sampling will be conducted in the spring of 2023 prior to initiating the recreational rainbow trout fishery.

In spring of 2023 following continued monitoring, fingerling, legal (> 8 inches) and trophy rainbow trout will be stocked. Fish will be sampled in the fall of 2023 and spring and fall of 2024 to determine if stocked rainbow trout exhibit adequate condition factor and fingerling rainbow trout are contributing to the fishery. This has been a popular and productive fishery in the past and should be in the future for years to come.

The Status of Fisheries in Oregon's Largest Reservoir.

Kirk Handley
Oregon Department of Fish and Wildlife
kirk.a.handley@odfw.oregon.gov

Owyhee Reservoir is the largest reservoir in Oregon and supports warm water fisheries for several species including Black Crappie, Largemouth Bass, and Channel Catfish. The warmwater fisheries in this reservoir are influenced by reservoir levels, water quality, and for some species, fisheries management actions. The Black Crappie population in the reservoir is stable but size varies annually as dominant cohorts of Crappie age and grow. Length at age of Largemouth Bass captured during reservoir electrofishing remains consistent among years. Long term trends in relative abundance estimates from biennial shoreline boat electrofishing suggest populations or distribution may be quite variable which could warrant further investigation.

Bass tournaments are frequently held on Owyhee Reservoir and may represent a significant proportion of the recreational angling that takes place during certain times of the year. In 2022, Oregon Department of Fish & Wildlife began implemented a mark recapture tagging study in concert with biennial monitoring and creel surveys to help understand how recreational angling and Bass tournaments influence bass survival and distribution throughout the reservoir. Preliminary results suggest angling recapture rates for Bass tagged at fishing tournaments will provide useful information on Bass movement and exploitation rates. A comparison of results from the current ongoing tagging

study with a previous study conducted in the early 1990s will help inform future management of this popular recreational fishery.

Comparison of three Hatchery Rainbow Trout stocks across 15 Oregon reservoirs using data coupled from a tag-reward program and trail-cameras.

Michelle Jones
Oregon Department of Fish and Wildlife
Michelle.K.JONES@odfw.oregon.gov

In an effort to streamline production and improve stocked recreational Rainbow Trout fisheries, the Oregon Department of Fish and Wildlife evaluated the relative performance of Oak Springs Hatchery Rainbow Trout (Stock 53) with two alternative stocks (Capecod Rainbow Trout - Stock 72 and Crane Prairie Rainbow Trout - Stock 127). Fish were stocked at 15 lakes and reservoirs across Oregon including Krumbo Reservoir, Yellowjacket Reservoir, Malheur Reservoir, Eel Lake, Butterfield Reservoir, Huddleston Pond, Wallowa Reservoir, Kinney Lake, Walton Pond, Three Creek Reservoir, Magone Lake, Heart Lake, Lofton Reservoir, Cooper Reservoir, and Galesville Reservoir. At each location, 150 floy-tagged fish from each stock type were released in the spring of 2021. Floy tags contained a website and phone line for anglers report their harvest. Reporting rates were assessed with a subset of tags visibly worth $50 when redeemed to the agency. Trail cameras were posted and programmed to take hourly photos at the primary access sites of each lake to estimate angling effort using a calibration from traditional pressure counts. In general, the Crane Prairie Rainbow Trout returned at the lowest rates and were often below the departments management target of 40% (mean return rate = 33%). Oak Springs (53) and Capecod (72) stocks performed similarly and did meet the department's production goal at most sites (mean return rate: stock 53 =55%, stock 72 = 57%). Based on these results, replacing Crane Prairie Rainbow Trout with either Oak Springs or Capecod Hatchery Rainbow Trout may improve the quality of stocked-trout recreational fisheries throughout Oregon.

Piscine Predator Control to Enhance Juvenile Salmonid Survival in the Federal Columbia River Power System Reservoirs.

Grant Waltz
Oregon Department of Fish and Wildlife
Grant.t.Waltz@odfw.oregon.gov
Co-Author: Kevin Rybacki, Kelsey Anderson, Paker Chambliss, Art Martin

The establishment of the Federal Columbia River Power System (FCRPS) led to the formation of numerous reservoirs and subsequent ecological changes that continue to the present. As a part of the mitigation measures for this hydropower system, FCRPS were required to fund work to reduce the level of piscine predation to out-migrating juvenile salmonids. The Northern Pikeminnow Management Program (NPMP) is a collaborative project among the Bonneville Power Administration (BPA), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), and Pacific States Marine Fisheries Commission (PSMFC) designed to reduce predation on juvenile salmonids through the reduction in population and size structure of Northern Pikeminnow (Ptychoeilus

oregonesis). NPMP also monitors the population of Northern Pikeminnow for evidence of declines due to these reduction efforts and to track fisheries indices to evaluate for compensatory responses from other piscine predators (e.g., Smallmouth Bass, Walleye). NPMP has met the population reduction target of 10 – 20% of the Northern Pikeminnow population nearly every year for the past 30 years thereby reducing Northern Pikeminnow predation on juvenile salmonids by an estimated 20 – 40%. To account for ongoing ecological changes inherent in natural systems impacted by significant anthropogenic manipulation, NPMP is adaptively managing the long-term efforts to control Northern Pikeminnow populations, monitor for signs of overfishing, and evaluate for signs of compensatory responses by Walleye and Smallmouth Bass to the removal of Northern Pikeminnow. Specifically, NPMP is assessing several new analytical approaches and field study design modifications to test some of the existing evaluation and monitoring methodological assumptions. These assessments will help inform adaptive management decisions needed by NPMP to continue to provide relevant and meaningful fisheries information for improved Columbia Basin reservoir management.

A proposed risk framework for evaluating fish stranding and trapping

Lucius Caldwell
Four Peaks Environmental Science & Data Solutions
lcaldwell@fourpeaksenv.com

Fish stranding and trapping have been documented within impounded reservoirs and along large rivers that support industrial ship traffic. Proximate causes for stranding and trapping include reservoir drawdowns and ship wakes. However, these factors only constitute a portion of the overall risk. In this presentation, we will present a fish stranding and trapping risk assessment framework modeled after the “Hazard Triangle” used by avalanche forecast professionals for nearly 30 years. Within this framework, the occurrence of stranding and trapping represents the intersection of three constituent risk aspects related to topography, hydrodynamics, and biology, with human observation sitting in the middle of this triangle. For stranding or trapping to occur, topographic features that present a risk to fish must be present, water must interact with those topographic features in such a way that fish could become stranded or trapped, and individual fish of the correct species and life stage must be present near these features at the time of dewatering. To document the occurrence of such phenomena, humans must be present at or shortly after the time of an event. Here, we discuss the rationale underlying the development of this risk assessment framework and the value in assessing risk in this way, then present empirical data from a case study employing this framework and discuss best practices for implementing similar evaluations in the future.

Battle of the nerkids: interactions among kokanee and Sockeye Salmon and how that may influence management of Wallowa Lake fisheries

Michael Lance
Oregon Department of Fish and Wildlife
michael.j.lance@odfw.oregon.gov
Co-Authors: Kyle Bratcher, Jeff Yanke

We reviewed existing knowledge about interactions between landlocked (kokanee) and anadromous (Sockeye Salmon) forms of Oncorhynchus nerka to understand how upcoming Sockeye Salmon reintroduction efforts at Wallowa Lake may influence existing stocks of kokanee. We reviewed fishing regulations at locations with both life history types present to identify potential fishery management actions after Sockeye Salmon are reintroduced to Wallowa Lake. Both landlocked and anadromous forms have established throughout the native range of O. nerka. Genetic patterns suggest landlocked populations originated from anadromous fish in geographic isolation from other landlocked populations. Once established, the two life history groups diverge genetically suggesting strong selective pressure against hybrids although some hybridization does occur. This genetic divergence may be driven by differences in spawning site selection, size selectivity during spawning, and potentially differences in spawning coloration. Increasing Sockeye Salmon fry densities after reintroduction to Skaha Lake in British Columbia did not decrease the abundance of pelagic fish or the survival and growth of age-0 kokanee. Among age-0 O. nerka in Skaha Lake, combined zooplankton consumption by both life history groups only comprised 3.6% of the total biomass of zooplankton consumed by fish and non-native opossum shrimp (Mysis diluviana). Sport fishery regulations for kokanee angling vary across waterbodies that also contain Sockeye Salmon and generally include a maximum size limit or seasonal closure on the harvest of O. nerka. Evaluations of kokanee and Sockeye Salmon interactions at other lakes suggest that reintroduced Sockeye Salmon are unlikely to influence the density or growth of kokanee in Wallowa Lake. Because Wallowa Lake kokanee can be large, future fishing regulations will probably involve a seasonal size limit restricting the harvest of larger O. nerka during periods when adult Sockeye Salmon may be present while allowing harvest of large kokanee during the rest of the year.

Walleye distribution in the Columbia Basin: Utilizing 30 years of data to assess spatiotemporal trends in an altered river system.

Kevin Rybacki
Oregon Department of Fish and Wildlife
kevinrybacki@gmail.com

The Oregon Department of Fish and Wildlife (ODFW) has been using electrofishing to annually tag and release the native Northern Pikeminnow (Ptychocheilus oregonensis) in the Columbia Basin for over thirty years. The objective of these tagging activities was to incentivize and monitor a sport reward fishery aimed to reduce predation on out migrating juvenile salmonids. During tagging events, ODFW also captured and released Walleye to gather biologic information on the non-native piscivore. This study examined electrofishing Catch Per Unit Effort for Walleye during annual tagging events and used GIS to visualize spatiotemporal changes in Walleye distribution in lower Columbia River reservoirs. Walleye appeared to show an increasing trend in abundance, punctuated by intermittent recruitment while abundance is potentially tempered by the recreational fishery or other processes. Walleye distribution was greatest in the middle and upper reaches of the Columbia River reservoirs with trends suggesting expansion within reservoirs. Identifying trends in non-native piscivore populations in the dynamic Columbia Basin is important in making adaptive management decisions on how and where to proceed with the established predator control program. This mapping activity is intended to provide information about potential long-term trends in predatory fish dynamics used to guide the Northern Pikeminnow Management Program going forward. Further investigation may provide insight on how

river conditions, predator/prey dynamics, and interspecies competition affect native fish populations and out-migrating juvenile salmonid survival. This information is critical to meet some of the challenges associated with mitigating the impacts of the Federal Columbia River Power System on ESA listed salmonids.

Native Fishes Session

Community dynamics of native and non-native fish in a changing ecosystem

Aleah Dew
Oregon State University
aleah.dew@oregonstate.edu
Co-Author: Melanie Davis

The Goose Lake Basin is an endorheic desert valley running north to south on the border of Oregon and California that has been heavily impacted by drought, wildfire, and other environmental stressors in recent years. The Goose Lake Basin is a region of concern for state and federal agencies because it is home to endemic fish species like the Goose Lake redband trout, Goose Lake lamprey, Goose Lake tui chub, and Goose Lake sucker. These endemics coexist with a variety of native and non-native species, including the recently delisted Modoc sucker. Consequently, the Thomas Creek – Goose Lake area has been listed as a "Conservation Opportunity Area" in the Oregon Conservation Strategy. Prior to this year, consistent monitoring efforts had not been conducted in the Goose Lake Basin for over a decade despite this system's sensitivity to disturbance events and its status as priority habitat for native fish. The goal of this project is to collect up-to-date and comprehensive monitoring on native and non-native fish abundance, distribution, and habitat use for the Oregon portion of the Goose Lake Basin.
We comprehensively sampled a total of 36 sites during the 2022 field season, all of which were sites that had been previously sampled by ODFW in 2007. At each site we electrofished, collected triplicate eDNA samples, and installed a continuous water temperature logger. An additional 35 randomly generated sites were sampled for eDNA only. In our preliminary results, fish abundances appeared to have declined between 2007 and 2022, although community composition remained relatively unchanged. Most notable declines occurred in the Drews Creek watershed. Sucker species declined the most, likely due to absences in lower Drews and Dry Creeks where they were highly abundant in 2007.

Genetic approaches reveal a healthy population and an unexpectedly recent origin for Foskett Spring Speckled Dace

Brian Sidlauskas
Oregon State University
Co-Authors: Samarth Mathur, Hakan Aydogan, Fred Monzyk, Andrew Black

The isolated Foskett Spring in Oregon's southern desert harbors a morphologically and genetically distinctive population of Speckled Dace (Rhinichthys osculus) that was federally listed as threatened between 1985 and 2019. Previous studies concluded that Foskett Dace separated from populations in Oregon's Warner Valley 10,000 years ago, thereby framing an enigma about the dace's surprising ability to persist for so long in its tiny habitat. Though recently delisted due to successful implementation of its

recovery plan and the establishment of a refuge at Dace Spring, maintenance of healthy population sizes appears to depend upon regular manual removal of encroaching vegetation. To help monitor the effectiveness of such interventions and to investigate the phenomenon of the dace's persistence, we assessed genetic diversity among daces inhabiting Foskett and Dace springs and three nearby streams. After screening out first and second-degree relatives, analysis of 3,354 single nucleotide polymorphisms revealed a robust effective population size (Ne) of nearly 5,000 within Foskett Spring proper, though Ne in the Dace Spring refuge is just 10% of that value. Observed heterozygosity is slightly lower than expected at all five sites, suggesting that all desert dace populations experience mild inbreeding, but not at a level of concern. These results confirm the genetic health of Foskett Dace. Unexpectedly, F statistics reveal closer similarity between Foskett Dace and dace in Nevada's Coleman Creek than between Foskett Dace and dace elsewhere in Oregon. Demographic modeling inferred the Nevada population as the ancestral source of Foskett Dace and reconstructed their isolation at just 600 years ago, much more recently than previously suspected. These results help to solve the enigma of persistence by greatly shortening the duration over which Foskett Dace have inhabited their isolated desert spring.

The Smith River Verification Study: A successful failure improves juvenile salmonid

Ronald Constable
Oregon Department of Fish and Wildlife
ron.constable@oregonstate.edu
Co-Author: Erik Suring

We attempted to determine whether electrofishing removal estimates or single pass snorkeling was a more reliable method for Oregon Department of Fish and Wildlife (ODFW) monitoring of juvenile coho salmon (Oncorhynchus kisutch) and steelhead (O. mykiss) abundance and occupancy trends. Based on 1997–2000 data we assumed abundance estimates from the method that tracked more closely with parental abundance would better approximate true juvenile abundance. Parental abundance from spawning ground surveys and juvenile abundance metrics unique to each method were estimated from 2000–2004 and 2007–2008. Parental abundance did not explain the variation in juvenile abundance from either method ($r2 < 0.22$), invalidating our assumption, but results had relevance for snorkel surveys used in ODFW monitoring. For both species, correlations between density (fish/m^2) and abundance (quantity, based on fish/km) estimates from snorkeling were weak ($r < 0.379$) but correlations between abundance estimates from both methods were strong ($r > 0.846$); implying abundance was more appropriate than density for ODFW monitoring. Neither method could sample all habitats, and annually variable proportions of coho salmon (15–47%) and steelhead (0–24%) abundance estimates obtained by electrofishing were in pools too shallow to meet the ODFW depth criterion for snorkeling. This resulted in lowering the criterion to ≥ 20 cm in 2010. The lower criterion, relative to original, has not shown differences in trends but 30% more pools have been sampled, resulting in 23% higher abundance estimates with 10% proportionately smaller confidence intervals. These changes improved ODFW monitoring and related management decisions.

A range-wide database of whole genomes illuminates the geographic and evolutionary context of adaptive variation in Chinook salmon

Tasha Thompson
Wild Salmon Center
tthompson@wildsalmoncenter.org
Co-Authors: Matthew Sloat, Mariah Meek

Adaptive genetic variation is critical to Chinook salmon's ability to occupy distinct habitats across the Pacific Rim and withstand environmental changes. Human actions can negatively impact adaptive variation, with serious consequences for resilience and long-term evolutionary potential. Genomic technologies have facilitated the interrogation of adaptive variation in wild populations, and markers for adaptive loci hold great promise for improving management of Chinook salmon populations. However, a given marker is typically identified in one or a small number of populations, and understanding its geographic/evolutionary context and validating its broader efficacy is time and resource intensive, which can create years-long delays in management applications. To expedite the time from initial discovery to broad application of adaptive genetic markers, we created a database of ~500 whole genomes from across the species' range. Here, we present our database as well as an example of its utility using the GREB1L/ROCK1 genetic region, the primary locus underlying run-timing diversity in Chinook salmon. We use our database to explore the geographic and evolutionary context of GREB1L/ROCK1 at a range-wide scale, gain insight into the causal mechanisms acting at the locus, and evaluate the breadth of efficacy of previously-developed markers.

Intestinal lesions and links to pre-spawn mortality in spring Chinook salmon (Oncorhynchus tshawtscha)

Tamsen Polley
Oregon State University
tamsen.polley@oregonstate.edu
Co-Author: Michael Kent

Pre-spawning mortality (PSM) is a major hindrance for population recovery of spring Chinook salmon in the Willamette River basin. Based on histology, we previously documented a strong correlation between intestinal lesions and PSM, which we conclude is caused by premature senescence. This was based on examination of ~800 fish from 2009-2021. These lesions are characterized by degeneration and ulceration of the epithelium with concurrent severe inflammation in the lamina propria of the intestine and pyloric caeca. They progress through the summer; 1) intestines are essentially normal in most fish shortly after they return to the river in late spring, then, 2) varying degrees of lesion severity are observed in midsummer in fish that appear to be clinically normal, and 3) almost all PSM fish collected in summer and post-spawned fish from the fall show profound manifestations of the lesions. When accounting for Julian date, less proportional epithelium remaining was strongly associated with being a PSM fish. In 2022, in addition to the Willamette Hatchery spawners, we examined adult spring Chinook from the Round Butte Hatchery, Oregon, on the Deschutes and from the White River Hatchery, Washington. The former had experienced high levels of PSM, and 100% (11/11) PSM fish and 100% (19/19) artificially spawned fish had profound lesions. In contrast, 100% (15/15) of brood fish from the

White River, with no reports of significant PSM, had completely normal, intact intestines with healthy folds and no to mild inflammation. These observations further support that these lesions are markers for PSM, and brings forward the question why are spring Chinook from White River, which also spend many months in freshwater before spawning, not affected by this syndrome. Here we expand on the pathologic description and report on intestinal changes in adult spring Chinook from two other locations outside of the Willamette region.

Populations on the Edge Session

Coquille River Fall Chinook--Challenges for Recovery of a Population on the Brink
Michael Gray
Oregon Department of Fish and Wildlife
michael.e.gray@odfw.oregon.gov

The estimated wild spawning escapement of Coquille River fall Chinook Salmon averaged 8,400 fish from 1974 to 2017, peaking with over 30,000 fish in 2010. Habitat improvement projects, fishery management, and gradual healing from legacy ecosystem impacts contributed to an increasing population trend during that period. In 2018, a severe decline was observed in the escapement estimate and this extremely low return has persisted to date. For the 2018 through 2021 returns, the escapement averaged just over 500 fish. Multiple factors ranging from a warm ocean, to in-basin drought conditions, to predation by invasive fishes have contributed to this decline and continue to limit the recovery of this population. Population history, limiting factors, ongoing recovery actions, and challenges to restoring this run are presented.

Population dynamics, genetic analysis, and conservation strategies for red abalone (Haliotis rufescens) in Oregon
Kendall Smith
Oregon Sea Grant
kendallrae2605@gmail.com

Increased concern for changing population dynamics in abalone fisheries has necessitated shifts in conservation and management. Whole genome sequencing (WGS) results indicate that red abalone (Haliotis rufescens) in Oregon are genetically connected to population strongholds. Principal Components Analysis (PCA) of H. rufescens genetic samples showed considerable overlap across four Oregon sites. Larval dispersal potential and rare hydrodynamic regime shifts could sustain a small population. The red abalone in Oregon is imperiled and its future is uncertain, requiring increased conservation and monitoring efforts. This conservation and management plan suggests focusing on understanding ecosystem shifts driving population levels. Future considerations for managing such a marine broadcast spawning invertebrate with low densities, limited dispersal, and variable recruitment that hold historical, social, and economic value are considered and explored as climate shifts are expected to affect ecological parameters at the local and population level.

Eastern Oregon Spring Chinook on the Edge

Kasey Bliesner
Oregon Department of Fish and Wildlife
kasey.bliesner@odfw.oregon.gov
Co-Authors: Ian Tattam, Joseph Feldhaus, Polly Gibson

Populations of spring Chinook in the John Day Basin are a wild un-supplemented population in Eastern Oregon with minimal Columbia River dams to pass and extensive habitat restoration underway within their distribution, yet the Middle Fork John Day River spring Chinook population has experienced two near quasi-extinction events in the last 6 years. Chinook populations in the Snake River ESU were listed as threatened under the Endangered Species Act, and the Grande Ronde Upper Mainstem spring Chinook population has been severely depressed for decades despite an active hatchery supplementation program and millions of dollars spent on habitat restoration. In this talk we will discuss the long decline of the Grande Ronde Upper Mainstem spring Chinook population and the recent declines in the Middle Fork John Day spring Chinook population. We will present similarities between the populations, potential common causes of decline, key concerns and limiting factors, what actions are being taken to conserve and recover these populations, the current state of the science, and what the future may hold for both of these eastern Oregon spring Chinook populations on the edge.

Year two: Observations of Fish Survival and Habitat Restoration in the Bootleg Fire in Southeast Oregon

William Tinniswood
Oregon Department of Fish and Wildlife
william.r.tinniswood@odfw.oregon.gov
Co-Authors: Benji Ramirez, Leigh Ann Vradenburg, Charles Erdman, Jorgan Ortega

The Bootleg Fire in Southeast Oregon was the third largest fire in Oregon's History burning 413,765 acres. Unfortunately, the fire burned during an unprecedented drought and at a high intensity that was most severe within riparian corridors. Fish biologists surveyed the streams using electrofishing and spawning survey methodologies to determine fish survival. The primary objective was to continue to determine relative survival of five of the eight populations of Klamath Basin Bull Trout within the Bootleg Fire perimeter. The secondary objective was to determine survival of other fish species. Fish survival within the core area of spawning and rearing of Bull Trout was very low. Bull Trout were not found in three of the five spawning populations with one population teetering on extirpation. One population appears to be doing well due to less extensive fire intensity. Survival of Redband Trout and Marbled Sculpin was zero at one site in the largest river system in the fire, The North Fork Sprague River in 2021. Redband Trout recolonized quickly at this site in 2022. Lamprey were detected on the North Fork Sprague in good abundance but not detected at sites within the Bull Trout core area. Conversely, survival of Brown and Redband Trout in streams downstream of beaver dams and ponds were exceptional. Using the gained information on the importance of beaver dams and associated conditions, habitat restoration was initiated immediately following the fire and continued by adding numerous large wood structures with the goal of sediment deposition and ameliorating the affects of toxic levels of turbidity. Bull Trout in these streams have a very weak migratory life history and there is little or no

mixing among the populations, therefore, population persistence is in serious jeopardy for four populations. Managers are currently working with Bull Trout experts and utilizing modeling to develop reintroduction strategy of Bull Trout throughout the Klamath Basin with a new emphasis on restoring populations that were severely impacted by the Bootleg Fire.

Reintroductions – Where are we Now Session

Is Three Years of Reintroduction Enough to Restore Oregon's Chum Salmon?

Kelcee Smith
Oregon Department of Fish and Wildlife
kelcee.l.smith@odfw.oregon.gov
Co-Authors: Scott Kirby, Derek Wiley, Erik Suring

Small or functionally extirpated populations face a myriad of ecological, demographic, and societal barriers on the road to recovery. Scientists facilitating recovery efforts meet these challenges in a variety of ways, including: habitat restoration, supplementation from in situ or ex situ populations, and/or directed educational outreach in local communities. But, it is rare for these approaches to be consistent enough over time, especially given limited resources (i.e., time and funding), to recover small populations either efficiently (i.e., as quickly as possible after population decline) or effectively (i.e., as directly as possible). One example of this phenomenon are the Oregon populations of Chum Salmon (Oncorhynchus keta) in the lower Columbia River, which are part of the Columbia River Evolutionary Significant Unit that has been listed as Threatened on the Endangered Species Act since 1999. Over the years, efforts to recover Oregon populations have ranged from transferring individuals or gametes from Washington to Oregon, outplanting adults or eyed-eggs via remote site incubators in unoccupied tributaries, conducting research on factors limiting survival at various life stages, and implementing habitat restoration projects in partnership with local watershed councils. However, most reintroduction strategies are limited by the number of adult Chum Salmon that return to the system, meaning that when returns are low, even if personnel and funds are available, reintroduction efforts essentially cease. Here, we show how three years of high adult returns can be used to more effectively and efficiently restore two of Oregon's Chum Salmon populations. Reintroduction of large quantities of fish over consecutive years may provide the foundation for recovery at specific sites, even those with imperfect habitat quality. Forecasting ahead, these populations may have the ability to maintain their size and meet recovery metrics, especially if freshwater and marine environmental conditions continue to be favorable.

Reintroduction of Bull Trout to the Clackamas River – A 10-Year Retrospective

Chris Allen
U.S. Fish and Wildlife Service
chris_allen@fws.gov
Co-Authors: Steve Starcevich, Marshall Barrows

Bull Trout (Salvelinus confluentus), a species of char present in five western states, are a threatened species under the federal Endangered Species Act. Due to a significant reduction in their distribution,

reintroduction has been proposed as a tool to promote recovery in portions of the species' range. Planning for a Bull Trout reintroduction in the Clackamas River, Oregon, began in 2005 and translocations using multiple life-stages of wild donor stock from the Metolius River occurred annually from 2011-2016. Translocated adults (age 5 or older) remained in their new basin and have been observed spawning annually since 2011. Translocated juveniles (ages 1-4) have survived to adulthood demonstrating the ability of the Clackamas River to support Bull Trout growth, survival, and maturation. However, recruitment of Clackamas-born progeny has not been detected in the spawning population to date despite verification of embryos in redds. In addition, attempts to detect juvenile Bull Trout have been unsuccessful. These results have led to concern that unknown factors may be limiting survival of early life-stages and ultimately may prevent the reestablishment of a self-sustaining Bull Trout population in the Clackamas River. This talk will highlight milestones of the project over the last decade including current efforts to monitor Clackamas-born survival to adulthood and a lab study evaluating the relative survival and development of fry from embryos hydraulically sampled from redds in tributaries of the Clackamas and Metolius rivers to determine if developmental abnormalities may be contributing to mortality in early life stages of Bull Trout in the Clackamas River.

We're back: recolonization of Chinook salmon in Quartzville Creek

Hans Berge
Cramer Fish Sciences
hans.berge@fishsciences.net
Co-Author: Ryan Flaherty

Historically, the construction of dams has often blocked access to critical habitats for salmon and trout species across the Pacific Northwest. As operations of hydroelectric projects and flood control dams have undergone changes in license and operational requirements, greater emphasis has been placed on ensuring access to habitats that were accessible prior to dam completion. In Oregon, there are increasingly more examples of recolonization of these blocked habitats by fishes present downstream of dams. Quartzville Creek, a tributary to the Middle Santiam River in Linn County, Oregon, has habitats that have been isolated from anadromous fish use by Green Peter Dam since construction was completed in 1966. In 2022, 200 adult hatchery origin Upper Willamette River Spring Chinook salmon were released at a single location into Quartzville Creek on 8 September. We conducted spawning ground surveys over a six-week period to document the temporal and spatial extent of spawning in Quartzville Creek and identified important factors for consideration in setting targets for recolonization in similar circumstances.

Guess who's back? Back again. Coho's back. Tell a friend: A status of Coho Salmon reintroduction in the Wallowa River Basin.

Kyle Bratcher
Oregon Department of Fish and Wildlife
kyle.w.bratcher@odfw.oregon.gov

Coho Salmon were once abundant in the Grande Ronde River Basin in Northeast Oregon but were extirpated during the early 1900's due to misguided hatchery practices, over harvest, and local dam construction. Historical documents suggest more than 20,000 Coho Salmon returned to the basin annually. Throughout the 1900's efforts were made to reestablish Coho Salmon, primarily within the Wallowa River watershed, however none of those efforts were successful. In 2017 the Nez Perce Tribe (NPT) and the Oregon Department of Fish and Wildlife (ODFW) initiated a 5-year pilot program with the primary purpose of Coho Salmon reintroduction into the Lostine River (Wallowa River watershed), and a secondary objective of returning 540 adults to the Lostine Weir to support future hatchery propagation. During this effort, 500K smolts from Tanner Creek stock (Bonneville Hatchery) were released annually into the Lostine River. Average estimated returns were 1,755 (200 - 3,200) adults to Lower Granite Dam from 2018 to 2022. However, an average of only 67 adults returned to the Lostine River Weir annually, less than the stated secondary goal of the pilot program. Returns of Coho Salmon did support establishment of recreational fisheries in the Snake River (2021 & 2022) and the Grande Ronde River (2020-22), though estimated annual harvest was limited to fewer than 100 and 30 individuals, respectively. During exploratory spawning surveys, core spawning areas and colonization of multiple tributaries was documented. Natural production was verified by capture of juvenile Coho Salmon at the Lostine River rotary screw trap, and what were likely natural adults returning to the Lostine River Weir in 2020. The NPT and ODFW is in the process of evaluating the success of the pilot program and will be developing management recommendations for continued reintroduction efforts.

Bull Trout Reintroduction Effectiveness and Prospects in the Upper Willamette Basin

Nik Zymonas
Oregon Department of Fish and Wildlife
nik.zymonas@oregonstate.edu

Reintroduction into formerly occupied sites represents an appealing approach to increasing the distribution and abundance of threatened species such as Bull Trout. A comprehensive multi-agency effort to recover Bull Trout in the Upper Willamette Basin has included a reintroduction component that began in the early 1990s and continues with effectiveness monitoring and feasibility assessments for future projects. Site selection has focused on cold water temperature, habitat connectivity, and lack of Brook Trout. Translocation of age-0 Bull Trout resulted in detectable levels of spawning beginning after 7-8 years and redd counts exceeding 20 redds after 13 years in Sweetwater Creek and 21 years in the Middle Fork Willamette. Releases of larger captively reared juveniles in one stream (Swift Creek) yielded only extremely low numbers of returning adults but continuing natural production. Management efforts to address threats to reintroduced populations have continued decades after the initial translocations. These reintroduction efforts have furthered resilience through increased abundance, genetic interchange among local spawning populations, and occurrence of spawning populations in multiple river basins. Habitat suitability assessments have identified potentially suitable sites for additional reintroduction projects in the North Santiam Basin and three watersheds in the Middle Fork Willamette Basin. Management actions to improve habitat connectivity and increase survival of Bull Trout may be necessary to establish populations at some sites.

Harvest Management Session

The science of Black Rockfish management

Leif Rasmuson
Oregon Department of Fish and Wildlife
leif.k.rasmuson@odfw.oregon.gov

In Oregon, Black Rockfish are the primary target of the recreational fleet and are an important component of the commercial nearshore fishery. Black Rockfish are managed by the Pacific Fisheries Management Council in a complex multiagency process. A key step of this management process is the stock assessment. In this talk I will consider what data streams, both fisheries dependent and independent, are used in the stock assessment for Black Rockfish. I will discuss how these data are generated and collected, and analyzed and discuss how scientists are pushing the boundaries to do a better job with more and better data. I will also talk about the process of getting new data incorporated into a stock assessment. Finally, I will introduce the stock assessment process and how suggestions are generated and provided to the council.

International in-season fisheries management challenges for Fraser River sockeye as abundances decline

Fiona Martens
Pacific Salmon Commission
martens@psc.org
Co-Authors: Catherine Michielsens, Eric Taylor, Merran Hague

Productivity of Fraser River sockeye has been declining for the last 25 years, and a population that once supported robust annual fisheries now typically only supports commercial fishing once every four years. Until recently, the dominant cycle, known for its large abundances of sockeye from the Adams River, has been excluded from the downward trends observed on the three other cycle lines. However, in 2022 the Fraser River experienced its lowest return on the dominant cycle since 1970, with only 6.8 million fish returning. This was largely the result of smaller than expected abundances of early and late summer populations from the Shuswap Lake region in the interior of British Columbia, and represented the lowest run size of late-timed Shuswap fish (“Late-run”) on this cycle line since 1952. Smaller abundances, in combination with in-season assessment uncertainty due to unique migration behavior by Late-run stocks, has challenged managers who must balance conservation concerns with international and domestic catch allocations on the last Fraser sockeye cycle that is still able to support commercial fisheries.

Shrimping without a quota

Scott Groth
Oregon Department of Fish and Wildlife
Scott.d.groth@odfw.oregon.gov

The US West Coast's ocean (aka pink) shrimp, Pandalus jordani, fishery is high volume, valuable, and managed sustainably; however, does not employ a quota. While many fisheries are managed using quota, the short lives and environmentally forced recruitment of P. jordani makes quota management impractical. The Fishery Management Plan (FMP) for Oregon ocean shrimp outlines Biological Reference Points (BRPs) which include environmental conditions and an index of abundance to trigger closures when spawning stocks are most valuable. Changing ocean conditions and improved fishery efficiency require periodic testing, followed by modifications to these BRPs.

Treaty and Non-Treaty Abundance-Based Management in the Columbia River

Kate Self
Columbia River Inter-Tribal Fish Commission
kself@critfc.org

The Columbia River Basin covers approximately 258,000 square miles, an area roughly the size of France. Tribes ceded approximately 66,591 square miles of this land (more than 25%) in treaties signed around 1855. Historic salmon returns are estimated to have been between 12-16 million fish per year but are now closer to 1 million fish per year. Heavy impacts such as unregulated harvest, dams, agriculture, mining, predation, forestry, and urban development have drastically changed the Columbia River. Due to the limited number of salmon returning to the river each year, fisheries management requires a dynamic and adjustable framework. Mainstem Columbia River fisheries are co-managed by state, tribal, and federal parties. These parties use abundance-based harvest rates with certain weak stock triggers to protect threatened or endangered stocks. When fish are abundant, the proportion of the fish allowed to be caught increases, but when runs are low, the proportion declines. Additional limits are put in place if certain wild stocks are at particularly low abundance. By managing fisheries on the actual run sizes returning to the river each season, managers can provide improved harvest responsiveness. This can be compared to ocean fisheries which are managed based on forecasted abundance. In low run years, abundance-based management provides for a higher proportion of the run being passed to spawning escapement which is a conservation advantage under conditions of low abundance. In high run years, fishing opportunity can be scaled to target stocks of higher abundance if sensitive stocks remain protected under harvest rate limits.

Klamath Basin Spotlight Session

Habitat fragmentation drives divergent survival strategies of a cold-water fish in a warm landscape

Nick Hahlbeck
MRAG Americas & Oregon State University
nhahlbeck4@gmail.com

Climate change is a global phenomenon, but natural selection occurs within landscapes. Many global analyses predict how climate change will shape behavior and physiology, but few incorporate information from the landscape scales at which animals actually respond to selective pressure. We compared cold-water fish (redband trout Oncorhynchus mykiss newberrii) from neighboring habitats in

a naturally warm, recently fragmented basin to understand how different responses to warming may arise from landscape constraints. Trout in warm, hydrologically connected Upper Klamath Lake fled summer temperatures and sought refuge in cool tributaries, while trout in an equally warm but fragmented reach of the Klamath River endured summer conditions. Trout in the river were more physiologically tolerant of high temperatures than trout in the lake across multiple metrics, including capacity for aerobic activity, recovery from exertion, and loss of equilibrium. Two independent metrics of energetic condition indicated that the behavioral strategy of trout in the lake came at a substantial energetic cost, while the physiological strategy of trout in the river was able to mitigate most energetic consequences of high temperatures. No clear genetic basis for increased tolerance was found in trout from the river, which may suggest tolerance was derived from plasticity, although our analysis could not rule out genetic adaptation. Our results show that landscape processes such as fragmentation can cause different climate survival strategies to emerge in neighboring populations. Connecting the mechanisms that favor similar survival strategies among related organisms at broad scales with mechanisms that drive landscape-scale variability within taxa should be a major goal for future predictions of biological responses to climate change.

A strategy for monitoring repopulation and pre-dam removal studies in the Upper Klamath Basin

Mark Hereford
Oregon Department of Fish and Wildlife
Mark.E.HEREFORD@odfw.oregon.gov

The Federal Energy Regulatory Commission approved the removal of the four lower Klamath hydroelectric dams on the Klamath River. The removal of these dams will allow access to hundreds of miles of habitat for anadromous fishes that have been blocked for over 100 years. The schedule for dam removal is set to begin in 2023 with full passage available in late 2024. In preparation for dam removal and the subsequent repopulation of anadromous fishes into Oregon, ODFW and partners have developed a strategy for monitoring Chinook Salmon, Coho, Steelhead, and Pacific Lamprey. Along with developing a monitoring strategy, ODFW and partners have conducted and continue to develop multiple pre-dam removal studies that investigate the basin-wide genetics of O. mykiss as well as the migratory behaviors and survival of juvenile Chinook Salmon in the upper basin. This presentation will briefly summarize the strategy for monitoring repopulation, genetic population structure of Steelhead and resident Redband and Rainbow Trout, and summarize preliminary data associated with a multi-year mark-detection study of released juvenile Chinook Salmon in the upper basin.

Engaging Agricultural Landowners in Fish Habitat Restoration: Pathways and Barriers

Laura Duffy
Oregon State University
duffyla@oregonstate.edu
Co-Author: Hannah Gosnell

The conservation community has long recognized the critical role that agricultural landowners play in efforts to improve fish and wildlife habitat in order to recover threatened and endangered species. In

many rural areas dominated by agricultural working landscapes, government agencies like the U.S. Fish and Wildlife Service (USFWS) struggle to gain the trust of ranchers and farmers, a prerequisite for successful federally funded habitat restoration projects, and coordinate habitat restoration across property lines. This project aims to identify barriers and pathways to fish habitat restoration on agricultural lands, drawing on theories associated with trust and collaborative conservation. Findings draw on interviews with practitioners across the U.S. who have had success engaging private landowners in habitat restoration; and a case study of landowner attitudes in the Upper Klamath Basin along the California-Oregon border in the western U.S. where two species of sucker fish with cultural importance to the Klamath Tribes are listed under the Endangered Species Act. The project aims to inform USFWS efforts to invest over $100m in restoration funds on private lands. In this presentation, we report on early results from this study, which have implications for efforts to improve working relationships between agricultural landowners and government agencies and implement a landscape scale approach to fish habitat restoration.

Fisheries Monitoring Elements of the Klamath River Renewal Project

Daniel Chase
Resource Environmental Solutions
Dchase@res.us
Co-Authors: John Lang, Joel Ophoff, Olivia Vosburg

Removal of four hydropower dams (Iron Gate, Copco 1, Copco 2, and J.C. Boyle) on the Klamath River in northern California and southern Oregon represents the largest dam removal and river restoration project in the country. The project will restore free-flowing conditions and volitional fish passage to more than 400 miles of currently cut-off anadromous fish habitat upstream of the lower-most dam, Iron Gate. RES was selected by the Klamath River Renewal Corporation to lead restoration for this ambitious effort, as well as accept liability associated with ensuring restoration meets ecological and biological performance standards and long-term goals/objectives. Restoring volitional fish passage to hundreds of miles of the Klamath River, once the third largest producer of salmon on the West Coast, will be an important achievement for this large, complex project. This presentation compliments the other Klamath River Renewal Project talks in the session and will focus on key elements of fisheries monitoring and protective measures incorporated into the project and when they will occur across the project timeline.

Avian Predation on Juvenile and Adult Lost River and Shortnose Suckers: An Updated Multi-Predator Species Evaluation

Allen Evans
Real Time Research
allen@realtimeresearch.com
Co-Authors: Quinn Payton, Nathan Banet, Brad Cramer, Dave Hewitt, Caylen Kelsey

Previous research suggests that predation by piscivorous colonial waterbirds may negatively influence the survival of ESA-listed Lost River and Shortnose suckers in the Upper Klamath Basin (UKB). Estimates

of predation from past studies, however, were minimum estimates of sucker mortality because analyses did not account for the proportion of sucker tags that were consumed by birds that were deposited beyond their breeding colony. To address this uncertainty, we conducted a field study to quantify PIT tag deposition probabilities by avian predator in the UKB. We then used a hierarchical Bayesian model to estimate predation on Sucker Assisted Rearing Program (SARP) juvenile suckers and on naturally-reared juvenile and adult suckers during 2009–2020. Deposition-corrected estimates of predation rates were approximately 2 times greater than those previously reported in the literature and ranged annually from 4.3% (0.9–13.2) to 10.5% (3.8–24.5) on juvenile suckers and 0.1% (<0.1–0.3%) to 7.2% (2.8–16.4) on adult suckers, depending on the species, rear-type, and location (Clear Lake Reservoir, Upper Klamath Lake). Results indicated that predation by colonial waterbirds was highly variable and, in some cases, represented a substantial source of sucker mortality. Future studies should consider models that jointly estimate both predation and survival and models that include biotic and abiotic factors that may influence sucker susceptibility to avian predators in the UKB.

Monitoring and managing a PNW river to mitigate disease in anadromous salmon: metrics that matter

Sascha Hallett
Oregon State University
halletts@oregonstate.edu
Co-Authors: Julie Alexander, Stephen Atkinson, Ryan Craig, Richard Holt, Jerri Bartholomew

The Klamath River supports ecologically, economically and culturally important populations of salmonids. However, anadromous fish passage has been blocked for over a century by the series of dams. To reduce the impact of habitat loss, natural-rearing fishes are supplemented annually with hatchery-reared Chinook and coho salmon, but infectious diseases cause significant population level impacts. In response to a visible fish disease outbreak in 2002, a multi-agency pathogen monitoring program was established. This comprehensive approach targets specific index sites, hosts (vertebrate and invertebrate) and waterborne infectious stages using sentinel fish exposures, benthic sampling and water sampling combined with microscopy and molecular analyses. It has focused on the myxozoan parasite Ceratonova shasta which causes enteronecrosis in juvenile salmonids and is being expanded to include other pathogens of concern. This long term project explores how parasite distribution and abundance vary among different water years and the biotic and abiotic factors that influence this occurrence. These efforts have enabled the identification of meaningful metrics and disease thresholds that inform management decisions. A subset of metrics are measured near real-time and can trigger adaptive management actions, which include manipulation of river water (prescribed flows) and timing of release of hatchery fishes. We will present the suite of metrics, what each informs and how these can be utilized to implement short and long term management and mitigation of diseases in salmonids. The lessons learned are applicable to other imperiled waterways and will be modified for post-dam removal monitoring.

This approach was possible due to the long term collaboration with Karuk and Yurok tribal biologists and financial support from the Bureau of Reclamation to all three entities.

Restoration elements of the Klamath River Renewal Project (i.e. Lower Klamath Project)

Dave Coffman
Resource Environmental Solutions
dcoffman@res.us
Co-Author: Gwen Santos

Removal of four hydropower dams (Iron Gate, Copco 1, Copco 2, and J.C. Boyle) on the Klamath River in northern California and southern Oregon represents the largest dam removal and river restoration project in the country. The project will restore free-flowing conditions and volitional fish passage to more than 400 miles of currently cut-off anadromous fish habitat upstream of the lower-most dam, Iron Gate. RES was selected by the Klamath River Renewal Corporation to lead restoration for this ambitious effort, as well as accept liability associated with ensuring restoration meets ecological and biological performance standards and long-term goals/objectives. RES is leading design and implementation efforts for the restoration of nearly four miles of priority tributary streams and associated fish habitat, as well as vegetation restoration for approximately 2,000 acres of previously inundated lands. Restoring volitional fish passage to hundreds of miles of the Klamath River, once the third largest producer of salmon on the West Coast, will be an important achievement for this large, complex project. Area Tribes have relied on salmon as a vital resource for generations; rehabilitation of salmon and steelhead populations is not only environmentally important but critical to sustaining their culture. RES will rely on native seed propagation for revegetation of upland, riparian, and wetland habitats, and large wood placement to stabilize sediments and improve habitat for native fish and increase river and tributary functionality. This presentation provides an overview of restoration goals and approach, and key elements of stream, riparian, and wetland restoration for the project.

Fish Protection Screens at Klamath River Diversions after Dam Removal: Design and Lessons Learned from the Elwha River

John Burnett
Intake Screens, Inc.
jburnett@isi-screens.com
Co-Author: Russel Berry IV

Removal of the four lower dams on the Klamath River will dramatically increase habitat availability to anadromous salmonids and other native species. Dam removal will also likely increase rates of injury and mortality of fishes that are entrained in the existing diversions unless fish protection screens are installed. NOAA Fisheries, Pacific States Marine Fisheries Commission, and Trout Unlimited identified 70 potential unscreened diversions in the dam removal area and ranked 26 of these projects as high priority, 13 as medium priority, and 31 as low priority. This presentation will provide an overview of fish screen design when retrofitting an existing diversion and provide lessons learned from design and installation of fish protection screens in the Elwha River after dam removal.

Epidemiology of two salmonid parasites in the Klamath River's hydroelectric reach

Elliott Cameron
Oregon State University
elliottcmrn@gmail.com
Co-Authors: Sascha Hallett, Jerri Bartholomew, Julie Alexander

Current plans to decommission and remove four hydroelectric dams on the Klamath River will allow anadromous salmon to access historic spawning grounds and alter their pathogen distribution in the hydroelectric reach. Two of these pathogens, Ceratonova shasta (Cs) and Parvicapsula minibicornis (Pm) (Cnidaria, Myxozoa), are obligate parasites that cause disease in salmon throughout the Pacific Northwest. Both parasites alternate between infecting salmon and annelid hosts, and two waterborne spore stages. We described the distribution of the parasites spatially and temporally, as well as the density and distribution of annelids, in the Klamath River's hydroelectric reach (KRHE). We sampled six sites for water and annelids. In 2021, Cs spore levels were highest in August at the majority of sample sites, measuring up to 28 spores/L. The distribution of Pm in water samples was more temporally variable, and the highest density measured was 78 spores/L. Annelid densities were highest downstream of the J.C. Boyle and Copco 2 dams, and these locations also had the highest densities of annelids infected with Cs (8248 worms/m2, and 3556 worms/m2, respectively). Interestingly, although densities of Pm were higher than Cs in water samples, the prevalence of Cs in annelids was higher than Pm. These data suggest there may be areas with a higher risk of myxozoan infections and provide a better understanding of disease dynamics in the KRHE. This will inform management efforts post-dam removal when salmon are reintroduced to the upper Klamath River.

A rolling rock gathers no worms: Responses of invertebrate hosts of salmon parasites to Klamath River flow events

Julie Alexander
Oregon State University
alexanju@oregonstate.edu
Co-Authors: Sascha Hallett, Jerri Bartholomew, Taylor Daley, Nicholas Som, Nicholas Hetrick

Changes in the dynamics of infectious diseases have been linked with hydrological change in aquatic systems but predicting the magnitude and direction of specific responses is challenging. We present an overview of myxozoan disease dynamics in the context of invertebrate host responses to flow events in the Klamath River, where enteronecrosis is associated with salmon population declines. The causative agent, Ceratonova shasta, alternately infects the annelid host Manayunkia occidentalis, which releases the parasite stage that is infectious for salmon. The demand for effective disease management solutions for Klamath River salmon has generated interest using flow manipulation to reduce M. occidentalis populations, and in turn, reduce disease risk for salmon. We used a tandem modeling approach for evaluating the effects of flow events on annelid hosts and validated predictions using data collected the following season. We also contextualized model outputs with infection data collected immediately before and after flow events. Our results demonstrate 1) hydraulic conditions during peak discharge (natural or managed) drive annelid host distribution and 2) winter conditions (discharge, temp) explain variation in C. shasta infection dynamics in annelid hosts. Our work provides tools that improve understanding of how annelid distribution responds to flow manipulation and allow evaluation of the

potential efficacy of proposed management scenarios, and ultimately, provide a better understanding of invertebrate host ecology.

Juvenile Spring-run Chinook Salmon Susceptibility to Pathogens in the Upper Klamath Basin, to Inform Reintroduction Efforts

Hayden Krause
Oregon State University
krauseh@oregonstate.edu

With the planned removal of the four lowermost dams in the Klamath River, spring-run Chinook will once again have access to the Upper Klamath Basin habitats. Using sentinel fish exposures and water sampling, we describe the presence and distribution of potential pathogens that may be encountered upon return. In spring 2022 (once in April and once in May), four cages each containing twenty brood year 2020 smolts, were held at two sites, Klamath Lake outlet (KPP) and Williamson River (WNC). Two cages at each site were removed at 3-days and 7-days post-exposure and the fish were transported to the J.L. Fryer Aquatic Animal Health Laboratory. Each removal was followed by a necropsy of half of each group of fish immediately. The other half were monitored for 28 days, followed by euthanasia and pathogen sampling. Fish were necropsied and tissues were tested using bacterial cultures, cell cultures for virus, molecular analyses and wet mount observations for external parasites. We supplemented the exposures with water sampling at each site, followed by molecular analyses to determine the distribution and abundance of waterborne pathogens. Renibacterium salmoninarum, Ceratonova shasta, Ichthyophthirius multifiliis and Trichodina spp. were detected at both sites with fluctuations in prevalence between months. Flavobacterium columnare was detected only at KPP during May, whereas Parvicapsula minibicornis and viruses were not detected. C. shasta, F. columnare, and I. multifiliis were more prevalent in May, associated with higher temperatures. C. shasta was determined to be ITS-1 type II and histology and PCR detection of C. shasta-infected intestinal tissues revealed that Chinook are a dead-end host. Detection of F. columnare, and I. multifiliis may raise concerns since disease is highly transmissible at elevated temperatures. This information reveals that pathogen infection prevalence is greater at higher temperatures and may inform management efforts when considering fish migration in the UKB.

The Mystery Age Class: 2022 movement and survival of juvenile suckers in Upper Klamath Lake

McKenzie Wasley
USFWS
mckenzie_wasley@fws.gov
Co-Author: Christi Kruse

This presentation will provide an update on movement patterns and survival of the Spring 2022 cohort of radio tagged fish reared by Klamath Falls National Fish Hatchery (KFNFH). Endangered C'Waam, or Lost River sucker (Deltistes luxatus) and Koptu, or shortnose sucker (Chasmistes brevirostrus), have been collected and reared by KFNFH since 2016. Klamath Falls Fish and Wildlife Office began monitoring juvenile suckers using radio telemetry technology in spring of 2022. This work is focused on investigating the movement and survival of juvenile suckers reared and released through the Sucker Assisted Rearing

Program (SARP) at KFNFH. The long-term project is designed to help inform future hatchery management decisions and recovery actions by identifying spatiotemporal patterns of juvenile sucker movement, habitat use, and mortality. In March of 2022, C'Waam and Koptu were implanted with radio tags and released into tributaries of Upper Klamath Lake (UKL). Researchers passively monitored fish movement using a newly established array of 12 remote receivers located along the shoreline of Upper Klamath Lake and its tributaries. Active monitoring methods included boat, plane, and vehicle surveys. Preliminary results suggest that from the 138 radio tagged fish stocked into UKL in the spring, approximately half of the fish died in the lake, 12 fish were not detected and the remaining proportions of fish are either alive or have left the system. Through this multi-year monitoring effort, researchers hope to identify crucial information to support SARP success and provide insight into the mystery that is the juvenile age class of suckers in UKL.

Estimating survival of juvenile Chinook Salmon through the outlet of Upper Klamath Lake and Keno Dam

James Whelan
California Polytechnic State University, Humboldt
lajolla.james@gmail.com
Co-Authors: Darren Ward, Mark Hereford

The planned removal of the four impassable hydroelectric dams on the Klamath River will allow salmonids to return to their historic range within the upper Klamath River watershed. Successfully reestablishing salmon populations in the upper Klamath River basin requires that juvenile salmon born in upper tributaries are able to outmigrate through the upper sections of the river. The Klamath River immediately downstream of Upper Klamath Lake poses several potential challenges for outmigrating juveniles, including two flow-control dams that are not scheduled for removal (Link River and Keno dams), major water diversions, and water quality concerns. We used an experimental release of radio-tagged juvenile Chinook salmon to evaluate outmigration survival through this reach, from the outlet of Upper Klamath Lake at Link River Dam downstream through Keno dam to JC Boyle Reservoir. Tagged juvenile Chinook were able to pass downstream over both dams. Estimated survival rate for downstream migrants was lowest in the reach immediately below Link River dam. We are repeating the experiment with a new release group in spring 2023 to evaluate specific locations that may be leading to reduced survival.

A Decade of Bull Trout Recovery in Middle Sun Creek Following Antimycin Treatment to Remove Nonnative Fish

Dave Hering
Crater Lake National Park
david_hering@nps.gov

In 2012 and 2013, the National Park Service and Oregon Department of Fish and Wildlife used the piscicide antimycin-A to eradicate nonnative trout from a 7-km reach of Sun Creek, Oregon, isolated by artificial passage barriers at the upstream and downstream ends. Prior to treatment, nonnative Brook

Trout and Brown Trout occupied the project area at high densities. Following treatment, native Bull Trout were allowed to passively re-colonize the reach from upstream but were not actively reintroduced. We monitored fish abundance and distribution annually by electrofishing, collected environmental DNA (eDNA) to verify removal of target species, and conducted quantitative fish abundance surveys during 2014-2016, 2021, and 2022. Post-treatment electrofishing and eDNA surveys detected no nonnative fish following the final piscicide treatment. Bull Trout colonized the renovated reach within the first year and successfully spawned during 2015. Three years after treatment, the native species was present throughout the reach, and by 2022, abundance of age 1+ Bull Trout in the project area had increased to approximately 925 fish. Beginning in 2021, we operated a fish trap to allow selective upstream passage of Bull Trout at the downstream exclusion barrier, and this effort moved 51 Bull Trout past the barrier over two summer seasons. Bull Trout continue to increase in abundance in the treated stream and are now also dispersing downstream from the renovated area into nearby habitats, including the Wood River. This project increased Bull Trout occupied habitat by 62% in one of only two extant Bull Trout populations in the Upper Klamath Core Area and strengthened the resilience of this important population to future disturbance. The results demonstrate the efficacy of nonnative fish eradication for recovery of Bull Trout in the Upper Klamath Basin.

A release study assessing the survival of juvenile spring-run Chinook salmon in the Upper Klamath River Basin to inform reintroduction

Rachelle Tallman
UC Davis
rltallman@ucdavis.edu
Co-Authors: Mark Hereford, Tommy Williams, Bob Pagliuco, Shahnie Rich, Robert Lusardi

Four hydroelectric dams on the Klamath River are slated for removal by 2023. While removing the dams will restore anadromous fish passage, it remains unclear whether native fishes will recover after the dam removal. The Oregon Department of Fish and Wildlife (ODFW), The Klamath Tribes (TKT) and the NOAA-Southwest Fisheries Science Center (NOAA-SWFSC) plan to actively reintroduce pathogen-screened spring-run Chinook salmon into suitable habitats within tributaries of Upper Klamath Lake. The goal of this reintroduction is to reestablish self-sustaining populations of spring-run in the upper basin. It has been over 100 years since spring-run have accessed the upper basin, and the degree to which they can survive and breed in heavily altered habitat remains unknown. Uncertainties surrounding reintroduction include: the out-migration survival of juveniles from their release site to Upper Klamath Lake (UKL) and their survival through UKL to Link River Dam. This past year juvenile spring-run were released into the Wood and Williamson Rivers where their survival was assessed to the entry of UKL, through UKL, and Link River Dam. This study will provide crucial data that ODFW, TKT, and NOAA to design an optimal reintroduction program to support a self-sustaining population of spring-run Chinook in the upper basin.

Characterizing riverscape patterns of dissolved oxygen in the Sprague River Basin

Jordan Ortega
Oregon State University

ortegjor@oregonstate.edu
Co-Authors: Alex Carnevale, Shahnie Rich, Nick Hahlbeck, Jonathan Armstrong, William Tinniswood

Dissolved oxygen is fundamentally important to fish health and is particularly relevant to climate change adaptation planning, because it responds to warming while also mediating the thermal tolerance of fish. However, compared to water temperature, we know very little about how dissolved oxygen varies spatially across riverscapes. We set out to characterize spatial heterogeneity in dissolved oxygen across the Sprague River Basin, which is hydrologically diverse and provides habitat for redband trout, Klamath suckers, and future runs of anadromous salmonids. We distributed ~25 dissolved oxygen loggers in the Sprague River and it's three major tributaries, the North Fork, South Fork, and Sycan River. We combined this spatially extensive sampling with higher resolution point sampling that generated maps of dissolved oxygen minimums. Here we describe both coarse-scale patterns along the longitudinal profile of the mainstem river and fine-scale patterns within reaches. These data identify hypoxic areas that pose risks to fish, as well as highly oxygenated areas that likely buffer fish from thermal stress.

Klamath Dam Removal Project: Status, Milestones, and Schedule
Mark Bransom
Klamath River Renewal Corporation
mark@klamathrenewal.org

The Klamath River Renewal Corporation (KRRC) is a non-profit corporation formed by the Klamath Hydroelectric Settlement Agreement (KHSA) and is the entity formally tasked with removing the four lower Klamath River dams, restoring formerly inundated lands, and implementing required mitigation measures in compliance with all applicable federal, state, and local regulations. The four hydroelectric dams on the Klamath River affect more than 400 stream-miles of historic fish habitat and spawning grounds, and reopening the river will allow salmon and steelhead to return to Southern Oregon. Klamath River salmon populations have fallen precipitously in recent years, with Coho salmon listed as threatened under federal and California law. Spring Chinook salmon, once the Klamath Basin's dominant run, have decreased by about 98% and are almost at an extinction level. On December 1, 2022, the Renewal Corporation and the States of Oregon and California notified the Federal Energy Regulatory Commission of their acceptance of license transfer for purposes of decommissioning the hydroelectric facilities. This presentation will provide an overview of the Klamath River Renewal Project, including current project status, dam removal and restoration timeline, and upcoming construction activities.

Climate Adaptation Session

Show Me the Money: Climate Resilience Funding that Benefits Fish, Wildlife, and Habitat
Joanne Throwe
Throwe Environmental, LLC
joanne@throwe-environmental.com

As communities across the country experience intensifying climate-driven and water-related hazards, it is essential that investments are made to expand local resilience. The National Fish and Wildlife

Foundation's (NFWF) National Coastal Resilience Fund (NCRF) provides immediate opportunities for Oregon to invest in sustainable, nature-based solutions. Over the next 4 years, NCRF will have over $140 million in available annual funding to support communities' resilience-building efforts that also enhance fish, wildlife, and habitat. With this in mind, NFWF has contracted Throwe Environmental to serve as Field Liaisons for NCRF to help promote the fund and discuss project ideas for the upcoming 2023 round of funding. This session will introduce potential applicants to NCRF and offer important grant tips that will be applicable to other state and federal sources of funding.
The presentation will offer a comprehensive overview of the program and provide useful tips on how to develop the most competitive proposals, along with some important "do's and don'ts" of grant writing. Participants will leave this presentation with a clear understanding of the NCRF program, insight as to how to leverage NCRF funding for the greatest impact, and have the ability to identify nature-based opportunities with the potential to catalyze larger habitat benefits to enhance Oregon fisheries.

Trout under drought: A long-term study of annual growth and body-condition of stream-living Coastal Cutthroat Trout

Ivan Arismendi
Oregon State University
Ivan.Arismendi@oregonstate.edu
Co-Authors: Brooke Penaluna, Stanley Gregory

Quantifying the dynamics of natural populations is a central issue in ecology. In the Pacific Northwest of North America, climate extremes are becoming more frequent and severe with projections of increasing winter floods and prolonged droughts during summer. Using a 13-year dataset of adult (Age 1+) trout (Oncorhynchus clarkii clarkii), we evaluate the effects of three drought events on annual growth and body condition in two stream reaches of Mack Creek, H.J. Andrews Experimental Forest, Oregon, USA. We found consistent evidence of slower individual growth rates across body sizes in drought years relative to reference years with an apparent greater effect in larger trout. There was evidence of slower growth and reduced body condition associated to higher trout abundances in the two reaches. In addition, growth rates and body condition were associated to timing (annual maxima) and frequency (days exceeding 14 °C) of warm events, and habitat size (pool depth). Faster growth rates, higher abundances, and improved body condition occurred in the second-growth forest reach compared to the old-growth forest reach. These illustrate that a combination of density-dependent and density-independent processes can explain observed patterns in growth and body condition over time. Each drought year had unique climatic characteristics compared to reference years, including differences in timing of precipitation, timing and magnitude of winter peak flows, and stream temperature conditions (especially in winter). Collectively, our findings suggest that growth and condition of adult trout are likely influenced by a complex interplay between density-dependence and density-independent factors. Thus, predictions about the effects of droughts on growth and condition in stream salmonids are likely difficult to generalize across regions. Our study demonstrates the utility of long-term studies in revealing the importance of considering multiple density-dependent and density-independent factors to improve future assessments of vulnerability of species and ecosystems under climate change.

Chinook salmon depth-use behaviors exacerbate bycatch in the Pacific hake fishery at night and in warm ocean temperatures

Megan Sabal
Oregon Department of Fish and Wildlife
megan.sabal@oregonstate.edu
Co-Authors: Kate Richerson, Paul Moran, Taal Levi, Michael Banks

Fisheries bycatch impacts marine species globally with increasing concerns over the potentially modifying influence of climate change. However, current efforts to understand bycatch often fail to incorporate a priori hypotheses of ecological mechanisms, which, if known, could improve bycatch mitigation and forecasts in novel conditions. Chinook salmon (Oncorhynchus tshawytscha) bycatch in the Pacific hake (Merluccius productus) fishery remains a management challenge. As Chinook salmon typically occupy shallower depths in the water column compared to hake, conditions under which salmon move deeper may increase spatial overlap and bycatch. We used Generalized Additive Models to determine whether diel vertical migration or thermal refugia influenced bycatch and if these patterns varied among salmon stocks. We used 20 years of data including over 54,000 hauls from the at-sea hake fishery spanning Oregon and Washington coasts including genetic stock identification for five salmon stocks. Our results suggest that Chinook salmon moved deeper both at night and when sea surface temperatures were warm, which increased spatial overlap with deeper-dwelling hake and exacerbated bycatch. These depth-use behaviors were more prevalent in southern (Klamath-Trinity, S. Oregon-N. California, Oregon Coast) compared to northern (Puget Sound, S. British Columbia) stocks suggesting stock-specific variation in behaviors that influence bycatch. Implications include mechanistic understanding of night fishing restrictions, potential for stock-specific management, and evidence that Chinook salmon bycatch may intensify under climate change. Therefore, an inference approach to examining bycatch patterns across ecosystems can increase biological understanding, guide management, and help forecast consequences in a changing world.

Coastal cutthroat trout navigate a temperature-oxygen squeeze in floodplain thermal refuge habitats

Hannah Barrett
Oregon State University
hannah.barrett@oregonstate.edu
Co-Authors: Jonathan Armstrong, Joel Ruprecht, Taal Levi

When the dominant thermal regime of a river becomes suboptimally warm, fish have been found to exploit fine-scale heterogeneity to increase physiological performance. While patches of cooler water can provide respite from an otherwise stressfully warm environment, the functionality of refuges, i.e., their ability to support fish during periods of stress, may depend on additional abiotic variables. For example, the hyporheic and groundwater flows that create thermal refuges are often low in dissolved oxygen, especially in lentic floodplain habitats that vertically stratify. These habitats often contain a warm and oxygenated epilimnion and a cold hypoxic hypolimnion, with a small boundary layer between vertical strata (the metalimnion). While the concept of a temperature-oxygen squeeze is often recognized for lakes and marine environments, little is known about how this phenomena affects river biota on floodplains. In this study, we characterized the temperature and oxygen profiles of several

stratified coldwater alcove habitats commonly used by coldwater fish during summer. We then used temperature sensing radio tags and measurements of fish internal body temperature, coupled with profiles of water temperature and dissolved oxygen, to determine fish location within the vertical water column. These data will also be used in a resource selection function to quantify how fish balance temperature and oxygen demands through a diel cycle. Preliminary results reveal pronounced stratification in both temperature and oxygen in several coldwater alcoves. Fish also appear to hold in a narrow lens of suitable habitat (the thermocline) where temperature and dissolved oxygen may be more optimal. Accounting for dissolved oxygen can change our inferences about the capacity for coldwater refuges to support fish, which represents a key uncertainty in climate adaptation planning.

How does dissolved oxygen vary across riverscapes and what does it mean for fish and conservation?

Jonathan Armstrong
Oregon State University
Jonathan.Armstrong@oregonstate.edu
Co-Authors: Joe Ebersole, Daniel Sobata, James McConaghie

As we consider the effects of climate change on riverine ecosystems, water temperature often plays a starring role. We are increasingly able to characterize temperature through space and time and understand its physiological effects on fishes. Historically, empirical data on dissolved oxygen have been far more limited due to the cost and difficulty of monitoring. However, the development of low-cost sensors is beginning to increase the coverage of dissolved oxygen data across river networks. Dissolved oxygen is more complex to understand and predict than temperature because it is controlled by and sensitive to a suite of abiotic and biotic factors at different spatial and temporal scales. Understanding the patterning and consequences of dissolved oxygen variation is critical for climate change adaptation, because oxygen is fundamentally important to fish and interacts with temperature to determine the physiological tolerances of fish and their responses to warming. Current standards and management approaches to meet standards for dissolved oxygen often rely on static thresholds applied uniformly over large spatial scales. Here we share field studies and statistical analyses that highlight key uncertainties associated with dissolved oxygen: (1) how is it patterned across riverscapes (2) how does diel variation in dissolved oxygen and synchrony with water temperature mediate physiological effects and the distribution of fish, and (3) how can we update and implement quantitative standards that are robust to these complexities and uncertainties? The views expressed in this abstract are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency or the OR Department of Environmental Quality.

We are living climate change! Applied climate science and climate stories

Kara Anlauf-Dunn
Oregon Department of Fish and Wildlife
kara.anlauf-dunn@oregonstate.edu
Co-Authors: Julie Firman, Joe Ebersole, Ashley Coble, Brooke Penaluna

We are seeing the effects of climate change in marine and freshwater ecosystems. With excessive heat warming the ocean, changes in temperatures are leading to cascading effects in marine systems, e.g. sea level rise, acidification, heatwaves. Similarly, freshwater streams and rivers are measurably warmer, low flows and stream drying are becoming more common, and drought is a persistent feature across the state. In addition to planning for a climate altered future, e.g. climate adaptation plans, we should be actively seeking data, tools, and solutions that will help us better adapt and protect natural resources and natural systems. In this session, we are hoping to highlight the data and tools needed that will help improve our decision making and planning around water quality, quantity and native species resilience. That might include updated spatial and temporal scaled data around thermal and flow regimes or tools to aid in planning and prioritizing. The focus of this session will not be on methodology but on the best way to leverage science to inform decision making around climate change adaptation. In the second part of the session, we will highlight communicating not just the state of climate science but its effects on natural systems and diverse communities. How do we tell impactful stories that covey the science and the sentiment around the changes we are starting to see and will see more and more? How can we leverage variability and uncertainty when we talk about the risks of climate change? How do we rebuild trust between scientists and communities such that climate adaptation is seen as necessary and time sensitive. We will highlight folks who are at the intersection of science and communication. We hope to learn how different groups are effectively communicating the effects of climate change, how those effects are already impacting communities and how folks are planning with climate change in mind.

Fifteenmile Action to Stabilize Temperatures (FAST): Climate Adaptability in a Small Temperature Limited Stream

Drake Gilbert
Wasco County Soil and Water Conservation District
drake.wascoswcd@gmail.com
Co-Author: Derrek Faber

We wish to present a case study of a farming community which leveraged historical weather data and real-time forecast information to accurately determine when to stop irrigation in order to prevent water temperatures from rising too high for the benefit of ESA listed steelhead. The success of this community-driven program was largely dependent on the involvement and dedication of local stakeholders, who contributed their knowledge and resources to help make the program work. Results demonstrate that the program was able to effectively reduce the incidence of high water temperatures for the benefit of fish, and provided a tool for farmers to plan effectively. Ultimately, the success of this program serves as a model for other farming communities seeking to limit the impact on susceptible aquatic species during critical time periods while maintaining crop production.

Percilidae: Will they survive the future threat of climate change?

Gustavo Adolfo Bizama Osorio
University of Concepción
gubizama@gmail.com

Co-Authors: Roberto Urrutia, Arif Jan, J. Andrés Olivos, Ivan Arismendi

Freshwater fauna are among the most threatened taxa worldwide due to changes in land use, the introduction of exotic species, and climate change. However, the knowledge about the regional effects of climate change on freshwaters is still incipient in the Southern Hemisphere. Here, we focused on the examination of potential contraction and fragmentation of ecological niches and the differential capacities for dispersal and adaptation of freshwater fishes due to climate change. A helpful tool in data-poor regions are species distribution models (SDMs), which can be used to develop research and hypothesis-based projections to better understand changes in the ecological niche of species between current and future scenarios of global environmental change. This is of particular importance in Mediterranean ecosystems that contain high levels of endemism. The Chilean Mediterranean ecoregion (27°-36° S) is particularly vulnerable to climate change, with recent mega-droughts. We developed SDMs for two endemic endangered Carmelitas Percilia irwinii and P. gillisi (Perciformes). These species are endemic and have restricted habitats, they have small body size and a limited dispersal within fragmented habitats. We hypothesized that both species would have significant contractions in their ecological niches due to climate change. Our research will provide insights useful to the management and conservation of endemic freshwater fishes in Mediterranean regions of the world.

Real-Time Monitoring and Forecasting of Water Temperature Conditions for Management Decision Making

Spencer Sawaske
Oregon Department of Fish and Wildlife
spencer.r.sawaske@odfw.oregon.gov

An automated program to track water temperature conditions in real-time was developed to facilitate timely water and recreational angling management decisions. During summer months, daily water temperature data are retrieved from USGS real-time water quality monitoring stations throughout Oregon and compared to relevant species thermal tolerance thresholds. In select locations, 3-5 day water temperature forecasts are produced using artificial neural network models. When real-time or forecasted projections indicate water temperatures are, or will, exceed species thermal thresholds, automated email alerts are distributed to relevant water or angling managers. The program is set to expand significantly with the addition of 40 new USGS real-time water temperature gages in 2023.

Act I: Communicating climate science: What is the problem?

Mark Blaine
University of Oregon
mblaine@uoregon.edu
Co-Author: Kara Anlauf-Dunn

People depend on science to make decisions. As we see the impacts of climate change, the need for communicating the science of it has never been greater. However, it is difficult to effectively

communicate science. The themes can be complex, and science often relates to social issues becoming more controversial, which can make it more challenging. What are we trying to do when we communicate science? Is our goal to share the excitement of science, increase the appreciation of science, improve understanding of a scientific topic, or influence people's opinions? The National Academy of Sciences has set out six goals for effectively communicating science. We will discuss these goals and what they mean in the context of the audiences we engage with. The aim of effective science communication is to ultimately help people understand the science and make it relevant to decisions they are making, while also recognizing that there are myriad other factors that will also affect their actions.

Act II: Science communication and longitudinal storytelling

Torsten Kjellstrand
University of Oregon
torstenk@uoregon.edu
Co-Authors: Kara Anlauf-Dunn, Mark Blaine

We live in a time of great change in the natural world, and looking around Oregon, the evidence is everywhere. But as academics and science storytellers we don't have an avenue for exploring those stories over long periods of time. The University of Oregon School of Journalism created an experiential class that engages students over multiple terms and asks faculty to design an educational experience that runs for multiple, connected years. This experiential learning finds ways to tell stories of people and places adapting to climate change. Now the faculty members and students are six years in on the Science Story and a decade in on Science & Memory. This is what they've learned.

Climate adaptation in managed forest watersheds

Ashley Coble
National Council for Air and Stream Improvement
acoble@ncasi.org
Co-Author: Mark River

Consideration of future climate conditions in forest watershed management is important for protection of surface water quantity, quality, and aquatic biota. Climate change is expected to affect hydrological extremes in the Pacific Northwest contributing to reduced low flows and increased frequency of peak flow events. Shifts in timing and type of precipitation also have implications for stream temperature, stream bank erosion or solute delivery, and aquatic biota. Longer and warmer growing seasons can also decrease stream water levels in late summer and contribute to more arid conditions that enhance wildfire risk, and wildfire can adversely affect surface waters. In this presentation, we will explore current initiatives that consider climate adaptation in managed forests including: 1) recent changes in regulatory forest practices in Oregon 2) development of Oregon's adaptive management program 3) recent changes in third party forest certification standards and 4) applied research. Recent changes to Oregon's Forest Practice Act, based on the Private Forest Accord, expanded riparian buffer protections, updated geospatial streamflow layers for fish presence and flow regime, and revised requirements of water crossing structures for fish passage. An adaptive management program will also be established in Oregon to facilitate future rule changes based on best-available science. Forestry certification programs

have also recently revised their forest management standards to incorporate climate change adaptation and promote fire resilience. Forest watershed research has focused on understanding the effects of forest management and climate change on summer low flow, evaluating the effects of alternative riparian buffer prescriptions on aquatic ecosystems, and understanding the effects of wildfire and post-fire management on hydrology, sediment, large wood, and aquatic biota. Collectively, a combination of scientific research that addresses knowledge gaps, updated regulatory and certification frameworks, and adaptive management will aid in identifying climate adaptation strategies to protect surface waters in a changing climate.

Act III: The science story: Dynamic watersheds in the Anthropocene

Mark Blaine
University of Oregon
mblaine@uoregon.edu
Co-Authors: Kara Analauf-Dunn, Torsten Kjellstrand

Understanding how experience shapes individuals and the stories they tell is a strategic part of understanding your audience. How do we tell stories that will connect with people in more meaningful ways? Science Story students will present perspectives based on their experience working with communities and scientists, providing examples of ways to tell impactful stories about people and life in a changing climate.

Leveraging VELMA-PENUMBRA Models to Understand Both the Effects Climate Change and the Effects of Climate Mitigation Strategies

Courtney Zambory
Oregon Department of Fish and Wildlife
courtney.zambory@oregonstate.edu

The Oregon Department of Fish and Wildlife (ODFW) has been implementing the Visualizing Ecosystem Land Management Assessments (VELMA) ecohydrological model and the PENUMBRA solar irradiance model to simulate daily streamflow and stream surface temperature under “current” (1990-2021) and “future” (2065-2075) climatic conditions. Even within the “current” conditions, changes in flow regimes and temperatures have been observed. This modeling effort has been implemented for stream reaches within Oregon Coast Coho independent population boundaries to understand how climate change will affect instream conditions for all life stages of coho. In addition to providing information on the magnitude and location at which climate change will affect stream temperatures and flow within the next 60 years, VELMA-PENUMBRA has the capability to be leveraged as a planning tool. By simulating different management scenarios and/or restoration activities such as varying timber harvest buffer widths or riparian plantings and examining both their immediate and long-term effects in presence of changing climatic conditions, we can identify strategies that will have the greatest impact to insulate streams from dramatic changes. The results of these scenario analyses demonstrate the importance and capability of using tools such as VELMA-PENUMBRA to quantify and direct effective climate change mitigation efforts.

Stream temperature models could support climate resilient riverscape management, if only we knew what to do with all that data.

Chris Jordan
NOAA
chris.jordan@noaa.gov
Co-Author: Jared Siegel

To support sustainable lotic ecosystems and thermal habitats for coldwater species like salmonids, we think that we need estimates of stream temperature that are high in scope and resolution across space and time. Existing models have predicted stream temperature at fine spatial or temporal scales, but rarely both simultaneously, which seems like a fatal flaw. To address this enormous resource management gap, we combined and enhanced elements of existing stream temperature models to produce a statistical model that reflects mechanistic processes using publicly available climate and landscape covariates in a Generalized Additive Model (GAM) framework. Unlike previous stream temperature models, we allowed covariates to interact, accounting for nonlinear relationships between temporal and spatial covariates and better representing seasonal patterns, that is to say, it is a really complicated modeling framework. We fit the model to stream temperature data from 1993-2013 and used the model to predict daily stream temperatures for ~218,000 free-flowing stream reaches across the Pacific Northwest from 1993-2017. Our daily model fit well compared to other published models of lower spatial or temporal resolution. Spatial and temporal cross-validation tests suggest that the model produces accurate predictions at unsampled locations across diverse landscape and climate conditions, but fails to suggest how and why these predictions are useful. Our approach is somewhat straightforward and could be adapted to new spatial regions or time periods, but why?

Marine heat wave impacts on Black Rockfish reproductive development

Claire Rosemond
Oregon State University
claire.rosemond@oregonstate.edu
Co-Authors: Melissa Head, Scarlett Arbuckle, Scott Heppell

The nearshore ocean ecosystem is highly dynamic, driven by seasonal fluctuations in ocean temperature and productivity but also extreme climate events. In the past decade, the Oregon coast has experienced multiple marine heat waves, prolonged periods of warmer-than-normal sea surface temperature. These periods of warmer ocean temperature occurred from 2014 to 2016, and again in 2019. Marine heat waves are predicted to occur more often and with greater intensity in the future. Our study investigates how seasonality and extreme climate events influence Black Rockfish reproductive development cycles. We sampled ovaries from over 500 Black Rockfish caught on recreational fishing charters off the coast of central Orgon from 2015 through 2020. Ovaries were histologically assessed for stage of maturity and prevalence of atresia. We evaluated age at biological maturity and functional maturity for female Black Rockfish during a period that included years with marine heat waves and non-anomalous years. Quantifying the influence of temperature-driven variability on reproductive development cycles of Black Rockfish will allow stock assessment scientists to incorporate this environmental variability into the assessment process when calculating metrics used to manage the fishery.

Fish Passage Session

2023 Culvert Repair Programmatic Agreement Update
Pete Baki
Oregon Department of Fish and Wildlife
pete.baki@odfw.oregon.gov

The Oregon Department of Fish and Wildlife have implemented two Culvert Repair Programmatic Agreements (CRPA) in 2015 and 2018 with the Oregon Department of Transportation (ODOT). Based on the success of the previous agreements, the ODFW Commission approved a new ten-year CRPA that will begin in 2023. This agreement allows ODOT to make short term repairs to failing culverts in conjunction with fish passage improvements. ODOT additionally commits $4.2 million to fish passage improvements yearly on the ODOT highway system. ODOT also provides ODFW a Fish Passage Compensation Fund that ODFW manages and disburses to off state highway high priority fish passage projects. This talk will provide an overview of work completed to date and the specifics of the new 2023 CRPA agreement.

Much ado about fish passage—minus romanticized context
Erick Van Dyke
Oregon Department of Fish and Wildlife
erick.s.vandyke@odfw.oregon.gov

Unimpeded movement within and among critical habitats is a corner stone of healthy riverine ecosystem function. This talk will contrast aspects of Columbia River System fish passage and management considered important for healthy and harvestable aspirations. Particular attention will be given to the role of delay in migration. The discussion will draw from lessons learned to define prospective.

State of Oregon New Fish Passage Administrative Rules
Greg Apke
Oregon Department of Fish and Wildlife
greg.d.apke@odfw.oregon.gov

The state of Oregon's fish passage rules and regulations were recently revised and adopted by the Oregon Fish and Wildlife Commission (Dec. 16, 2022) and will be effective on January 1, 2023. ODFW administers and enforces the state's fish passage rules. This presentation will provide an overview and summary of the new fish passage rules, particularly the design criteria changes that are important for fish passage project designers and practitioners. Greg Apke, ODFW's Statewide Fish Passage Program Lead, will drill into the weeds for those designing and implementing fish passage projects in Oregon.

North Fork Dam Juvenile Collection System Performance
Nick Ackerman
Portland General Electric
NICK.ACKERMAN@PGN.COM
Co-Author: Brian Pyper

North Fork Dam was built on the Clackamas River, Oregon in 1958. Over the ensuing 57 years downstream passage was provided with a surface collection system providing 200 cfs of attraction flow. In 2015, as part of a new FERC License, Portland General Electric added a floating surface collector to the forebay providing an additional 1,000 cfs of attraction flow. Both collectors transition fish into a pipeline that bypasses the three-dam project, discharging into the Clackamas River 7 miles downstream. Between 2016 and 2021 PGE released 7,004 PIT-tagged Chinook, coho, and steelhead juveniles and 226 acoustic-tagged Chinook juveniles to determine the effectiveness of the collection system. Fish collection efficiency varied by species, ranging from 83-94% among species. The partition of collections between the 200 cfs and the 1,000 cfs collectors varied substantially by species. Chinook were almost exclusively collected in the 1,000 cfs collector whereas nearly 40% of steelhead used the original 200 cfs collector. Our analysis revealed seasonal patterns in collection efficiency for Chinook, as well as covariate effects on both travel time and collection probability for all three species. This presentation will focus on key results of the collection system performance evaluation.

Science informing decisions: development of an assessment tool to support decisions around tide gate improvements

Kara Anlauf-Dunn
Oregon Department of Fish and Wildlife
kara.anlauf-dunn@oregonstate.edu
Co-Author: Courtney Zambory

Estuaries and tidal wetlands located along the Oregon Coast provide invaluable off-channel habitats for juvenile salmonids. Because of the mixing of waters with dissimilar salinities, there are increased levels of biological productivity in estuarine environments. This creates complex food webs and increased biodiversity. There have been considerable changes in the connectivity between rivers, estuaries, and floodplains along the coast of Oregon. Dikes and levees have been built all along the coast to support agriculture, development, or to protect flood-prone areas. To allow freshwater to flow into the estuaries but prevent the upstream movement of brackish estuarine waters, tide gates have additionally been put in place. While the habitat potential behind tide gates along the Oregon coast is variable, improving tide gate design can provide access to historical off-channel habitats when inundated during flooding related to either rising tides or high water from storm events. We sought to describe the habitats around each tide gate and thereby the potential benefits that could be realized should the tide gate be replaced with one that provides more tidal inundation and access to tidal areas beyond the tide gates. To do this we developed a decision support model to identify and document the potential benefits of properly functioning tide gates. Specifically, the model can be used to a) prioritize tide gates deserving further consideration or scrutiny for appropriate mechanical restoration, b) help generate and direct restoration funds, and c) consistently perform assessments across the state so landowners may understand how regulatory agencies evaluate their tide gates. Decision support tools can provide transparency in decision making, leveraging valued science while also acknowledging the complexity of our social and ecological systems.

Another One Bites The Dust: The Top Coos Fish Passage Barrier Is Reduced To Rubble

Allison Tarbox
Coos Watershed Association

atarbox@cooswatershed.org
Co-Author: Jason Richardson

The upper Williams River habitat is very unique in the Coos basin due its different temperature regime from the rest of the basin, making it critical habitat for the resiliency of salmonids as climates and ocean conditions shift. In 2021, rock hammers and drills were utilized to break up massive instream boulders in order to eliminate the 60-year-old Williams River Quarry Falls that has restricted salmonid access to 21 miles of furthest extent spawning and rearing habitat. Early road building and quarry operations on Weyerhaeuser's Millicoma Tree Farm severely confined the Williams River by narrowing the channel and depositing massive boulders in the channel to make a three-tiered boulder falls on a tight meander bend. This recent fish passage project widened the narrow 8-10 foot channel to nearly 45 feet to decrease velocities, mimicking historic channel widths and flows, and added rootwads and grout into the new bank for added stability during high winter flows. Additionally, the massive instream boulders were removed to eliminate jump heights and plunge pools for a consistent gradient through the reach for the first time since the 1960's. This project restores natural processes that have restricted salmonid access to critical habitat upstream and ultimately the productivity in the basin. Increasing the quality, quantity, and diversity of instream habitats and ensuring the connectivity between them as this project has is the best way to improve resiliency of Oregon Coast coho.

Fish Passage at the Winter Lake Restoration and Tide Gate Upgrade Project

Julie Huff
Coquille Watershed Association
jhuff@coquillewatershed.org
Co-Authors: Jamie Anthony, Chris Claire, Gary Vonderohe

There are over three thousand tide gates in the estuaries along the Oregon Coast that keep tidal waters off of low-lying lands to protect community buildings and agricultural lands. Many are aging and near the end of their useful life. Therefore, the restoration community has focused efforts to upgrade old tide gates to side-hinge, self-regulating style tide gates which are credited to be fish-friendly. The Winter Lake Restoration project in the Coquille Valley is one such project and has been extensively monitored since 2018. Currently, it is part of the Lower Coquille Tide Gate and Fish Passage Monitoring program that examines coho fish passage with respect to tide gates at three tide gate upgrade sites. The Winter Lake project houses the largest upgraded tide gate complex along the Oregon Coast and is comprised of 7 electrically operated slide gates which service 3 hydrologically separate units within the 1700-acre Beaver Slough Drainage District.
Passive Integrated Technology (PIT) tags and antenna arrays are the foundation of the monitoring program as they allow tracking of individual coho through the tide gates and allow analysis of site conditions at the time of passage. Here, we examine six different site conditions (hour of day, velocity, upstream (landward) water level, rate of change in landward water level, tidal bin, and hydraulic head) of coho entering and exiting the Winter Lake Unit 3 tide gate from the 2022 sampling season. The results show there were significant differences between the distributions of conditions available and used for entry times for all six parameters while distributions of conditions available where significantly different from those used during exit for all parameters except tidal bin. These results grant us insight into how coho access tide gated systems and provide dialogue on how tide gate management can be modified to improve passage.

Field test of a low-Voltage system for blocking and removing invasive carp during seasonal migrations: applications for Western US

Przemek Bajer
Carp Solutions
contact@carpsolutionsmn.com
Co-Authors: Michael Hirt, Cameron Swanson, Emil Kukulski, Matthew Kocian

Many invasive fish conduct seasonal migrations, which create opportunities for large-scale removal. However, labor costs, cumbersome logistics and environmental conditions (water depth, current etc.) often make such efforts not feasible. We tested a semi-autonomous system for removing invasive common carp during spawning migrations in a natural stream (20 m wide, 1.5 m deep) over two migration seasons. A low-Voltage, vertical deterrence and guidance system (DGS) was used to block the migrating carp and direct them into a large enclosure near shore. Additional electrodes placed in the enclosure created a sweeping electric field to push the carp towards one end and aggregate them over submersed conveyers that removed the carp from the water. PIT tags and antennas were used to monitor carp behavior. Each year, spawning migration lasted approximately two months and removal efforts occurred on 19 (year 1) and 20 (year 2) days. The DGS blocked over 90% of the carp and directed them into our trap. In year 1, 65% of the migrating carp were removed, and 68% were removed in year 2 (23,500 carp removed overall). In the final iteration of the system, a crew of three was able to conduct the removal, primarily by operating control systems on shore and visually monitoring carp behavior. Similar systems could be used for other invasive fish in larger and deeper environments where direct human labor is problematic. Such systems could also be used for native species to help them navigate passageways or to deflect them from entrainment areas.

You Otter See This Fish Ladder

Richard Grost
PacifiCorp
rich.grost@pacificorp.com
Co-Authors: Chris Sheely, Brian Hanson, Sam Moyers, Jason Brandt

Soda Springs Dam was built on the North Umpqua River in 1952, about 180 miles upstream from the Pacific Ocean, and blocked upstream access to 8 miles of rugged river habitat. Access to most of that habitat was restored in 2013 with the completion of a fish ladder ascending the 60 ft height from tailwater to reservoir. Recolonization of anadromous fish has occurred volitionally, with passage of adult fish monitored constantly via video surveillance and human analysis. Over the first 10 years of ladder operation, spring Chinook salmon were the most numerous upstream migrants (5,900) and Pacific lamprey the least (2), with both trending upward. Winter steelhead outnumbered summer steelhead by about 5 to 1, and coho salmon numbers were quite variable with no strong trend aside from flow dependency. Otter visits were intermittently numerous, often entertaining, and occasionally fatal for finned fauna, as we'll attempt to show.

Breaking Down Barriers Between Fish and Wildlife: Quantifying Benefits to Integrated Fish Barrier Removal Planning

Laura McMullen
ICF
Laura.McMullen@icf.com

Co-Authors: Shannon Crossen, Kevin MacKay

We demonstrate that multi-factor prioritization of fish barrier removal can not only improve salmon populations, but also improve wildlife connectivity and decrease wildlife and human injury and mortality. This process can cost-effectively enhance long-term planning and conservation outcomes. Hundreds of miles of quality fish habitat in Oregon are blocked by undersized culverts or other artificial barriers, with many of the blocked miles being potentially cooler areas that may be strongholds for salmonids under a changing climate. The majority of barriers are associated with highways or roads, with vehicles traveling above, sometimes at high traffic volumes. Roads and highways also impose barriers to wildlife movement and fragment habitats, impacting a wide variety of species, such as seasonally-migrating frogs to Pacific marten and Columbian white-tailed deer. Habitat fragmentation decreases access to life-sustaining resources, causes genetic isolation, and precludes species ability to adapt to changing conditions and climate change. Further, wildlife-vehicle collisions cause direct injury and mortality to both wildlife and humans constituting an important conservation and public safety issue. Using a case study from Washington state, we demonstrate a method for first prioritizing culvert removal using ICF's spatially-explicit salmonid habitat model, Ecosystem Diagnosis & Treatment. Prioritization of barrier repair or replacement using this model incorporates not only quantity of habitat opened, but also the quality of that habitat for each species evaluated, ultimately producing estimates of changes in equilibrium abundance for each species with removal of different barriers. Next, we examine the costs of not integrating terrestrial wildlife passage considerations into fish barrier removal planning and design, by quantifying the costs of collisions within one-mile radii of each fish barrier. We combine these metrics to create a useful fish-and-wildlife transportation planning package, that can evaluate costs of and identify opportunities for integrating terrestrial wildlife passage into fish barrier removal.

Jointly Modelling Covariate Effects on Salmonid Survival During Outmigration Through The Columbia River Power System

Quinn Payton
Real Time Research
quinn@realtimeresearch.com

Identifying where, when, and how many animals live and die over time is principal to understanding factors that influence population dynamics. Capture–recapture–recovery (CRR) models are widely used to estimate survival and, in many cases, quantify specific causes of mortality (e.g., harvest, predation, starvation).
However, the CRR framework can inhibit the consideration and inclusion of some types of tag recovery data and inhibit the exploration of covariates like biotic (e.g., fish size and rearing-type) and abiotic (e.g., spill, date of arrival, and travel times) factors, factors which may affect survival probabilities. To address this need, we developed a Bayesian model to jointly or simultaneously estimate cause-specific mortality and survival probabilities across multiple spatial and temporal scales by incorporating fish tag recoveries from indeterminate temporal or spatial origin. The model can now also be used to assess the relationship among various sources of mortality and to account for potential biotic and abiotic covariates that influence survival probabilities. Here, we present case studies of the survival and mortality of juvenile salmonids during outmigration through the Columbia River power system over the past decade to illustrate this new modelling framework.

Warner Basin Fish Passage Program
Troy Brandt
River Design Group, Inc
tbrandt@riverdesigngroup.net

River Design Group, Inc. (RDG) is working with a stakeholder group and local landowners to restore Warner Sucker (federally threatened) and Warner Lakes Redband Trout (species of concern) access to historical habitat in the Warner Basin, an endorheic basin in southcentral Oregon. Since 2012, RDG has coordinated with water users to replace degraded irrigation diversion infrastructure and provide passage through weir removal and the construction of technical and nature-like fishways in the three main tributaries in the Warner Basin: Twentymile Creek, Deep Creek, and Honey Creek. Diversion improvements have also included transferring water rights and working with the Oregon Department of Fish and Wildlife (ODFW) on fish screen designs and installation. ODFW has also monitored fish passage at upgraded diversions in each of the three tributaries, confirming fish passage through roughened channels, bypass channels, and a pool and weir fish ladder. Additional fish passage and screening projects are currently in design and ODFW will continue to monitor passage in 2023. The Warner Basin fish passage program is an example of a successful partnership involving resource agencies, watershed council, and local water users working together to recover Warner Sucker and ensure the continuity of multi-generational ranches.

Marine and Estuary Invertebrates Session

Oregon's Pacific Razor Clam Resource; Historic And Current Management
Matthew Hunter
Oregon Department of Fish and Wildlife
matthew.v.hunter@odfw.oregon.gov

The Oregon Department of Fish and Wildlife (ODFW) has been monitoring the Pacific razor clam (Siliqua patula) resource and its fisheries in some capacity since 1935. The region of coast on the most northern 18 mile stretch of beach, known as Clatsop Beach, supports Oregon's largest recreational and commercial razor clam fisheries. An estimated 90% of the overall harvest and effort occurs in this region as does the research and management of the resource.
Following improved transportation that subsequently led to easier access to beach harvest areas and a shift to more leisure activities in the American culture in the late 1940's, a dramatic shift in user profiles took place. Prior to this improvement, commercial harvest accounted for 75% of the use. By the middle 1950's this ratio had completely reversed and the recreational component accounted for nearly 80% of the total use. Historical monitoring focused heavily on the commercial fishery but with the user profile change, monitoring efforts and regulation changes began to focus primarily on the recreational fishery. These monitoring data sets included; 1) effort indices during harvest time periods, 2) harvest rates and estimates, and 3) annual age and length composition.
As these fisheries continue to evolve and the resource adapts to changing environmental conditions, adaptive monitoring to account for and anticipate future issues is becoming more necessary. This presentation will illustrate management strategies to mitigate current and future issues as well as projects and policies that are currently being conducted to facilitate a sustainable natural resource.

Challenges associated with adaptive management of commercial bay clam fisheries in Tillamook Bay

Mitch Vance
Oregon Department of Fish and Wildlife
mitch.vance@odfw.oregon.gov
Co-Authors: Steve Rumrill, Summer Henricksen

Two distinct fisheries exist for commercial harvest of bay clams from Tillamook Bay, including: (1) Bay Clam Intertidal Fisheries (harvest from the intertidal zone); and (2) Bay Clam Dive Fishery (harvest from the subtidal zone). Both fisheries target identical species of clams but differ in requirements for licensing, permitting, harvest methods, landing limits, and other rules. The bay clam dive fishery has recently undergone substantial growth, and annual landings quadrupled from about 200,000 to 800,000 lbs over the last decade as harvesters attain the maximum limits currently allowed by ODFW (185,000 lbs for cockles, 235,000 lbs for gaper clams, and 225,000 lbs for butter clams). The vast majority of the bay clams taken by commercial harvesters are sold as bait for the commercial Dungeness crab fishery. The rapid increase in commercial landings of bay clams raised concern among sport clammers and other stakeholders regarding allocations and sustainability of the bay clam resources. ODFW conducted fishery-independent stock estimates throughout the intertidal and subtidal regions of Tillamook Bay in 2010-2012, and these historic stock estimates were used to establish the current annual landing limits. New fishery-independent surveys were initiated in 2022-2023. Management of the bay clam dive fishery is challenging because harvest activities are driven directly by changes in the market value of clams. For example, bay clams increased in market value from about $0.50 per lb (2008-2012) to over $1.00 per lb in 2018-2022. The increase in economic value of bay clams contributes directly to growing commercial interest, elevated effort, and enhanced harvest of the bay clam resources in Tillamook Bay. The Tillamook Bay Clam Advisory Committee was established in 2020 to balance commercial and recreational fisheries, identify ways to reduce conflicts, and explore potential new rules related to management of the bay clam fisheries.

Recent changes rocky reef invertebrate communities and kelp habitat along the southern Oregon coast

Steve Rumrill
Oregon Department of Fish and Wildlife
steven.s.rumrill@odfw.oregon.gov
Co-Author: Scott Groth

Recent climate-related changes in nearshore ocean conditions along the west coast of North America contributed to broad-scale impacts to rocky shore habitats and communities located along the southern Oregon coast. Anomalously high seawater temperatures associated with the coastwide marine heat wave (2014-2017) were followed immediately by a period of warm El Nino conditions (2018-2020). Prolonged warming of nearshore marine waters has had long-lasting consequences for the community composition and complexity of trophic links within Oregon's kelp beds, shellfish communities, and rocky reef ecosystems. These disruptions to rocky reef habitats are substantial, including declines in the spatial cover of bull kelp (Nereocystis leutkeana) and understory seaweeds, dramatic increases in densities of purple sea urchins (Strongylocentrotus purpuratus), starvation by abalone (Haliotis rufescens), and coastwide demise of sunflower sea stars (Pycnopodia helianthoides). Together, the magnitude of ecological changes to kelp beds and rocky reef habitat is unprecedented in recorded history, and provide evidence that Oregon's nearshore marine ecosystem has experienced a consequential shift over the past 5-6 years. Understanding the extent of climate-driven shifts in rocky

reef habitat is further complicated in Oregon because not all sites have exhibited identical transitions in ecological communities. Kelp beds have persisted at some sites (e.g., Rogue Reef, Cape Arago) where ecological communities are presumed to function in a typical manner. In contrast, kelp habitat has disappeared at other sites (e.g., Orford Reef, Humbug Reef) where community composition and food webs have been disrupted. The ODFW Marine Resources Program is working in collaboration with multiple stakeholders to generate new data to characterize the current status of kelp, seaweeds, sea urchins, abalone, and sea stars that inhabit kelp beds at priority rocky reef sites in Oregon.

The first decade of tracking marine invertebrate trends at the Redfish Rocks

Stephanie Fields
Oregon Department of Fish and Wildlife
stephanie.a.fields@odfw.oregon.gov
Co-Authors: Lindsay Aylesworth, Ryan Fields

The Oregon Department of Fish and Wildlife (ODFW) Marine Reserves Program conducts long-term, fisheries-independent monitoring in Oregon's marine reserves for fish, invertebrate, and algae species to track ecosystem changes over time. This talk will focus on results of the last 10-years of SCUBA invertebrate and benthic cover surveys at the Redfish Rocks Marine Reserve, one of Oregon's oldest marine reserves, located off the coast of Port Orford. Using generalized additive mixed models, we explored trends through time and differences between the marine reserve and its nearby comparison area, a similar location that is open to fishing pressure. While it's too soon to attribute any changes in this temperate ecosystem to reserve protections, we detected changes through time in abundances of sea stars, sea urchins, and algae cover. These yearly trends are evident both at the marine reserve and in its nearby comparison area. We discuss the implications of our findings in terms of tracking species responses to natural stressors over time.

Long-term Remotely Operated Vehicle Data Provides Context for Sea Star Density Trends in Oregon Marine Reserves Amidst Changing Ocean Conditions

Ryan Fields
Oregon Department of Fish and Wildlife
Ryan.T.FIELDS@odfw.oregon.gov
Co-Authors: Stephanie Fields, Lindsay Aylesworth, Scott Marion

Marine disturbances including heat waves, hypoxic events, and wide-scale disease outbreaks are occurring with increasing frequency and intensity and threaten the stability of nearshore ecosystems. Long-term datasets help provide this context and serve a foundational role in disentangling natural from anthropogenic drivers of a rapidly changing ocean environment. The Oregon Department of Fish and Wildlife has been conducting remotely operated vehicle (ROV) surveys off the coast of Oregon since 2010, providing over a decade of high-resolution, non-extractive video surveys of benthic invertebrate and fish communities. Between 2014 and 2016, the Pacific Coastline concurrently experienced a large marine heatwave dubbed 'The Blob' as well as wide-scale Sea Star Wasting Disease that affected many sea star species. Using generalized additive models, we summarized trends in multiple sea star species abundance through time at Redfish Rocks Marine Reserve Cascade Head Marine Reserve as well as the associated comparison areas to evaluate potential responses to these disturbances. Results suggest that different sea star species exhibit differing trends through time and by site. At Cascade Head, Blood Stars decreased in density and have not since recovered since the initial disease outbreak. Other sea star

species like the False Ochre Star have steadily increased in density through time across all survey areas at Cascade Head. These trends were different for these species at Redfish Rock Marine Reserve suggesting additional nuanced mechanisms are driving spatially explicit responses to marine stressors. Additional research will be necessary to understand the driving mechanisms for these disparities. These data also provide a baseline understanding of natural stochastic variability through time and across large ecosystem disturbances. These data also imply increased rates of sampling may be necessary to elucidate patterns of ecosystem changes more fully across slow growing, temperate species.

How the Oregon Pink Shrimp fishery said goodbye to bycatch

Eric Anderson
Oregon Department of Fish and Wildlife
eric.s.anderson@odfw.oregon.gov
Co-Author: Scott Groth

Bycatch is a key issue for fisheries, where the sustainability of non-target species is affected by the fishing practices for the target species. Oregon's Pink Shrimp (Pandalus jordani) fishery employs fine mesh trawls, which historically had high rates of bycatch. In the early 2000s, large fishes common in shrimp bycatch (e.g., Lingcod, Canary and Yelloweye Rockfish) were designated as "overfished." In response, industry and researchers developed and adopted Bycatch Reduction Devices (BRDs), which eliminated this bycatch. Similarly, a smaller bycatch species, the southern Distinct Population Segment of Eulachon Smelt (Thaleichthys pacificus), was designated "threatened" under the Endangered Species Act in 2010, spurring research leading to the discovery that using LED fishing lights dramatically reduces bycatch rates. Current bycatch rates in the ocean shrimp fishery are low (<5% of catch) with the use of these devices, lowering the impact of the fishery and improving its sustainability. The development of these bycatch reduction tools are prime examples of fishermen and scientists working together to improve the efficiency and sustainability of a valuable fisheries resource.

Increased abundance of non-indigenous European green crab in Oregon bays and estuaries

Summer Henricksen
Oregon Department of Fish and Wildlife
summer.j.henricksen@odfw.oregon.gov
Co-Authors: Steve Rumrill, Mitch Vance

European green crab (Carcinus maenas; also known as "green crab") are a non-native species that has rapidly colonized temperate coastlines at several locations around the world where they are an aggressive invader that has the potential to disrupt communities of native shellfish (other crab, clams, oysters, etc.). Populations of green crab initially became established in San Francisco Bay before 1989, and then spread rapidly along the west coast over the period of 1996 to 1999. The numbers of green crab remained relatively low in Oregon bays and estuaries from 1997 to 2015, followed by a steady increase along the coasts of California, Oregon, Washington, and British Columbia during the period of changing ocean conditions and elevated seawater temperatures associated with the recent marine heatwave (2015 to 2021). Populations of non-native green crab have now become established in many bays and estuaries in Oregon, and evidence suggests that they have the capability for self-recruitment to sustain populations along the Oregon coast. Monitoring data show that the Catch-Per-Unit-Effort for green crab captured in popular Fukui and/or crayfish traps deployed in the intertidal zone of Coos Bay currently averages about 4 to 6 crab per trap per day. Similarly, standardized crab sampling conducted

by the ODFW Shellfish Program has also documented an increase in the bycatch of green crab captured along with native Dungeness and red rock crab in the subtidal channels of Yaquina Bay. The increased abundance of green crab has raised concern about the ecological impact of this non-indigenous predator to local ecological communities, and prompted public requests to allow a greater level of harvest by recreational crabbers. ODFW recently increased the daily catch limit to 35 green crab per person per day, while maintaining consistent limits on gear and other management measures followed to catch other species of crab.

Monitoring Bay Clams in Oregon's Estuaries – The Shellfish and Estuarine Assessment of Coastal Oregon Project

Anthony D'Andrea
Oregon Department of Fish and Wildlife
tony.f.dandrea@odfw.oregon.gov

The Shellfish and Estuarine Assessment of Coastal Oregon (SEACOR) Project is a dedicated work group within the Oregon Department of Fish and Wildlife (ODFW) Shellfish Program that conducts periodic surveys of bay clam populations and estuarine habitats in Oregon's major bays and estuaries. In each estuary, SEACOR uses a stratified random sampling design to collect clam population data along with habitat characteristics (e.g., tidal height, sediment type, vegetation including the native eelgrass Zostera marina). These data are used to identify patterns in bay clam species composition, abundance, size, spatial distribution, and habitat associations. This presentation will give an overview of how the SEACOR datasets are used to manage shellfish fisheries and estuarine resources. Specific examples will be provided on the use of SEACOR data in generating bay clam stock estimates and habitat mapping efforts, including the use of emerging technologies such as Unoccupied Aerial Vehicles (UAS, or drones).

Biotelemetry Studies and Data Analysis Session

Evaluating Outmigration Behavior and Survival of Juvenile Chinook Salmon Within the Blocked Area of the Columbia River

Rick Raymondi
Spokane Tribe of Indians
rick.raymondi@spokanetribe.com
Co-Authors: Casey Baldwin, Tom Biladeau, Conor Giorgi, Toby Kock

Hydroelectric development occurring throughout the 20th century extirpated fishes exhibiting anadromous life histories in the upper Columbia River Basin. The absence of these fishes, especially Chinook Salmon (Oncorhynchus tshawytscha), is a significant cultural loss to the Columbia Basin Tribes and ecosystem processes that historically relied upon them. In 2022, staff from upper Columbia Tribes, their consortium, and the U.S. Geological Survey implemented the first year of a reintroduction pilot study designed to investigate migratory behavior and dam passage survival of juvenile summer Chinook Salmon within the blocked area of the Columbia River using acoustic telemetry. The study area included Chief Joseph Dam, Grand Coulee Dam, and Lake Roosevelt on the Columbia River, and Little Falls, Long Lake, and Nine Mile dams on the Spokane River. A total of 5,341 yearling Chinook salmon were tagged (4,588 fish tagged with a PIT tag; 753 fish tagged with a PIT tag and acoustic transmitter) and released in spring of 2022. We found that fish outmigrated slowly through the study area, but also noted that flow

conditions were unique during April-June 2022. The study provided information about fish behavior and passage at the five dams we evaluated along with survival estimates for reaches between the dams. Additionally, climate change has exacerbated population declines of many anadromous fishes through the loss of suitable habitat, the reintroduction of salmon into the blocked area will allow access to habitat that is more resilient to the effects of climate change. Lastly, the first-year results of this pilot study is one step towards addressing historic transgressions and restoring the cultural and spiritual significance of salmon to the tribes of the upper Columbia River.

Time Synchronization of Acoustic Telemetry Data: Assessment of Techniques

Drew Stang
Four Peaks Environmental Science and Data Solutions
dstang@fourpeaksenv.com
Co-Authors: Elizabeth Ng, Mark Weiland, Leah Nagel, Rohan Adla

For many studies, a commonly overlooked yet crucial component of acoustic telemetry data processing is the synchronization of detection times between receivers in an array. Acoustic tag positioning is a function of the time difference of arrival between receivers and requires that their clocks are synchronized. If the receivers do not have GPS chips to actively correct the receiver clocks or access to GPS is lost, clocks on receivers tend to drift, resulting in inaccurate positioning estimates. We have used several techniques to time synchronize receiver data, each unique to specific study objectives and limitations in the equipment or the environment in which the receivers are deployed. This presentation will provide an overview of three time synchronization techniques used in recent studies. Method 1 used beacon tag detections between receiver pairs through time to construct linear regressions of the time drift from land-based GPS-corrected receivers. Method 2 used a similar beacon tag regression technique but had to account for receiver movement through time and lacked GPS-corrected receivers. Method 3 used a download technique to correct for time and position. Although each technique had its benefits and drawbacks, it was found that the linear regression of beacon tag detections produced the best results. Overall, the capability to time synchronize clocks depended on the receiver deployment configurations, specifically the receiver spacing, beacon tag deployments, and the presence of GPS-corrected receivers. The approaches presented here provide techniques and considerations that can be implemented in various acoustic telemetry positioning studies.

Multiyear Acoustic Telemetry Analyses of a Floating Surface Collector

Elliot Koontz
Four Peaks Environmental Science & Data Solutions
ekoontz@fourpeaksenv.com
Co-Authors: Mark Weiland, Samuel Haffey, Lucius Caldwell

In recent years floating surface collectors (FSCs) have been employed to facilitate downstream fish passage at high head hydropower projects. In this presentation, we summarize the deployment of acoustic arrays, the filtering and analysis of corresponding detection data, and insight into the various environmental data collected that appear to affect fish behavior and performance of FSCs. These studies have employed acoustic receivers and tagging efforts to assess the FSC performance and behavior of juvenile salmonids approaching and interfacing with FSCs in a variety of environmental and operational contexts. We will describe various algorithms used to screen for false positive detections and infer positions of individuals from detection data collected in a variety of challenging acoustic environments.

Fish positions are aggregated across time and individuals to provide estimates of entrance, retention and collection efficiency through a mark-recapture framework. Individual time series of detections were analyzed to determine which environmental and operational factors (i.e. weather conditions, water temperature, debris, human presence, sound) contribute to rates of passage attempts and relative success of these attempts. Further analytic development of this framework includes estimating errors in positions and expanding the mark-recapture framework to include time-varying transition probabilities. These approaches speak to the utility of bioacoustics as an efficient method for analyzing fish behavior at similar facilities. We propose this framework can act as a means of producing a more standard approach for measuring and discussing collection efficiency standards at fish passage facilities.

Analyzing Movements and Habitat Use of Acoustic-Tagged White Sturgeon in Response to Limited Recruitment in the John Day Reservoir

Gabriella Brill
Oregon Department of Fish and Wildlife
Gabriella.S.Brill@odfw.oregon.gov

White Sturgeon (Acipenser transmontanus) are indigenous to major river systems in the Western U.S. and Canada. Oregon Department of Fish and Wildlife and their partners, Washington Department of Fish and Wildlife and Columbia River Inter-Tribal Fish Commission, have managed and monitored sturgeon populations in the Columbia River since 1989. Since the construction of the Federal Columbia River Power Systems, White Sturgeon populations have become reproductively isolated, resulting in declining recruitment particularly within the middle and upper river impoundments. To address potential limiting factors affecting spawning and recruitment in the John Day Reservoir specifically, ODFW implanted acoustic tags (69kHz V16-6x) in 61 adult White Sturgeon during 2018-2021. Innovasea VR2W and VR2AR acoustic receivers (69kHz) were strategically deployed throughout the John Day Reservoir to track broad-scale movement patterns of mature adult White Sturgeon. A dense array of receivers was deployed 2018 and 2019 in the tailrace of McNary Dam, but data collection and analyses were hindered by lost receivers, tailrace noise, and tag collision. Despite data collection limitations initial analysis conducted in 2018 and 2019 demonstrated males congregating in the tailrace where spawning activity has been previously documented (Parsley and Beckman 1994). Females were detected moving in and out of this area throughout the summer, likely leaving after potential spawning events. Both males and females appear to congregate in the tailrace area during the winter months. Additional research will include a revised attempt to utilize the dense array for fine-scale modeling to determine precise spawning locations. The telemetry data will be paired with location data collected from stock assessment monitoring to create a holistic understanding of large-scale seasonal movements across different age classes. Habitat models for areas that could potentially be used for spawning or rearing will be generated by utilizing side-scan images and environmental data collection.

Eastern Oregon Fish Research Session

Lessons learned evaluating eight brood years of spring Chinook Salmon acclimated and direct stream released into the Imnaha River

Ethan Brandt
Oregon Department of Fish and Wildlife
ethan.j.brandt@odfw.oregon.gov
Co-Author: Joseph Feldhaus

Both acclimation and direct stream release strategies are used to release hatchery-reared spring Chinook Salmon (Oncorhynchus tshawytscha) smolts into the Imnaha River at the Imnaha River Acclimation Facility (IAF). The study goals were to evaluate juvenile and adult survival rate metrics between Acclimated and Direct stream releases from Brood Years (BY) 2010–2017. We calculated juvenile survival rates from IAF to Lower Granite Dam (LGD) using hatchery smolts from each release group that were tagged with Passive Integrated Transponder (PIT) tags. No difference was found in the mean (± SD) juvenile smolt survival rate to LGD for either the acclimated (67.0 ± 3.0%) or direct stream (65.8 ± 2.5%; P=0.3) release strategies. Release strategy did not appear to be a primary determinant of juvenile distribution and arrival timing at LGD. However, later release dates resulted in fewer travel days and significantly lower juvenile survival to LGD (P<0.01). We calculated mean (± SD) Smolt-to-Adult Survival (SAS) rates for age 3-5 returns to Bonneville Dam using coded-wire-tags (CWTs). There was no difference in the mean SAS rate for the acclimated (0.64 ± 0.14%) or direct stream (0.60 ± 0.17%, P=0.6) release strategies. Similarly, there was no difference in age-at-return or stray rates between the acclimated or direct stream releases. Results from this study suggest similar overall juvenile and adult performance between the acclimated and direct stream release groups and support the use of direct stream releases as a viable option for releasing hatchery smolt into the Imnaha River.

Distribution and density of juvenile salmonids within the Wallowa River basin

Fred Drascic
Oregon Department of Fish and Wildlife
frederick.j.drascic@odfw.oregon.gov
Co-Authors: Polly Gibson, Ian Tattam

The Wallowa River basin, a major tributary of the Grande Ronde River in Northeast Oregon, has had targeted small-scale fish population surveys in the past, but no large-scale juvenile fish population surveys. Snorkel density surveys provide a simple low-cost way to survey a wide area while collecting information on fish species composition, size structure, and habitat use. Our snorkel surveys are conducted across 30 sites within the Wallowa River basin. Survey sites were selected based on public/private land access, with 9 sites occurring on completed restoration projects located on private land. This project has two goals: 1) Provide understanding of the current juvenile salmonid distribution and density within the basin. 2) Determine the fish use of restoration projects compared to unrestored and wilderness sections of river.

Forty Years of the Imnaha River Chinook Salmon Supplementation Program: Is Supplementation Working?

Joseph Feldhaus
Oregon Department of Fish and Wildlife
Joseph.FELDHAUS@odfw.oregon.gov
Co-Authors: Timothy Hoffnagle, Richard Carmichael

Imnaha River Chinook salmon Oncorhynchus tshawytscha of northeast Oregon are an unique spring/summer race that migrates and matures later than other Snake River populations in Oregon. The Imnaha River Chinook Salmon Supplementation Program has been operating since 1982, with annual smolts release goals ranging from 360,000 to 490,000. Here we update previous analysis that compared smolt and adult characteristics between hatchery and natural Imnaha River Chinook salmon to

determine whether the Supplementation Program has been successful in accomplishing its life history goals. We also compared abundance and productivity of Chinook salmon in the Imnaha River with similar but unsuplemented Snake River Basin populations to evaluate whether abundance and productivity of the Imnaha River have increased above what might have been expected without supplementation. We found that hatchery smolts are larger than natural smolts and that they return at a younger age and run and spawn later in the spawn season than natural adults. There is complete overlap in spawning distribution between hatchery and natural adults, but hatchery adults tend to spawn lower in the system near and below the acclimation site. Although the mean hatchery recruit:spawner ratio is nine times that of naturally-spawning salmon, the Supplementation Program has not increased total number of spawners in the Imnaha River to pre-supplementation levels. Concerning is the finding that proportionate natural influence index has been consistently <0.5 for the last 25 years suggesting that hatchery selective forces dominate. Mean recruit:spawner ratio for natural salmon has exceeded replacement for only 8 of 37 brood years since beginning supplementation, whereas productivity exceeded replacement for 19 of 33 years immediately prior to supplementation. It is time to substantially re-evaluate the Imnaha River Chinook Salmon Supplementation Program, with changes in weir management, broodstock collection, hatchery rearing, and/or smolt releases.

Tipping the scales: a ray of insight into the accuracy and precision of two different age structures for Spring Chinook Salmon

Emily Treadway
Oregon Department of Fish and Wildlife
Emily.M.Treadway@odfw.oregon.gov
Co-Authors: Mike Greiner, Ethan Brandt, Joseph Feldhaus

Use of calcified structures to estimate age of Chinook Salmon (Oncorhynchus tshawytscha) is widely utilized in fisheries research and management. In Oregon fish scales are the most common hard structure used to estimate age of adult Chinook Salmon. The Northeast Oregon Fisheries Research Office has started using dorsal fin rays in Oregon to estimate age of adult Chinook Salmon. Copeland et al. (2007) determined that dorsal fin rays were both a more accurate and precise structure for age estimation than scales for adult Chinook Salmon in Idaho. We have >125 known age fish sampled from the Grande Ronde and Imnaha River Basins in 2021 that had both scales and fin rays collected. Known ages come from coded-wire tags (CWT), passive integrated transponder (PIT) tags, and genetics. Our primary objectives are to determine if precision and accuracy of age estimation of adult Chinook Salmon differs between dorsal fin rays and scales. A secondary objective is to create a digital library of fin ray and scale images with known ages that can be used for training. Accuracy will be determined by the percent of estimated ages that agree with the known age. We will determine discrepancies and bias in scale versus fin ray ages using an age bias plot. Precision will be determined using coefficient of variation (CV) between reader estimates. We expect to replicate the results of Copeland et al. (2007) and have greater accuracy and precision using fin rays.

Unintended consequences of spawning early returning steelhead broodstock. Is the juice worth the squeeze?

Mike Greiner
Oregon Department of Fish and Wildlife
michael.j.greiner@odfw.oregon.gov
Co-Authors: Jorden Smith, Mike Flesher, Joseph Feldhaus

To reduce high stray rates of Wallowa stock hatchery summer steelhead into the Deschutes River and modify run-timing to enhance fall fishing opportunities, a new line of progeny was developed from early returning steelhead captured by angling in the Grande Ronde River each October in return years 2003-2006. Fall broodstock (hereafter, fall brood) are spawned separately from standard Wallowa production fish (hereafter, production) and are marked with an adipose and right ventral (RV) fin clip to distinguish them from production fish when returning as adults. Though stray rates were not reduced with the new fall brood line, the program was continued, and the proportion of fall brood was increased to half the Wallowa stock hatchery steelhead production to capitalize on the earlier run timing and increased fall harvest previously witnessed. However, low numbers of adult returns led to spawning the fall brood progeny collected at Wallowa Hatchery rather than yearly hook and line sampling of early returning adults. Initial program evaluations noted a lack of statistical power due to the low number of replicate years. Here we evaluate all 15 available adult return years (2007-2022) to determine if initial harvest benefits were maintained over time. Overall, adult fall brood progeny failed to maintain either earlier run-timing or fall harvest benefits. Currently, fall brood progeny are comprised of a higher proportion of age-3 than age-4 adults and are significantly smaller than production progeny selected for broodstock in 10 of 15 years (67%, $p \leq 0.01$) with a difference in mean fork length ranging from 15 – 59 mm. Smaller steelhead may not be desirable to anglers especially without any added benefit of fall harvest when weather conditions and flesh quality are most desirable. Our results suggest the current fall brood program should be discontinued.

A genetics Canadian tuxedo: Part 1 (the gene jacket) using parentage assignments to assess adult spawner pairing and distribution

Joseph Lemanski
Oregon Department of Fish and Wildlife
joseph.r.lemanski@odfw.oregon.gov
Co-Authors: Lindsy Ciepiela, Matthew Kayor, Melody Feden

This presentation will be the first of three presentations covering the results, observations, and lessons learned from a pilot study conducted on the Middle Fork John Day River which leveraged a genetics-based parentage analysis approach for linking patterns in spawning adult distribution and pairings with patterns in distribution, dispersal, abundance, tributary use, and survival of their offspring. In 2020 spawning ground survey crews recorded a total of 162 redds throughout 30 kilometers of the known spawning distribution of spring Chinook salmon on the Middle Fork John Day and collected tissue samples and biological information from a total of 141 carcasses encountered on the spawning grounds. Tissue samples from carcasses were delivered to the Columbia River Inter-Tribal Fish Commission's Hagerman Genetics Laboratory where specialists were able to successfully genotype 46 males and 67 females (113 total) of the spawning adults. Tissue samples from the juvenile offspring of 2020 spawning adults were collected in 2021 to generate single and two-parent assignments, as well as generate a presumed point of origin for each juvenile successfully matched back to their maternal parent. A total of 337 juveniles sampled in 2021 were successfully matched to two parents, resulting in 72 unique male-female pairings. From these male-female pairings we determined that 50% of males spawned with a single female (range 1-7) and 50% of females spawned with a single male (range 1-3). The distance between the location of redd(s) where an individual was believed to have spawned and their carcass location was generally much greater for males, supporting the notion that females tend to remain proximal to their spawning locations.

A genetics Canadian tuxedo: Part 2 (the genes) Watershed-scale assessment of juvenile Chinook Salmon dispersal patterns

Matthew Kaylor
OSU/CRITFC
matthew.kaylor@oregonstate.edu
Co-Authors: Linsy Ciepiela, Joseph Lemanski, Melody Feden, numerous others

Understanding the factors that facilitate fish habitat use and distribution across river networks is critical to effective conservation and restoration planning. Juvenile dispersal from spawning locations is an important factor shaping distribution and habitat in later life-stages, but little empirical data exists for wild populations of Pacific Salmon species. We utilized a genetics-based approach to assess spring Chinook Salmon dispersal from spawning locations to summer rearing habitats across the Middle Fork John Day River, Oregon. We sampled post-spawn female adults in 2020 and then sampled parr in summer 2021 throughout the mainstem and nine tributaries. We estimated abundance using snorkel and electrofishing surveys and then predicted abundance throughout the watershed. Adults and parr were genotyped, and 1,326 parr (39% of total) were assigned to 65 females. The prevailing paradigm is that juvenile salmonid dispersal is restricted (< 500 m), but our results challenge this as 25% of estimates exceeded 3.7 km downstream and 25% exceeded 0.9 km upstream (range = 28.5 km downstream - 10.6 km upstream). Overall, dispersal was downstream-biased (median = 0.8 km downstream), but at finer spatial scales, dispersal bias varied with watershed position. Parr originating higher in the watershed exhibited downstream bias and high variability, whereas parr originating lower in the watershed exhibited upstream bias and lower variability. Overall, this study provides an approach and methodology to quantify juvenile salmon dispersal across watersheds and our results suggest greater dispersal at early life-stages than prior published estimates.

One fish, two fish… estimating abundance of wild summer steelhead in the Deschutes

Jeremy Henderson
Oregon Department of Fish and Wildlife
jeremy.s.henderson@odfw.oregon.gov
Co-Authors: Ian Tattam, Jason Seals

Abundance estimates of wild summer steelhead in the Deschutes River, Oregon, have been generated since 1977 by a yearly mark-recapture effort. Fish are initially captured in the ladder at Sherars Falls, are tagged, and then recaptured at the Pelton trap and Warm Springs National Fish Hatchery. This long running dataset is an important component of fisheries management for one of the most popular fisheries for summer steelhead in Oregon. The length of these data (45 years) and the consistency in the methods provide an opportunity to 1) compare abundance from the traditional mark-recapture equation with an alternate estimation of abundance using capture efficiency of hatchery summer steelhead that are marked and recaptured as part of the same study, and 2) examine the output from a forecasting tool for managers consisting of a generalized linear model that predicts abundance mid-season using data from dam counts or creel data and the number of one-salt returns the year prior.

Using a Mobile PIT Tag Monitoring System to Assess Habitat Preference of Juvenile Salmonids in the Middle Fork John Day River

Lizz Blackburn

Oregon Department of Fish and Wildlife
lizzblackburn@outlook.com
Co-Authors: Lindsy Ciepiela, Melody Feden, Alex Wollen

One of the primary factors limiting Chinook (Oncorhynchus tshawytscha) and steelhead (Oncorhynchus mykiss) population viability throughout the Columbia River Basin is rearing habitat. Since 2011, projects implemented in the Middle Fork John Day River Forrest Conservation Area aim to improve salmonid spawning and rearing habitat. The objective of this study is to improve our understanding of how fish use habitat throughout newly improved reaches. We constructed and used a floating mobile PIT tag monitoring system equipped with a floating PIT tag antenna, a bluetooth enabled Biomark IS1001 transceiver and a bluetooth enabled GPS transceiver to trace fine scale fish movement across a wadeable river network. We then used mobile PIT tag antenna surveys in conjunction with habitat surveys to quantify juvenile Chinook habitat use in both restored and unrestored reaches. Our preliminary results suggest that juvenile chinook do not show strong habitat preference, at the habitat unit scale, throughout our sample reaches. However, fish found within our restored reach were detected in close proximity to complex habitat characteristics such as large woody debris and in stream torrent sedges. Additionally, we determined detection efficiency of the antenna across species and tag sizes by conducted mobile PIT tag antenna surveys following capture-mark sampling to detect a known number of 9mm and 12mm PIT tagged Chinook and a known number of 12 mm PIT tagged steelhead. We combined habitat survey data with our detection efficiency data to evaluate the impact of habitat type on detection efficiency. Overall, we redetected 31.4% of 9mm tagged Chinook, 58% of 12mm tagged Chinook and 41.9% of O. mykiss. We observed a significant effect of tag size on detection efficiency and did not observe a significant effect of habitat characteristics on detection efficiency.

Monitoring Migration Patterns in Umatilla River Summer Steelhead

Stacy Remple
Oregon Department of Fish and Wildlife
Stacy.L.Remple@odfw.oregon.gov
Co-Author: Josh Hanson

Passive Integrated Transponder tags (PIT tags) are an invaluable tool for monitoring steelhead (Oncorhynchus mykiss) migration in the Columbia River Basin. Adult steelhead migration patterns in the Columbia River are poorly understood, however two major migration patterns, “overshoot” and “fallback” have been identified. Overshooting is defined as passing above one’s natal stream, and fallback refers to fish that overshoot, but return later to their natal tributary. The Mid-Columbia summer steelhead distinctive population segment (DPS) is listed as threatened under the Endangered Species Act (ESA) and tributary overshooting was identified as a “key concern for population recovery” by NOAA. The Umatilla River steelhead population is included in the Mid-Columbia DPS. The mouth of the Umatilla River is located three miles downstream of McNary Dam. Three Mile Dam is located on the Umatilla River three miles upstream of its confluence with the Columbia River. Both McNary and Three Mile dams maintain PIT tag detection infrastructure, this configuration allows for monitoring of both overshoot and fallback migration patterns. Long-term average overshoot rates at McNary Dam for Umatilla natural origin adult steelhead are 44%. However, historically insufficient detection at Three Mile Dam makes estimating fallback rates more uncertain. Recent upgrades to the PIT tag infrastructure at Three Mile Dam now allow for detection probabilities of ≥ 99% for adult summer steelhead passing upstream. Here we investigate overshoot and fallback migration patterns observed in Umatilla River summer steelhead using environmental and biological factors (e.g., tributary flow and temperature, spill

at McNary Dam and age structure of overshoots/overshoot fallbacks) and consider the management and recovery implications.

A genetics Canadian tuxedo: Part 3 (the vest) - Linking restoration impacts on shifting spawning distributions to offspring tributary use

Lindsy Ciepiela
Oregon Department of Fish and Wildlife
lrciepie@gmail.com
Co-Authors: Joseph Lemanski, Matthew Kaylor, Melody Feden, Stefan Kelly, Ian Tattam

Ongoing restoration efforts across the Pacific Northwest aim to enhance steelhead trout and Chinook salmon productivity by promoting increased habitat quality and quantity. While restoration efforts are extensive throughout salmonid spawning and rearing habitat, we lack a holistic understanding of how impacts of restoration actions on one life stage can further influence other life stages. Within the Middle Fork John Day River, 10 years of redd surveys, pre- and post-restoration, indicate spawning Chinook salmon preferentially select restored, over unrestored, habitat, ultimately shifting spawning distributions. Although redd success to the point of hatching is expected to increase in restored habitats, we currently have limited understanding of how spawning redistribution affects access of subsequent life stages to critical resources. For salmonids rearing in the Middle Fork John Day River, cooler water, found in tributaries, is a critical, though limited, resource. We conducted a genetic parentage analysis to examine the relationship between mainstem spawning location and tributary use of juveniles. Our results indicate cold-water refugia support juveniles throughout the spawning distribution, with juveniles originating closer to tributary confluences having a higher likelihood of rearing in adjacent tributaries. Furthermore, we used PIT tag detection data to compare rearing and migratory survival rates across groups of individuals rearing in tributaries and mainstem habitats. Our results provide insight into how shifts in spawning distribution – stemming from restoration in this case – may impact offspring access to limited resources like cold-water refugia and ultimately population productivity.

Investigation and Mapping of John Day Steelhead Overshoot

Logan Breshears
OSU & ODFW
logan.breshears@oregonstate.edu
Co-Authors: Ian Tattam, Jonathan Armstrong, Guillermo Giannico

A large proportion of summer steelhead from the John Day River, Oregon “overshoot” the John Day River confluence with the Columbia River and ascend McNary Dam (119km upstream of the John Day River confluence). Approximately 60% of John Day River origin steelhead display this straying behavior, which may be temporary, but is also associated with permanent straying of some individuals. High levels of straying could be detrimental to the abundance and viability of the John Day River “source” populations. In addition to the risk of straying, and hence, complete loss of reproduction in the John Day basin, fallback over Columbia River hydrosystem dams may increase mortality of adult steelhead. In this study we examined overshoot and fallback of John Day River summer steelhead by characterizing adult migration patterns upstream of Bonneville Dam with emphasis on the John Day River confluence; and identifying key thermal refuge areas downstream of the John Day River. In order to achieve these objectives, we acoustic tagged 200 wild adult summer steelhead and deployed 35 acoustic receivers between Bonneville and Priest Rapids dams on the Columbia River.

Outreach Session

Reflecting on 10 years of Communications and Outreach Efforts in Oregon's Marine Reserves
Kendal Smith
Oregon Sea Grant
kendallrae2605@gmail.com
Co-Author: Lindsay Aylesworth

It's been just over 10 years since in the implementation of Oregon's Marine Reserves program. Outreach, and community engagement are key mandates set by the State Legislature for Oregon's marine reserves. The Governor's Office, Legislature, and constituents have significant expectations about the successful implementation of this work. But how do you build an effective communications and outreach program? This talk will focus on sharing challenges and lessons learned after 10 years of implementing outreach and communications efforts about Oregon's marine reserves.

Exploring Social Constructs to Improve Monitoring of Oregon Marine Reserves
Thomas Swearingen
Oregon Department of Fish and Wildlife
thomas.c.swearingen@odfw.oregon.gov

Numerous human dimensions studies pertaining to natural resources include research questions that are considered standardized scales. One example would be studies conducted using the Connectedness with Nature Scale, a measure of values based on identity with or affinity for nature. The Oregon Department of Fish and Wildlife has a legislative mandate to monitor the socioeconomic impacts of the Oregon Marine Reserves. In this context, there were no preexisting metrics to assess marine reserves awareness, knowledge, and support among Oregon residents and coastal visitors. Any such measures would of necessity be quite unique and specific to these marine reserves. Over the past decade, numerous exploratory studies were conducted to understand effective research methods to assess these social constructs. Multiple studies were conducted involving samples drawn for various populations, including coastal residents, coastal visitors, recreational fishers, and other Oregon residents. This presentation will describe how this work evolved over time to delve into various aspects of these constructs, and how that research will contribute to long-term monitoring of the reserves. The value of complementary, long-term human dimensions research will be highlighted.

Fishing: The key to cultivating public interest in ecosystems and habitats conservation. A primer on recruiting and sustaining support for conservation
Antonio Salgado
Oregon Department of Fish and Wildlife
jose.a.salgado@odfw.oregon.gov

Even though most people are aware fishing is an activity practiced across the nation, not all those aware of the activity practice it, nor do they understand the connection between fishing, conservation, and proper fisheries management. To increase the number of people advocating and involved in the conservation of aquatic and riparian habitats we must take them outdoors. Most people that hike, kayak, canoe, boat, and camp, also fish, they are also invested in protecting the places and species living

in the spaces where they recreate. Now, recruiting people into fishing is not as easy as handing someone a fishing pole though, it often requires taking that person on a hike first, watch wildlife along the way, after that, taking them fishing could be the next step.

Barriers to recruiting anglers
•Access to fishing areas
•Disposable income
•Understanding the fishing regulations
•Knowledge of fishing techniques and gear
•Understanding what to do with the "catch"
oDispatching, cleaning, & cooking
oRelease techniques

R3 Action Plans:
•Recruitment: Host events/activities that generate awareness and interest in fishing, as well as provide opportunities for people to try it
•Retention: Host events/activities that provide the support necessary for novice recreationists to build their skills until they can fish independently
•Reactivation: Host events/activities that help lapsed anglers become active participants again

Outdoor Recreation Adoption Model five stages are:
1.Awareness
2.Interest
3.Trial
4.Continuation with support
5.Continuation without support
Program-planning process: recruitment programs fall within the first three stages (awareness, interest, and trial). Retention programs fall within the last two stages (continuation with support and continuation without support). Reactivation programs were added to accommodate people who have lapsed or have permanently deserted the activity.

Oregon marine reserve stakeholders' feelings as indicators of underlying goals and perceptions of fairness

Brain Erickson
Oregon State University
brian.erickson@oregonstate.edu
Co-Author: Kelly Biedenweg

Even though emotions play a major role in public evaluation of conservation processes and projects, they are typically understudied in human dimensions research. Scientists, policy makers, and practitioners often dismiss public emotional reactions as irrational and subjective. However, emotions impact public processes and can be indicators of people's interests and concerns. The formation of Oregon's marine reserve system was a decade-long process that created public conflict, contention, and a wide-range of emotional reactions. With the reserves currently under a 10-year review, this presentation explores how knowledgeable stakeholders felt about Oregon marine reserves. I will share preliminary results from a mixed methods study that had 53 participants rate how much they felt 29

emotions. Cluster analysis identified two subgroups based on patterns of responses. I'll explore what these subgroups felt and why.

Tough Conversations: Using the science of communication to strengthen fisheries management
Vaughn Robison
Oregon State University
vaughn.robison@oregonstate.edu
Co-Authors: Megan Jones, Brian Erickson, Kelly Biedenweg

Communication is a critical tool for fisheries management. Its importance is reflected in calls for Outreach, Education, Social Marketing, and Engagement as communication approaches to achieve the goals of fisheries management institutions. Yet these four approaches can be misunderstood as synonymous and can fixate on communicating the natural science that underpins fisheries management. While important, over-focusing on communicating natural science can neglect to engage the social science that supports effective communication. This presentation aims to expand fisheries managers' and scientists' understanding of how the science of communication can facilitate effective fisheries management. It defines and creates distinctions around the common but conflated fisheries communication approaches: Outreach, Education, Social Marketing, and Engagement. Further, it explains the scientific principles that support each communication approach and offers practical examples. Finally, it highlights different communication research fields and professional skill sets that can produce science for implementation in fisheries communication practice. These explanations support an understanding that for communication to meet the professional needs of fisheries managers it must meet the needs of their audiences. The presentation closes by discussing issues that can surface when fisheries managers conflate these four communication approaches, eschew the science behind them, or neglect to recognize the perspectives and integrate the needs of their audiences.

Beyond Commercial Fishing: Exploring Perceived Impacts of Oregon's Marine Reserves on Other Coastal Businesses
Adrian Laufer
Sea & Shore Solutions, LLC
adrian@sea-shoresolutions.com

When Oregon's system of 5 marine reserves was first conceptualized in 2008, one of three guiding goals was to "avoid adverse impacts on communities". After 10 years of marine reserve implementation, the Oregon Marine Reserves Program has a wealth of human dimensions research conducted with the purpose of identifying if that goal is being met. This research spans multiple aspects of coastal communities, from economic impacts to intrinsic valuation. Marine reserve impacts on commercial fisheries is often the primary focus; however, Oregon's coastal economy is quite heavily reliant on tourism and recreation, much of which is fueled by recreational fishing and seafood. These businesses warrant a deeper investigation in order to robustly and realistically assess marine reserve impacts on communities. This presentation will explore social science research spanning the decade, illustrating initial apprehensions, decreasing adverse expectations, zero negative expectations, and limited perceived positive effects. Tourism-focused visitor intercept surveys over the decade (2012-13, 2014, 2015, 2021) provide more insight into limited perceived positive effects, which are primarily due to minimal marine reserve awareness and lack of reserve impacts on visitors' travel motives. Surveys and interviews with recreation-related businesses (2010, 2011, 2014, 2015, 2022) indicate that many

business owners initially expected that marine reserves would negatively impact business, but that over time these adverse expectations did not persist. Indeed, negative perceptions among business owners and managers were nonexistent in the most recent survey. Through this comparative discussion considering multiple longitudinal data sources, we can explore a more holistic assessment of marine reserve impacts and discuss the value of complementary, long-term human dimensions research.

10 years of Oregon's Marine Reserves: What have we learned?
Lindsay Aylesworth
Oregon Department of Fish and Wildlife
lindsay.x.aylesworth@odfw.oregon.gov

It has been just over a decade since Oregon implemented its system of marine reserves, and now is a time of reflection. The Oregon Department of Fish and Wildlife (ODFW) Marine Reserves Program stands as the state agency responsible for both the implementation and monitoring of Oregon's five marine reserves since 2009. What have we learned? What were the goals and objectives of Oregon's Marine Reserves? The program is currently under-going a legislative programmatic review that will be completed by June 2023. As part of this programmatic check-in, ODFW published a 2022 Marine Reserve Synthesis Report to summarize and highlight the accomplishments and lessons learned in the first 10-years of the program. This talk will cover the establishment and evaluation processes for Oregon's Marine Reserves and discuss takeaways from the first decade of research.

Fish Culture Session

Dude should be a Lady?-Implications of dense salmon rearing practices on sex ratios
Morgan Davies
Oregon Department of Fish and Wildlife
John.M.DAVIES@odfw.oregon.gov

Pink and chum salmon in the Pacific Ocean are known to hatch as female and determine sex during the alevin stage. The sex ratio in these species is thought to be determined by hormones or chemicals released by their cohorts. In situations where dense populations occur the sex ratio is skewed towards males. It is unclear whether this happens with other salmonid species; however, in Coos Basin fall Chinook hatcheries a shifted sex ratio has been observed that is not represented in the wild population. Could our hatchery practices, which by their nature replicate an over-populated system, be shifting our population to a male dominated population? Implications of this range from harder to achieve broodstock goals, increased jack production, and an overall smaller fish for the fishery.

Big fish with tiny friends: the role of the microbiome in Pacific salmon health
Claire Couch
Oregon State University
claire.couch@oregonstate.edu
Co-Authors: James Peterson, Micheal Kent, Carl Schreck

The microbes that live on and in organisms can significantly impact the health of their hosts, as well as serving as biomarkers for underlying physiology and disease states. Recent studies have begun to highlight the critical importance of the microbiome in fish health, especially in the context of fish culture. Our current research, conducted in partnership with the Oregon Hatchery Research Center and the wild fish surrogate program at the Fish Performance and Genetics Lab, is exploring relationships between the microbiome, stress, diet, and disease in Pacific salmon. Pacific salmon experience prolonged elevation in corticosteroid hormones during important life history events including migration, reproduction, and senescence. These periods of elevated corticosteroids correspond with changes to immunity and energy metabolism; therefore, fish may be particularly vulnerable to mortality at these times. Recent studies found that stress-induced cortisol release associated with microbial community shifts in salmonids, raising the question of how longer-term corticosteroid dynamics that accompany life history transitions affect salmonid microbiomes and ultimately, health outcomes. We found that treatment with slow-release implants of the corticosteroids cortisol or dexamethasone resulted in persistent changes to the gut microbiomes of juvenile Chinook salmon (Oncorhynchus tshawytscha). Morbidity was also associated with microbiome composition, suggesting that the gut microbiome reflects individual differences in susceptibility to opportunistic pathogens. In a follow-up study, we are currently analyzing the effects of different diets on the gut microbiome and innate immunity in juvenile Chinook salmon. Preliminary results suggest that diet alters innate immunity, with potential consequences for microbiome communities and long-term disease susceptibility of fish reared on standard hatchery diets. Our ongoing efforts will seek to inform improvements to culture techniques that mitigate the effects of hatchery rearing on the microbiome and disease resistance.

Rearing velocity influence size variation among full sibling families of steelhead (Oncorhynchus mykiss)

Miriam Obley
Oregon State University
obleym@oregonstate.edu
Co-Authors: Jen Krajcik, Michael Blouin

Hatchery-reared steelhead (Oncorhynchus mykiss) tend to have lower fitness than natural-origin fish when allowed to spawn in the wild. This decrease in fitness is likely due to rapid adaptation to hatchery conditions which vary considerably from the natural rearing environment. Adaptation to captivity is thought to involve behavioral traits that promote rapid growth in the hatchery because size at release is correlated with survival at sea. Exercise induced by increased water flow throughout rearing tanks has been shown to positively influence weight and condition factor in a hatchery setting. In this study, we will compare variation in growth among full sibling families in tanks with water flows of 0 body lengths/s and 1.5 BL/s during rearing. We hypothesize that making fish swim constantly will reduce agonistic behaviors, and so the flow tanks will exhibit less growth variation and healthier fish.

The Oregon Hatchery Research Center: A retrospective and forward look at sustainable hatchery management

Seth White
Oregon State University

seth.white@oregonstate.edu
Co-Authors: Ryan Coture, Selina Heppell, Marc Johnson, Jen Krajcik, Craig Lawson

The Oregon Hatchery Research Center (OHRC) is a leading facility for the study of hatchery science and its impacts on wild fish populations. Our mission is to provide science-based solutions for the sustainable management of fish populations and the role of hatcheries, with a focus on the Pacific Northwest region. As a literal and figurative laboratory for studying the ecology and evolution of fishes, research at OHRC aims to understand the impacts of hatcheries on wild fish populations, including the effects of hatchery-reared fish on genetic diversity, survival, and reproduction of wild fish. We also study the impacts of hatcheries on ecosystem function and the management of hatcheries to minimize negative impacts and maximize benefits to recreational and commercial fisheries as well as wild fish populations. OHRC is committed to outreach and education, including engagement with students and the dissemination of our research findings to resource agencies, tribes, and stakeholders. We also work to engage the public in understanding the role of hatcheries in resource management and the importance of science-based decision making. As part of our new vision, OHRC is committed to deepening our engagement with tribal communities and taking a riverscape perspective on hatchery sciences. This includes working with tribes to understand their cultural and resource management goals. We believe that this approach will be critical to the sustainable management of hatcheries and wild fish populations in the Pacific Northwest. This presentation provides the backdrop for several of the forthcoming talks in this session focused on specific research projects at OHRC. We additionally honor the legacy of the previous OHRC Director, Dr. David Noakes.

Operational Research at the Oregon Hatchery Research Center

Jen Krajcik
Oregon Department of Fish and Wildlife
Jennifer.A.KRAJCIK@odfw.oregon.gov
Co-Authors: Craig Lawson, Brian Willett, BayLee Moser

The Oregon Hatchery Research Center (OHRC) is a facility dedicated to studying salmon and steelhead. While much of the research done at the facility is long-term projects with large budgets, smaller projects that can be more directly applied to hatchery practices are also conducted. In recent years, these projects have included looking at the effects of added tank structure, directional flow, sorting eggs by size, and feeding method on the growth, condition factor, and fin quality of fish reared. Other projects have approached hatchery issues such as warming water temperatures. Experimental treatments are determined based on previous Oregon State University studies or current hatchery issues and are conducted by OHRC staff looking for observational differences as opposed to molecular or hormonal differences. The purpose of these projects is to translate academic findings into observable results that will improve hatchery rearing techniques. This presentation will give an overview of these recent projects and their findings.

Creating a Unique Odor Bouquet to Improve Homing of Hatchery-Reared Salmon

Andrew Dittman
NOAA
andy.dittman@noaa.gov

Co-Authors: Marc Johnson, Ryan Gertken, Thomas Quinn, Seth White

Salmon are renowned for their ability to home to their natal streams to reproduce. Juvenile salmon imprint on the olfactory signatures of their rearing water and later use this information to home back to their natal site as adults. Here, we describe studies to improve homing by Chinook salmon released from the Elk River Hatchery, Oregon, USA. A large percentage of these fish do not return to the hatchery but rather spawn in the river, thereby impacting the threatened, wild population. The Elk River Hatchery utilizes mainstem river water for rearing and one concern is that the water emanating from the hatchery does not provide a unique olfactory signature for returning adults to distinguish from Elk River water. We explored the feasibility of adding chemicals to hatchery water to impart a unique odor signature that would facilitate imprinting and homing. First, we determined the profile of amino acid odorants and other dissolved organic matter in the water entering and exiting the hatchery to determine whether the hatchery environment altered the chemical signature of river water. We then identified candidate odors that salmon can detect and learn that could be used to alter the odor signature. Finally, using physiological indicators of smolting and olfactory function, we determined developmentally sensitive windows for imprinting to establish the appropriate timing for exposing salmon to our added chemicals. Based on these results, we have initiated a multi-year study of homing fidelity in salmon exposed to our unique chemical signature or control hatchery water.

VALUE TAGGING 1,000s of 'wild-like' hatchery salmon to test innovations and improve the vitality of hatcheries.

Michael Banks
Oregon State University
michael.banks@oregonstate.edu

Hatcheries continue to play a pivotal role in maintaining life history diversity among salmon that are an important component of the splendor of life in the Pacific Northwest, despite advantages and challenges they present to and within the context of our changing world. Here we describe research into new tagging and mating innovations designed to overcome shortfalls in the status quo among hatcheries. Taking advantage of the fact that DNA from just 2 parents will tags all 3-5,000 of their offspring at no additional tagging cost, VALUE TAGGER is designed to sample 1,000s of salmon per day without interrupting normal operations already established in most hatcheries. Because parent based tagging allows identification of all offspring, applications with VALUE TAGGER may overcome estimate expansion, straying and other behavioral uncertainties associated with metal and other tagging methods applied to assist current hatchery management. ‘‘Wild-like’ hatchery salmon’ refers to a second innovation and experiments designed to determine if breeding hatchery fish using patterns observed more fit among natural mating contexts may lessen fitness differences apparent from many hatchery and wild fish scenarios of today. Preliminary evidence from a 3-year test among over a million coho bred at Sandy Hatchery, Oregon, indicates that adopting approaches which emulate ‘wild-like’ mating strategies yields more returning offspring than those from randomly chosen partners. While it remains important to verify consistency of these findings among most of the offspring from this experiment still braving freshwater or marine phases of their lifecycle, if promising results remain affirmed, and folk in policy and management agree on merit, these innovations may transform hatchery practice towards more prosperous futures for all.

Fish Habitat Session

Good Neighbor Authority How Federal Partnerships with States & Tribes Can Fund Fish Habitat Restoration Projects

Karen Hans
Oregon Department of Fish and Wildlife
karen.m.hans@odfw.oregon.gov

The Good Neighbor Authority (GNA) allows the US Forest Service (USFS) and the Bureau of Land Management (BLM) to develop partnerships with states, counties, and tribes to conduct projects on federal, state, and private lands using federal funding. Timber sale, mitigation, Bipartisan Infrastructure Legislation (BIL), Inflation Reduction Act (IRA), and wildfire recovery funds can be channeled from federal agencies to states and tribes through the GNA. The role of states, counties, and tribes of under GNA is to speed the pace and scale of fish and wildlife restoration projects. The federal funds available from the BIL and IRA are providing an unprecedented opportunity to restore fish & wildlife habitats but only if state, county, and tribal Fish Biologist understand how to work with federal agencies to develop and implement projects under the GNA.
In my presentation I will give a history of the Good Neighbor Authority and how the program is administered by partner agencies. I will also discuss how the Oregon Dept of Fish & Wildlife and Oregon Dept. of Forestry have implemented the GNA to expand fish and wildlife restoration project. As the GNA continues to expand in size and scope across federal lands, now is a good time to learn how this program can fund fish habitat and research projects in your area.

Habitat use of anadromous sturgeon in North America: a systematic review

Erin Lunda
Oregon State University
erin.gilligan@oregonstate.edu
Co-Authors: James Peterson, Adam Duarte

Sturgeon species (Acipenseridae) are considered among the most endangered fishes in the world and populations are facing declines throughout their native range. Resource limitations are common for endangered species research including lack of funding available for replication studies, limited access and availability to the species of interest, and small population sizes. Because of this, sturgeon are generally understudied and lack the species-specific information needed to inform management decision-making. Five species of sturgeon in North America are anadromous, exposing them to additional environmental and anthropogenic threats as well as increased challenges in monitoring and management. Information relating to habitat and life history are readily available for these species, but the typical small sample sizes and limited spatial extent make it difficult to make broader inferences. The goal of this research is to synthesize information across species of anadromous sturgeon throughout North America to identify species-specific knowledge gaps and do a quantitative comparison of species-habitat relationships across species and geographic regions. Habitat usage and suitability at different life history stages will be combined and analyzed using Bayesian hierarchical approaches. Estimates for each species will be provided and variation among these estimates will be discussed further. From this research, managers will be provided with criteria that can be used to inform knowledge gaps about life history needs for anadromous sturgeon. In addition, this work will also contribute towards the

development of decision support tools that are empirically ground and can be used to prioritize habitat restoration work for these difficult to monitor species.

Assessing the Need of Habitat Restoration to Return Reach 2 of Summit Creek to "Stage 0", Malheur National Forest OR

Rebecca Schwartz
Confederated Tribes of Umatilla Indian Reservation
Rebeccahschwartz93@gmail.com
Co-Author: Ken Diebel

Summit Creek is located within the Malheur National Forest and contains highly diversified fishery resources ranging from cold-water-dependent ESA listed Bull trout (Salvelinus, confluentus), Redband trout (Oncorhynchus, mykiss), and Cutthroat trout (Oncorhynchus, clarkii). Summit Creek is in need of habitat restoration to protect ESA-listed, native fish and wildlife populations. As human activities such as grazing, logging of old growth forests, road construction, and trapping beaver for their furs and removal their dams for agriculture, many sections of Summit Creek have lost critical aspects of its geomorphology that fish populations require to persist. Human activities on Summit Creek has led to a transition historically being a densely vegetated meadow that allowed for key riparian vegetation like carex, juncus, and salix spp. to proliferate. Summit Creek now has weak and unstable streambanks, channelization and disconnection of the river from the floodplain. Downcutting of streambanks has contributed over time to a lower water table, increasing water temperature, and a loss of essential spawning and rearing habitat for native fish species. To identify suitable restoration techniques for Reach 2; vegetation community data were collected during July 2021 to understand existing vegetation communities, evaluate streambank stability as compared to historical values, evaluate restoration techniques used on previously completed restoration projects on Summit Creek, and assess the stream geomorphology of Reach 2 was assessed. Understanding the geomorphological characteristics of Reach 2 in addition to applying processed based approach to address these characteristics, can be used inform restoration design criteria. Applying these methods to ultimately transition Reach 2 Summit Creek to "Stage 0" to be reconnected to its historical floodplain, will addresses the hydraulic processes that are not functioning, and allow ESA listed and native fish and wildlife species to proliferate once again.

A meta-analysis of Oncorhynchus mykiss habitat use and ontogenetic niche shifts incorporating geographic variability

Lauren Diaz
Oregon State University
lauren.diaz@oregonstate.edu
Co-Authors: James Peterson, Adam Duarte

Oncorhynchus mykiss exhibit a high degree of phenotypic plasticity in response to their physical environment. Variation in environmental growth conditions may affect whether O. mykiss adopt anadromy and become steelhead trout, or mature in freshwater as rainbow trout. This diversity of life-history strategies is believed to promote population resiliency to environmental change, and there is an increased emphasis on the conservation of alternative life-history strategies within populations. As populations in heavily altered watersheds are becoming increasingly homogenous in their life-history distributions, it is necessary to understand how to manage O. mykiss habitat to promote life-history diversity. It is uncertain how environmental growth conditions interact with regulatory mechanisms such

as density dependence and intraspecific competition across the native and introduced global range of O. mykiss. In this study, we conducted a meta-analysis of age-specific O. mykiss habitat use to evaluate how niche-partitioning between age classes relates to in-stream and landscape level habitat variation. We found that air temperature, annual precipitation, catchment area forest cover, and ecoregion were all strong predictors of habitat use and that the highest degree of habitat-use overlap between age classes occurred in relatively shallow and low velocity habitats. This is the first global-scale meta-analysis of O. mykiss habitat use and age-specific niche partitioning and we intend to use the results of this study to develop habitat-use rule sets that will be used to in decision support models for guiding O. mykiss management in altered watersheds.

Setting targets and effectiveness monitoring of restoration actions using the Unit Characteristic Method

Hans Berge
Cramer Fish Sciences
hans.berge@fishsciences.net
Co-Authors: Ryan Flaherty, Kristin Connelly

Articulating clear goals and objectives for restoration projects has become increasingly important for securing project funding and achieving desired restoration outcomes. Fish-habitat models are valuable tools for managers to identify limiting factors for target species, design actions to illicit specific improvements to the processes and functions that are limiting, and inform restoration effectiveness. We present an example of using the Unit Characteristic Method (UCM), a fish-habitat model, to evaluate how implementation of a restoration project affected Chinook, coho, and steelhead at a site in southwest Washington. The UCM is a mesohabitat-based model that relates channel unit type (e.g., pool, riffle, cascade) and wetted area to productivity of rearing habitat. In the UCM, predicted parr densities are multiplied by scalar values that affect productivity and survival (e.g., cover and temperature) to estimate capacity. To account for differences in rearing strategies by species and stream flow, we used a hydraulic geometry modeling approach to predict stream habitat characteristics (e.g., channel unit depth and wetted area) under winter flow conditions, which in turn estimate winter parr capacity. Results of the study illustrate how key stream habitat metrics were affected by the restoration efforts and how those changes influence rearing and spawning capacity.

Identifying the drivers of aquatic ecosystem vulnerability to wildfires in the Pacific Northwest

David Roon
Oregon State University
david.roon@oregonstate.edu
Co-Authors: Kevin Bladon, Becky Flitcroft, Joe Ebersole, Jana Compton

Wildfires can have complex effects on aquatic ecosystems that vary widely depending on the characteristics of the fire and the ecological context of the watershed, making predictions of fire effects on species of social and conservation interest, like salmonid fishes (Oncorhynchus spp.), difficult. As fire regimes shift, resource managers want to predict where on the landscape wildfires pose a risk to fish and aquatic habitats. However, before we can effectively predict where aquatic systems will be vulnerable to wildfires and shifting fire regimes, we first need to understand how and why fires influence aquatic ecosystems. Here, we present two complementary modeling efforts that seek to synthesize the effects of fire on aquatic ecosystems, identify the drivers that can lead to aquatic

ecosystem vulnerability, and develop a spatial risk index to predict where fires may pose a risk for fish and aquatic habitats. First, we adapted a food web system-dynamics model to explore how wildfires influence aquatic ecosystems at multiple trophic levels via the physical and biological processes that support them. Model simulations were then repeated to explore how variation in fire severity and ecological context influenced ecosystem responses and the associated pathways driving those responses. Second, we are leveraging the pathways identified by food web modeling to inform a spatial index of wildfire risk to predict the relative vulnerability and resilience of watersheds regionally across the Pacific Northwest. Taken together, these modeling approaches aim to contribute an improved understanding of the effects of fire on aquatic ecosystems that can help to develop new conceptual models, direct empirical studies, as well as guide management actions in the Pacific Northwest.

A 3D View of the Past

Jeffery Varga
Southern Oregon Community College
jwvarga@me.com
Co-Author: Morgan Davies

As early as the 1840s European settlers started making their mark on the Coquille Valley whose large marshy estuary historically limited most travel to canoe by the natives and later steamboat by the settlers. Land was cleared and drained to make way for a booming dairy industry and the old growth forest was slowly cut down as the logging and mining industries expanded in the area. The most accurate view of the vegetation and landscape we have from that time comes from land surveys from the 1870s and 1880s. Patricia Benner compiled these surveys into an extensive report in 1991. We took this report and reconstructed Benner's maps in ArcGIS. Using a combination of LIDAR elevation maps and other shapefile we created a basemap of the valley with accurate elevation, major waterways, and historic vegetation. We then imported those data into a 3d modeling software called Blender. Using Blender and other software and addons we were able to populate our 3d map with accurate pre-European vegetation. This tool can then be used as an education device or for the use of planning restoration.

Invasive performance and climatic niche dynamics of Rainbow and Brown trout in the Himalayas

Arif Lan
Oregon State University
arif.jan@oregonstate.edu
Co-Authors: Guillermo Giannico, Ivan Arismendi, Rebecca Flitcroft

Rainbow Trout (Oncorhynchus mykiss) and Brown Trout (Salmo trutta fario) have been introduced to the Himalayan ecoregion for commercial and recreational purposes. These non-native trout compete for space and resources with native coldwater cyprinids i.e., Schizothorax species a.k.a. Snow Trout. The distribution of two flagship species i.e., S. plagiostomus and S. richardsonii substantially overlaps with the distribution of introduced Rainbow and Brown trout. Little is known about the invasive performance of non-native trout in the Himalayas which impedes making clear policies about their propagation via hatchery programs. We used COUE scheme (Centroid shift, Overlap, Unfilling, and Expansion) to study niche dynamics and overlap of non-native trout with Snow Trout. We found no significant ($p>0.05$) climatic niche conservatism for Rainbow and Brown trout in the Himalayas. However, niche dynamics indices suggest more invasive potential for Brown trout than Rainbow Trout. Lack of niche conservatism

for non-native trout is because of either “expansion” to new habitats or “unfilling” of suitable habitats (yet) in the Himalayas. More “stability” was observed in the climatic niche of Rainbow trout (99%) than for Brown trout (72%), whereas more “expansion” to novel environmental conditions was observed for Brown trout (28%) than for Rainbow trout (1%). Rainbow trout has more potentially suitable conditions yet to fill i.e., “unfilling” (13%) than Brown trout (5%) in the Himalayas. Rainbow Trout also has significant ($p<0.03$) climatic niche similarity with both Snow Trout species and in case of invasion, which is very likely under the current high propagule pressure, may negatively affect native Snow Trout more than the already invasive Brown Trout. Brown trout will likely continue to be invasive whereas Rainbow trout still seems to be in lag-phase before its “ecological surprise”. Our results provide decision support for taking proactive measures to protect sensitive habitats in the Himalayas from further introductions.

How does stream light change stream ecosystem characteristics and fish abundance in Oregon Coast Range streams?

Ashley Sanders
Oregon State University
sanderas@oregonstate.edu
Co-Authors: Dana Warren, Ashley Coble

Stream light, mediated by the riparian canopy, is an important driver of ecosystem productivity in small headwater streams. Though stream food webs largely rely on allochthonous carbon, benthic biofilms are often a higher quality food resource and are disproportionately represented in consumers in stream food webs. Many studies suggest that patches of light can release primary production from light limitation and stimulate upper trophic levels through bottom-up pathways. A legacy of clearcutting and replanting riparian forests in the Pacific Northwest has led to dense riparian canopies that shade streams and reduce autotrophic basal resources. Contemporary forest management includes retention of streamside trees in riparian buffers, but the links between buffer configuration, stream primary production, and ultimately stream vertebrate communities (fish and salamanders) remain unresolved. We implemented a before-after control-impact (BACI) study to explore how different buffer configurations that yield different changes to the stream light environment can affect stream temperature, net standing stocks of periphyton, and cutthroat trout (Oncorhynchus clarkii clarkii) demographics across 10 small streams on private timberland in the Oregon Coast Range. Treatments caused a spectrum of increases to the stream light environment, and nearly all sites experienced increases in stream temperature that loosely correspond in magnitude to the change in light. Most sites experienced increased fish abundance and biomass after harvest, in particular, we observed increases in cutthroat trout juveniles in the first post-treatment year. This may be attributed to increases in basal resource or to increased stream temperature (leading to earlier emergence). In the sites with an additional year of post-treatment data, we found that the increase in juveniles in the first year after treatment corresponded to increased adults in the second post-treatment, suggesting that changes to trout demographics may persist for years following harvest.

Risk vs. Reward: Juvenile Salmonid Rearing Potential in Seasonally Disconnected Floodplain Habitats in the Skagit River, WA

Maddie Hicks
Oregon State University
maddie.hicks@oregonstate.edu
Co-Authors: Jonathan Armstrong, Catherine Austin

Seasonally disconnected floodplains have been overlooked as juvenile salmonid rearing habitat in the Pacific Northwest. These dynamic habitats may offer optimal water temperatures and high prey densities for much of the year, but they can also exhibit poor rearing conditions when disconnected from the mainstem in mid- to late-summer. A key challenge for managers is to understand the seasonal floodplain habitats available to juvenile salmonids and how they function to support fish. We used Relative Elevation Models (REMs) to identify potential seasonally disconnected habitats in the Skagit River, WA. We ground truthed each site during reconnaissance surveys in 2021 and selected a subset of sites for more rigorous assessment of rearing potential in 2022, including water level and quality, fish size distribution, and fish diet. We found changes in size structure suggestive of ontogenetic habitat shifts and migration, with larger age-1 fish being replaced by a smaller age-0 cohort in spring. Sites typically disconnected from the mainstem in July, with water temperature increasing and water level decreasing throughout the summer. Warming varied between sites, with temperatures approaching 20°C in the warmest sites. Temperature mapping showed spatial variability in several sites, likely due to groundwater or hyporheic inputs. Three sites dried completely before reconnecting with the mainstem in the fall, resulting in large mortality events. We will be inputting temperature and fish diet data into bioenergetics models to explore the mechanisms driving seasonal variation in growth. The results from this study will help our partners understand growth opportunities and mortality risks for juvenile salmonids rearing in seasonally fragmented habitats in the Skagit Basin.

When in drought: Fish, salamander and ecosystem process responses to an experimental drought

Dana Warren
Oregon State University
Dana.Warren@oregonstate.edu
Co-Authors: Allison Swartz, Catalina Segura

In western Oregon the Mediterranean climate with limited summer rainfall translates to summer low flow conditions that rely on the legacies of precipitation the previous winter and spring. In the Cascade Mountains, summer streamflow may be severely depressed if there is limited snowpack (even if total winter precipitation is not low). These “snow drought” conditions are expected to become more common and more severe in the future as the climate changes and winter temperatures in the region increase. What impact will greater snow drought conditions have on fish? We are focused in particular on headwater streams in this study because a change in flow in these systems can have substantial implications for habitat availability. In addition to low discharge, drought conditions also generally include elevated stream temperatures, which can be a concern for coldwater fish that dominate Oregon headwaters. In this study, we implemented an experimental drought in which we separated reduced flow and elevated temperature effects of a drought. We diverted a portion of the flow from a 120m reach of headwater stream for 7 weeks in summer 2022, creating a “low flow” reach. We warmed the diverted water passively and in so doing created an elevated temperature (+1°C) reach below the low flow reach. We measured fish and salamander abundance in the two treatment reaches and in an upstream reference reach in mid-July, before we applied the drought manipulation. In early September, at the end of the drought manipulation, we resampled fish and salamanders. We found that fish abundance and summer growth declined in the low flow reach relative to the reference reach. In the warmed reach, fish abundance increased slightly relative to the reference reach, and summer growth of tagged fish was also greater on average. These results suggest that within forested headwaters, reduction in flow, rather than increases in temperature (of up to 1 C) are the dominant drivers of potential drought impacts to fish.