ORAFS2021 VIRTUAL MEETING
Book of Abstracts

Oral Presentations

Inside the Enemy Mind: Identifying molecular marker for *Ceratonova shasta* life stages

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Ceratonova shasta is a fish parasite native to the Pacific Northwest. It infects many species of anadromous salmon including threatened Klamath River coho salmon. C. shasta abundance in the Klamath River is closely monitored and informs fisheries management, particularly the release of dammed waters to mitigate disease events. *C. shasta* belongs to an anciently derived clade of Cnidaria, the Myxozoa. These microscopic parasites utilize vertebrate (fish) and invertebrate (aquatic worm) hosts and alternate between two life stages: myxospores, which infect worms, and actinospores, which infect fish. The current monitoring program uses qPCR to detect C. shasta DNA in water samples and cannot differentiate actinospores from myxospores. We used C. shasta transcriptomes extracted from two model hosts: Rainbow trout (*Oncorhynchus mykiss*) and the annelid *Manayunkia occidentalis* to identify parasites genes that are differentially expressed between developing myxospores and actinospores. We identified several isoforms of voltage-gated calcium channels that may play a role in host attachment and differ between life stages. In subsequent works, these will be the target of an assay which will differentiate *C. shasta* myxospores and actinospores and provide better information to fisheries managers.

Virtual Environmental Education Collaborations

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This year has been a great way to pull together partners to create new/engaging online or virtual content. It has been a great pleasure working with Watershed Councils (Instagram Live programming), Master Gardeners and Cities in Marion County (urban irrigation and stormwater education on Facebook Live), Fish Biologists (The Delisting of Oregon Fish, the amazing Karen Hans and STEP-videos and collaboration), World Salmon Council and Freshwaters Illustrated (Salmon Watch Streaming videos and vocab activities). Many of the listed outreach events above were born from frequent conversations and meet-ups with the regional environmental education community. This type of communication allows interested agencies to partner to provide relevant outreach activities without too much duplication. Providing virtual environmental education seems like an oxymoron and a bit ironic. Nevertheless, we will not replicate the magic that happens when students visit the great outdoors, yet, we can engage them to the point of curiosity about our natural resources. It is at that point when we can make the educational connections between people and conservation. Conservation cannot be done without people. Partnering to provide diverse, engaging, relevant conservation education programs is a priority for Marion SWCD. We have been providing Salmon Watch education for 13 years along the North Santiam River in partnership with Marion County, City Stormwater Personnel, USFWS, ODFW, and many others. The Willamette Valley has a plethora of education experts with vast knowledge of the local natural resources. It is my hope to share examples of environmental education collaboration virtually, how to choose engaging content, and encourage partnerships with regional outreach groups/agencies/individuals.

Developing a fast method to evaluate body length of live aquatic vertebrates

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Body size is one of the most obvious characteristics of organisms. Larger body size provides benefits to individuals leading to increases in survival and the persistence of populations. Traditional methods to obtain body size of aquatic vertebrates relies on extended handling times and use anesthetists. These procedures can increase stress potentially affecting the animal's welfare after their release. We developed a simple procedure to obtain body size data from Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii*) and Coastal Giant Salamander (*Dicamptodon tenebrosus*). We took digital images of live animals in the field and used ImageJ2 to posterior images processing. The mean $\pm$ SE percent error of our approach compared to the use of traditional graded board was relatively small for all metrics (for total length of trout was -2.2 $\pm$ 1.0; for snout-vent length and total length of salamanders was 3.5 $\pm$ 3.3 and -0.6 $\pm$ 1.7 respectively). We cross-validated our results by using two independent observers and found no evidence of significant differences in body size distributions for all metrics of the two species. Our procedure provides fast and reliable information of body size minimizing stress and reducing handling time. The inclusion of multiple animals per image can increase sampling efficiency and stored images can be available to be revised multiple times. Our method is transferable across taxa and can improve the collection of body size information from large sampling efforts and broader spatiotemporal contexts to improve our understanding about species responses to natural and human-related disturbances.

Co-authorship network in fisheries sciences
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The resilience and adaptability of the fisheries profession is dependent on a robust and diverse workforce. However, the inclusion of diverse groups in our profession has shown little progress over the last two decades for various reasons, including structural barriers within both society and academia. Collaboration networks are important for productivity, promotion, and scientific impact, yet the extent to which the structure of these networks affects the inclusion of minoritized groups remains unknown. We evaluated trends in published research between 1965 and 2017 within the US fisheries science academic co-authorship network and evaluated its structural composition focused on gender and race/ethnicity. Although the number of publications, number of authors per article, and lead authorship by women and people of color have increased over time, white men still led more than 70% of published articles. Network analysis demonstrates a shift in the structure of the network over time from an initial concentration of research among a few fragmented clusters to a nearly completely connected network by 2016. However, centrality metrics for women and people of color consistently showed lower scores suggesting that their full integration into the network remains incipient. Our findings illustrate that although progress has been made towards the inclusion of diverse talent over time, continued progress may require explicit efforts to overcome barriers.

Connecting the Upper, Middle, and Lower Willamette: The Willamette River Network
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We are a network of over sixty organizations and foundations who believe a healthy Willamette River system is within our reach. Our mission is to catalyze, align, and leverage efforts to create a healthy river system and thriving communities with meaningful connections to rivers and streams in the Willamette Basin. With our traditional partners, we work to center tribal voices and communities of color in the process of co-creating strategies and policies that will bring about lasting change for all Oregonians. We envision a healthy Willamette River system where water flows are abundant and clean, forests are managed and expanded, and native wildlife and plants are thriving. We aim for a welcoming river that is not only swimmable, fishable, and drinkable but also accessible for cultural, spiritual, and recreational practices. The Willamette River Network provides opportunities for our partners to connect, build capacity, and decolonize their approach to river stewardship. Our goal is to expand the Willamette Basin restoration movement with a deeper focus on human justice and

community wellbeing. We offer quarterly regional convenings and an annual network-wide conference known as "Within Our Reach". We intend to expand our offerings by providing monthly professional development opportunities through a virtual community of practice to provide best practices and networking opportunities.

Indigenous Systems of Management for Culturally and Ecologically Resilient Pacific Salmon (*Oncorhynchus* spp.) Fisheries

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Pacific Salmon (*Oncorhynchus* spp.) are at the center of social-ecological systems that have supported Indigenous Peoples around the North Pacific Rim since time immemorial. Through generations of interdependence with salmon, Indigenous Peoples developed sophisticated systems of management involving cultural and spiritual beliefs, and stewardship practices. Colonization radically altered these social-ecological systems, disrupting Indigenous management, consolidating authority within colonial governments, and moving most harvest into mixed-stock fisheries. We review Indigenous management of salmon, including selective fishing technologies, harvest practices, and governance grounded in multi-generational place-based knowledge. These systems and practices showcase pathways for sustained productivity and resilience in contemporary salmon fisheries. Contrasting Indigenous systems with contemporary management, we document vulnerabilities of colonial governance and harvest management that have contributed to declining salmon fisheries in many locations. We suggest that revitalizing traditional systems of salmon management can improve prospects for sustainable fisheries and healthy fishing communities and identify opportunities for their resurgence.

An Overview of the Native Fish of the Willamette River Basin

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While salmonids dominate local conversations about fish research and management, the Willamette River basin is home to a diverse native fish community. There are 36 native and 33 nonnative fish species that currently live in the basin. The diversity of the native fish community reflects the high diversity of aquatic habitats found in the basin. This presentation will highlight, and celebrate, many of the oft-forgotten native nongame fish throughout the Willamette River basin, from valley bottom to upper tributaries, and briefly discuss ecology and the conservation of several species.

A novel social-ecological clam garden site selection process

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Clam gardens are intertidal features modified by Northwest Coastal Indigenous people to enhance clam habitat for optimal shellfish production. The Swinomish Indian Tribal Community (SITC) recently initiated a clam garden project to address the suite of ecological and cultural concerns documented in SITC's Climate Adaptation Action Plan. This effort will promote the integration of traditional ecological knowledge in contemporary resource management and climate change adaptation strategies as well as encourage local food security, support tribal treaty rights, and provide ecological and cultural benefits to the community. Because biophysical conditions and community engagement are both important to the success of a clam garden, we have co-designed an ecological and socio-cultural site selection process. Since relic clam gardens have not been identified in Washington state waters, SITC staff are collaborating with knowledge holders and researchers in British Columbia to better understand this Indigenous aquaculture practice and advise the Tribe's clam garden efforts. Thus far, information gathered from B.C. experts has helped build a SITC-specific spatial exclusion model in ArcGIS to map viable clam garden locations on the Reservation. Biophysical intertidal data collected from 15 candidate sites identified in the map were then used to design a multi-criteria decision analysis (MCDA) model. The MCDA provided a ranking of the candidate sites which were then presented to SITC community members for prioritization and final site selection. Coinciding with the site selection process, Swinomish community members have been visiting B.C. clam gardens and participating in restoration events. Visiting these clam gardens has provided invaluable opportunities for transboundary and intergenerational knowledge exchange. As understanding and enthusiasm about clam gardens spreads throughout SITC and Washington state, local support for the clam garden project grows.

Willamette River coastal cutthroat trout use of thermal refugia during summer

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Vast portions of the Pacific Northwest's freshwater habitats will exhibit stressfully high summer temperatures in a warmer future. The potential for these seasonally warm habitats to provision coldwater fisheries may depend on whether fish can avoid high temperatures by exploiting smaller-scale thermal refuges. Understanding how fish use refuge habitats and how this use scales up to benefit fish at the population level is needed to better manage coldwater fisheries, especially under a warmer climate. To evaluate thermal refugia use in the Willamette River, we tracked coastal cutthroat trout movements and habitat use from late spring to early fall, using mobile radio telemetry. Despite suboptimally warm mainstem temperatures, most fish did not move into thermal refuge habitats. However, a small number moved into several coldwater alcoves or up into the cooler McKenzie River. While current temperatures in the mainstem Willamette River appear to still

be tenable to these fish, individuals displayed behavioral flexibility, a trait which may enhance adaptive capacity to climate change vulnerability as warming continues.

Climate vulnerability for stream fishes in the Pacific Northwest

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Assessments of vulnerability of species to changing climate conditions are necessary to effectively identify and prioritize conservation needs. For fish, exposure to conditions such as water availability, temperature, and discharge have primary importance because they can affect species occurrence, metabolic demands, and resource (e.g., food, habitat) availability. How these three conditions vary across time and space, and interact with each other, largely dictates the macro-suitability of habitat for fish which are then further constrained by varying species-specific requirements. Substantial progress has been made to better quantify exposure through the recent modelling of spatially continuous estimates of streamflow presence/absence (PROSPER), streamflow magnitude (Monthly Streamflow Estimates), and stream water temperature (NorWeST) at a regional scale and relatively fine (e.g., 1 km or less) spatial resolution. Additionally, recent development of a dataset for stream-dwelling fishes accompanied by analysis of species intrinsic sensitivity to climate change includes many rare species that have received relatively little attention. Finally, statistical approaches that leverage the expertise of regional fish biologists have been developed to effectively assess species sensitivity. As a result, we are now well positioned to integrate these data sets and approaches to more comprehensively assess vulnerability for a suite of rare and sensitive fishes of the PNW. Here, we describe a project that informs climate adaptation efforts in the Pacific Northwest (PNW) by assessing the vulnerability of rare fish species based on their ability to cope with changes in streamflow and water temperature expected under climate change.

Incoherent dimensionality in fisheries management: consequences of misaligned stock assessment and population boundaries

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Fisheries policy inherently relies on an explicit definition of management boundaries that delineate the spatial extent over which stocks are assessed and regulations are implemented. However, management boundaries tend to be static and determined by politically negotiated or historically identified population (or multi-species) units, which creates a potential disconnect with underlying, dynamic population structure. The consequences of incoherent management and population or stock boundaries were explored through the application of a two-area spatial simulation-estimation framework. Results highlight the importance of aligning management assessment areas with underlying population structure and processes, especially when fishing mortality is disproportionate to vulnerable biomass among management areas, demographic parameters (e.g., growth and maturity) are not homogenous within management areas, and connectivity (via recruitment or

movement) unknowingly exists among management areas. Bias and risk were greater for assessments that incorrectly span multiple population segments compared to assessments that cover a subset of a population segment, and these results were exacerbated when there was connectivity between population segments. Directed studies and due consideration of critical population segments, spatially-explicit models, and dynamic management options that help align management and population boundaries would likely reduce estimation biases and management risk, as would closely coordinated management that functions across population boundaries.

Beyond Consilience: Traditional Ecological Knowledge and Western Social Science Contributions to Orca Conservation

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The factors affecting fisheries and wildlife population health are complex and constantly changing. Traditional approaches have not been successful, so implementing effective strategies to conserve and restore orca along with complementary species and other populations requires looking beyond Western biophysical science. More holistic sources of Traditional Knowledge, like that of Indigenous Science and Traditional Ecological Knowledge, and Western social science are more grounded in social reality. Approaching and incorporating data from these diverse social sciences has shown to greatly benefit Western fisheries and wildlife. In this talk, we present our efforts to find key synergies between Western social scientific knowledge and Traditional Ecological Knowledge to understand the context of orca conservation in the Puget Sound of Washington State. The combination of these two knowledge systems in fisheries and wildlife management help us move toward and beyond what E.O. Wilson coined "Consilience". By integrating the many relevant sources of knowledge, we aim to bring a greater understanding and bridge aspects where Western biophysical science is unable to fulfill resource management needs.

New environmental DNA sampling model refines known distribution of Pacific Lamprey across the Deschutes River basin

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Pacific Lamprey (*Entosphenus tridentatus*) is a vital resource to Native American tribes across Oregon and is a U.S. Fish and Wildlife Service Species of Concern. Upstream of Pelton Round Butte Dam (PRBD) on the Deschutes River, Pacific Lampreys have been extirpated due to absence of passage, and downstream of the dam, monitoring distribution and recolonization across such a large area and following removal of barriers remains a challenge. Using a live-cage field experiment, Cramer Fish Sciences in collaboration with the Middle Deschutes Watershed Council, the Confederated Tribes of the Warm Springs Reservation, and the Yakama Nation developed a Pacific Lamprey environmental DNA (eDNA) sampling protocol. The controlled experiment and associated detection modeling

allowed us to construct a sample layout for Pacific Lamprey that provided an a priori probability of detection based on important sampling variables, such as volume of water sampled, number of filters collected, and distance to known numbers of Pacific Lampreys. We will present eDNA-based observations confirming known distributions of Pacific Lamprey downstream of PRBD, as well as detections where to our knowledge, Pacific Lampreys have not been recently observed. The new eDNA sampling protocol and detection model can be used to support Pacific Lamprey monitoring and recovery across Oregon.

Swim and face the strange: hydrologic change drives seasonal habitat use by juvenile summer steelhead in intermittent headwaters of the Middle Fork John Day River

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An improved understanding of fish habitat use in highly dynamic environments can inform restoration plans addressing limiting factors for population productivity. Intermittent streams provide important spawning and rearing habitat for Pacific salmon and steelhead Oncorhynchus spp., but seasonal desiccation of degraded habitats (e.g., incised stream channels) can strand juvenile fish and create a potential ecological trap. Restoration work by the U.S. Forest Service is slated for an intermittent section of Summit Creek in the headwaters of the Middle Fork John Day River, OR, which supports wild populations of spring Chinook salmon *O. tshawytscha* and summer steelhead *O. mykiss.* This project aims to improve geomorphic and hydrologic function in the study area through the use of Beaver Dam Analogs (BDA). During the summers of 2018 and 2019 we conducted pre-project monitoring in the Summit Creek study area to (1) determine changes in the extent and duration of surface water connectivity from summer to fall, (2) survey adult steelhead spawning activity, (3) compare seasonal distribution and abundance of juvenile steelhead between continuously wetted and intermittent reaches, and (4) estimate downstream emigration and over-summer mortality due to stranding and desiccation. Streamflow became discontinuous in Summit Creek by mid-summer and 52% of the study area remained wetted on 9/1/2018. A comparison of July 2018 abundance estimates, when sampling locations were continuously flow-connected, indicated that reaches which became desiccated by mid-summer supported fewer juvenile steelhead than reaches that remained wetted. Spatial and temporal patterns in fish habitat use could inform design and implementation phases of restoration plans for intermittent streams of conservation interest.

Bigger isn't always better: Relationships between juvenile migration traits and age-at-return in a Columbia River hatchery salmon population

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Published evidence indicates Pacific Salmon are returning at younger ages and smaller sizes. Hatchery culture, management practices, and environmental factors greatly influence release size and

juvenile migration timing. These factors in turn influence important demographic characteristics in returning adults, including age-at-return. We analyzed more than 450,000 PIT-tagged spring Chinook Salmon juveniles detected exiting Cle Elum Supplementation and Research Facility (Yakima River, Washington, USA) acclimation sites over twelve brood years (2003-2014; juvenile migration years 2005-2016; adult return years 2006-2019) and evaluated juvenile size and migration timing relative to other factors. Except in very low flow years (drought conditions) when fish left earlier, flows did not appear to affect the date that juveniles volitionally exited acclimation sites. We observed a relationship between fork length at PIT-tagging and volitional exit timing of fish from acclimation sites, with larger fish tending to migrate earlier than smaller fish. Fish that left acclimation sites earlier had longer travel times to downstream detection sites than fish that migrated later. Larger and earlier-emigrating fish had slightly lower than expected juvenile detection rates at Bonneville Dam (500-530 km downstream of acclimation sites). In general, for fish surviving to adult return, those that returned at younger ages were earlier juvenile migrants and larger at release, whereas fish that were older at return were later juvenile migrants and were smaller at release. Our results support a growing body of evidence that hatchery practices may result in larger smolts that tend to return at younger ages. Given the biological and economic consequences of younger age-at-maturation, Pacific Salmon hatchery managers should explore and implement methods that might begin to reverse observed trends toward younger ages in returning fish.

Estuary Contributions to Resilient Salmon Populations

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Life history diversity strengthens salmon population resilience in variable environments. Estuaries contribute to this diversity by providing alternative pathways for juveniles to feed and grow before entering the ocean. Diking and filling of tidal wetlands and other shoreline developments have reduced salmon rearing opportunities in Pacific Northwest estuaries. In the Columbia River basin, Chinook Salmon stocks exhibit distinct temporal and spatial patterns of rearing and migration that require habitats located in different hydrogeomorphic reaches of the estuary. Fragmentation of wetland landscapes now limits off-channel rearing opportunities throughout the estuary and may be one of many factors contributing to the apparent simplification of life history variation in Columbia River Chinook Salmon. The salmon support functions of estuarine rearing habitats are regulated by hydrological processes that inundate tidal and seasonal floodplains, allowing salmon to access a site and transporting prey and organic matter to other areas of the estuary. Restoration designs that mimic or partially restore natural flooding regimes—water control structures and "fish friendly" tidegates, for example—generally fall short of fully re-establishing these salmon support functions. Long-term research in Oregon's Salmon River basin demonstrates that estuarine life histories in salmon populations can recover if wetland habitat opportunities are restored. A diversity of estuary-associated life histories in the Salmon River Chinook and Coho Salmon populations re-emerged after dikes and tidegates were removed, reconnecting ~60% of the estuary's historical tidal wetlands. Up to 75% of the adult Chinook and 20 - 35% of the adult Coho now returning to spawn in the Salmon River are the survivors of juvenile life histories directly tied to the restored tidal marshes.

The results suggest that reconnecting estuarine landscapes can be an effective strategy to strengthen resilience and increase the productivity of salmon populations.

Opportunities, Tensions and Sweet Spots: Pathways to Resolve Entrenched Natural Resource Conflicts

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Natural resource conflicts permeate our profession and, if not successfully managed, can impede or foreclose effective stewardship. This paper is a condensed version of a guest lecture exploring some of the underlying elements of these conflicts and useful dynamics necessary for resolution (https://webpages.uidaho.edu/mediasite/CNR/Fish%20and%20Wildlife%20Science/Opportunities,_tensions_and_sweet_spots__Pathways_.P2G/). Providing good ecological science that reduces uncertainty is vital. However, if social, economic and political sideboards are incongruent with this science, real or perceived uncertainty regarding the science (or the scientist) can be exploited and weaponized to avoid aligning decisions with good ecological science. This is often at the core of entrenched natural resource conflicts. In these situations, achieving science-based solutions requires shifting the social, economic and political sideboards enough to overlap with sound ecological science. Finding this "sweet spot" is not easy, but can be achieved through an opportunistic array of education, collaboration, incentives and tensions. Case examples that help illustrate this process and outcome include Oregon's coastal multispecies management plan, Oregon's marine reserves and the Columbia Basin flexible spill and power agreement.

Essential Salmonid Habitat – Updating Habitat Protections for Oregon's Indigenous Anadromous Salmonids

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The Oregon Chapter of the American Fisheries Society's Legislative Committee recently participated on a resource advisory committee (RAC) to consider updates to Oregon's Essential Salmonid Habitat (ESH) mapping procedures. Oregon Department of State Lands (DSL) regulates fill placement or removal in areas designated as "essential indigenous anadromous salmonid habitat" for anadromous salmonid populations listed as sensitive, threatened, or endangered by state or federal government. Indigenous anadromous salmonids with protected status include Chum, Sockeye, Chinook, and Coho Salmon, Steelhead, and Cutthroat Trout. While DSL regulates ESH, the Oregon Department of Fish and Wildlife (ODFW) is responsible for maintaining and periodically reviewing ESH maps for accuracy and to reflect changes in fish habitat distribution data. DSL consults with ODFW annually, and updated maps are adopted every five years through the State's rulemaking process. Maintaining current and accurate ESH maps is critical for protecting spawning and rearing habitats of sensitive species. Between 2013 and 2017, the ORAFS Legislative Committee responded to multiple legislative bills that ultimately led to the substantial reduction of suction dredge mining in Oregon. Suction dredge mining is now excluded from ESH mapped waterbodies, providing protection to indigenous anadromous salmonid spawning and rearing habitats that were previously accessible to miners. Additionally, dam removal and other fish passage restoration projects often seek to restore anadromous salmonid access to historical habitats previously blocked by instream obstructions, expanding the ESH channel network. These two examples highlight the importance of current and accurate ESH data. DSL and ODFW formed the ESH RAC to provide recommendations on the frequency and process for updating ESH maps. RAC members included representatives from recognized Tribes within Oregon, agriculture, municipalities, conservation organizations, state and federal agencies, developers, and ORAFS. The presentation will review the ESH mapping update and implications for indigenous anadromous salmonids in Oregon.

Using acoustic telemetry to quantify the utilization of Columbia River thermal refuge areas between Bonneville and McNary Dams by A-run summer steelhead

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The trunks of river networks must be navigated by all anadromous fishes returning to a basin, yet they are often where the highest maximum temperatures occur and where water temperatures are least buffered from a warming climate. High summer temperatures in the mainstem Columbia River poses a threat to migrating salmonids, but thermal refuge areas such as tributary confluences may help migrating fish escape summer heat stress. The utilization of thermal refuge areas in the Columbia River was examined for steelhead (*Oncorhynchus mykiss*) during their upstream migration. 200 wild A-run summer steelhead were equipped with gastrically implanted acoustic tags at the Bonneville Dam Adult Fish Facility between July and September of 2020, with a portion of the tags containing temperature and pressure sensors. Genetic samples were also taken from each steelhead sampled. Acoustic receivers were deployed in known thermal refuge areas between Bonneville Dam and McNary Dam outlined by the EPA's cold-water refuge plan. Locations of receivers included Eagle Creek, Herman Creek, Wind River, Little White Salmon River, White Salmon River, Klickitat River, and the Deschutes River. The percentage of tagged fish in this study will be compared to mean weekly Columbia River temperatures using temperature data from Bonneville and The Dalles Dams. Regression plots and cross wavelet plots will be created to analyze this data. Migration rates will then be calculated to compare fish using thermal refuge areas versus fish that do not use thermal refuge areas. Comparisons among population subgroups of A-run summer steelhead throughout the Columbia River basin can then be determined using the genetic samples collected throughout the duration of the summer sampling period.

Comparing losses of tidal forests and tidal marsh on the Oregon coast: A paradigm shift for estuary restoration and conservation

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How have Oregon's estuarine wetlands changed in the past 150 years? What do those changes mean for fish and for people, and what actions should we take to address these changes? In this 2019 analysis, we used elevation-based estuary mapping methods and historical vegetation data to document the historical extent, current extent, and losses of tidal forested wetlands on the Oregon coast, compared to emergent tidal marsh and tidal scrub-shrub wetlands. We found that historically, forested and scrub-shrub tidal wetlands (collectively called "tidal swamp") formed a majority (57.8%) of the coast's tidal wetland area, with tidal forested wetlands strongly predominating (54.4%). Emergent tidal wetlands ("tidal marsh") occupied a smaller area (42.2%). However, diking and vegetation conversion have resulted in the loss of 95% of historical tidal forested wetlands and 96% of historical tidal scrub-shrub wetlands, compared to 59% of historical tidal marsh. Based on recent studies, tidal forested wetlands provide important salmonid habitat, and diversity of tidal wetland habitat types likely contributes to the resilience of salmon populations. Beyond fish benefits, forested tidal wetlands offer many other valued functions and services, such as high levels of carbon sequestration in soils and vegetation. We can respond to the disproportionate losses of tidal swamps by prioritizing the conservation of remaining examples of these habitats, and by prioritizing restoration of tidal swamps where appropriate. This presentation and the associated report include information on approaches and methods for tidal swamp restoration and emphasize the need for further field monitoring and research to support these efforts.

A summary of DEQ's Toxics Monitoring Program sampling in the Willamette River Basin from 2008-2016.

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In 2016, the Department of Environmental Quality conducted water quality, sediment, and tissue sampling of 16 rivers and creeks in the Willamette River Basin. This sampling builds on previous water quality and tissue sampling DEQ conducted between 2008 and 2010 in the basin. The goals of this sampling were to gather information on chemicals of concern, to identify potential sources, to make the information available to the public, and to work with internal and external partners to reduce pollutant concentrations. DEQ analyzed water, sediment and tissue samples for over 460 chemicals and detected 318 chemicals across all media. The analysis included chemicals from nine chemical groups including current-use pesticides, consumer use products, combustion by-products, dioxins and furans, flame-retardants, industrial chemicals, legacy pesticides, PCBs, and metals. In the upper Willamette sub-basin, DEQ detected 152 chemicals in sediment collected immediately downstream of a storm water outfall near Maurie Jacobs Park than all other sampling locations in the sub-basin combined. DDT concentrations in the mid-Willamette sub-basin sediment samples exceeded the benchmark at every sampling location. In the lower Willamette sub-basin, water samples continue to show high concentrations of legacy pesticides a result also found during the 2008-2010 study. Based upon the results of this study, DEQ staff selected eleven monitoring locations that will become a part of the Toxics Monitoring Program's trend network. The results from this study will be used to inform the total maximum daily load (TMDL), national pollutant discharge elimination system, and stormwater programs, and will also be incorporated into the Integrated Report and DEQ's toxics reduction strategy. The full Willamette Basin Toxics Monitoring Summary was recently released and can be found at https://www.oregon.gov/deq/wq/Pages/WQ-Monitoring-Statewide.aspx.

All about that bass: some trouble for rearing steelhead

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As restoration implementers work diligently to improve population viability of the threatened Middle Columbia River steelhead population a new and emerging threat is lurking in the background. Climate induced stream warming is accelerating the upriver range expansion of smallmouth bass, increasing the likelihood of sympatry between smallmouth bass and steelhead. Smallmouth bass, as a non-native predator, have the potential to negatively impact steelhead populations through direct predation or competition, yet, few studies have quantified if smallmouth bass depress population vitality within invaded populations. We used a field-based before-after-control-impact experimental design to quantify the effect smallmouth bass have on the abundance of steelhead fry in their rearing habitat. We observed 4.8 times more steelhead in our impact reach (i.e. low smallmouth bass density) than we did in our control reach (i.e. high smallmouth bass density). Smallmouth bass isotope analysis and stomach content analysis provided evidence that the observed changes in steelhead abundance were driven by direct predation. Our results indicate smallmouth bass represent a significant threat to invaded populations of steelhead and may present a substantial hurdle to ongoing and future recovery efforts.

From disaster to success story: the role of the West Coast Groundfish Observer Program in the recovery and management of groundfish stocks

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In 1999, the West Coast groundfish fishery was declared a federal disaster. Landings and revenues were in decline following decades of insufficient data to inform stock assessments, unknown at-sea discard amounts, and overcapitalization. Stock assessments determined nine stocks were overfished, leading to a series of new management measures aimed at rebuilding these populations and increasing fishing opportunities. One key initiative was the establishment of the West Coast Groundfish Observer Program, which began deploying onboard fisheries observers in 2001 with the primary goal of identifying and quantifying at-sea discards. Observer training, deployment, and data analysis is overseen by the Fisheries Observation Science Program (FOS) at the Northwest Fisheries Science Center, which places observers in a variety of fisheries that target or incidentally catch groundfish. Observer data play a particularly large role in the Trawl Catch Share Program, which was implemented in 2011 and which allocated individual fishing quotas for over 60 species to fishery participants. To ensure individual accountability, this program requires vessels to have an observer on all trips, ensuring accurate and complete information about catches, discards, interactions with protected species, and other fishery operations. Twenty years after the disaster declaration, the management of the groundfish fishery is highlighted as a success, with eight of the nine overfished

groundfish species rebuilt, a reduction in at-sea discarding, and new fishing opportunities. We will provide an overview of the FOS Program operations, and how observer data has played a key role in the recovery and sustainable management of West Coast groundfish stocks."

The Ebbs and Flows of High School Environmental Education

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This presentation will focus on the ups and downs of building a comprehensive environmental education program at an off-campus location called the Land Lab in Central Point, Oregon. I will touch on historic partnerships and the challenge of taking over a program designed to be a fish hatchery for salmon, that never got off the ground. I will discuss how the integrated wetland, creek, and pond system was revamped to propagate native riparian and wetland plants with a floating island system. Then, our ponds were further repurposed to rear gambusia, and we became the primary source of mosquito fish for local vector control. I will also discuss our students' ongoing participation in the classroom incubation of Chinook eggs, volunteering at community events to lead stations about salmon anatomy and macroinvertebrate identification, fish hoop surveying in local tributaries of Bear Creek, and our extensive planting and restoration efforts both on our own facility and throughout the Rogue Valley. I will also cover our pitfalls and obstacles, in terms of program funding, dealing with invasive fish species, and the ever-swinging pendulum in education between focusing on state testing vs. hands-on, project based learning. Recently, our program underwent another major shift, and we have become a CTE Program (Career Technical Education), which has expanded our curriculum focus, our connections with businesses and organizations in the broader natural resources industry, and has brought funding to improve our technical equipment, our skill-based training abilities, and our connections to other schools in the state. We are now part of a state cohort of educators, called ONREP (Oregon Natural Resource Educators Partnership), whose focus is on providing students with a clear path to a career in natural resources. We have a new student leadership organization called FNRL (Future Natural Resource Leaders) in our school, and these students will travel the state to compete in regional and state-level competitions in the areas of: aquatics, wildlife, soil and land use, and forestry. Students demonstrate mastery of water and soil testing equipment, digital and hand-held forestry tools, use of keys to identify tree and plant species, wildlife identification including fish, birds, mammals, insects, and herptiles, as well as a current event topic that changes annually. We are also hosting the first Southern Oregon Regional Envirothon this year at the land lab, which is an event that will bring 200 students together (in person or virtually), which will be in preparation for the Oregon State Envirothon competition. This year's current event topic is: Water Use and Management, so our learning focus will be on keeping water sources free of sediment, chemicals, NOM, DBP's, and the impact of fire and logging practices on these criteria. I am always looking to connect my students to research work, application of real data, grants, environmental policy, and careers in this field!

Optimism's Role in Resilience

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Commercial fishing in Oregon is full of change, challenge, and reward. Oral history interview research with commercial fishing community members over two decades has captured how these small, family businesses cope with economic, environmental, regulatory, and social vulnerabilities. Fishing Community Resilience is a series of three short, authentic, interdependent videos that were crafted and produced by Oregon State Productions from research funded by Oregon Sea Grant and NOAA. Each video shares a montage of eloquent voices and images that weave together the components of fishing community resilience. Maintaining a sense of optimism, especially in times of uncertainty and change, was a theme that emerged from the research as key to fishing community resilience. Change is challenging but it's also exciting. The "Optimism and Change" video provides a glimpse into the innovation and willingness that the fishing community has developed to maintain a sense of optimism and create strategies needed for success in the ever-changing and coupled human-natural marine system.

Make Angling Great Again: Influence of terminal tackle and environmental conditions on survival of caught and released salmon and steelhead

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Gear-type restrictions in recreational fisheries are intended to improve survival of caught and released fish by reducing handling times and lowering injury rates. To test the merits of these regulations, we conducted a three-year angling mark-recapture study using a control-treatment study design in the Lower Cowlitz River, Washington. Over 7,200 rod-hours were expended angling 2,787 salmon and steelhead with a variety of methods and gear types. 2,101 of these fish were landed and 1,507 hatchery-origin salmon and steelhead were marked with anchor tags. Over 3,700 fish were also trapped, tagged, and released to serve as study controls. Across all species, the average weighted recapture rate of angled fish was 2% lower than control fish, suggesting that mortality due to angling was rare. Recapture rates of fish caught on barbed hooks trended lower compared with fish caught on barbless hooks. Fish hooked in critical locations (eyes, gills, esophagus, tongue), were recaptured at a rate that was 11.4% lower compared with fish hooked in non-critical locations (body, maxillary, jaw, head). Further, fish caught using bait were more likely to be hooked in critical locations compared with other gear types and resulted in those fish being 15% less likely to be recaptured compared with fish caught using other gear types. Water temperature was also found to have a significant effect on recapture, where the probability for recapture declined by 17% for salmon and 9.5% for steelhead with each degree of temperature increase. This large data set can be used to inform regulatory measures that reduce mortality of caught and released fish while maximizing angling opportunity.

Queen Conch Mariculture in the Caribbean

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The queen conch, *Aliger gigas*, formally known as *Strombus gigas*, is the most important molluscan fishery in the Caribbean and is in a state of steady decline due to overfishing and habitat degradation across its geographic range – the Caribbean Sea, The Bahamas, Gulf of Mexico, Florida, and Bermuda. The heritage of conch, a species of subsistence and economic importance, is deeply rooted in the island nations. As a response to population declines, queen conch mariculture began at many laboratories in the 1970s and a commercial farm operated in the Turks and Caicos from 1984 to the mid-2010s. Female conch typically lay nine egg masses during the summer mating season, with each containing close to 500,000 eggs. After three to four days, the eggs hatch and planktonic veligers (larvae) develop for three weeks before metamorphosis into benthic juveniles. As the plight of the conch persists, the need for solutions has become urgent. Conch mariculture for restoration and sustainable seafood production has received high interest as one of the solutions along with improved fishery regulations, to help conserve populations. A fishers-operated queen conch hatchery and nursery in Puerto Rico, U.S. Caribbean, was initiated in 2019 with support from a Saltonstall-Kennedy NOAA grant. In the Dutch Caribbean, CARMABI started an experimental queen conch hatchery in 2019 and in 2020, the Curaçao Sea Aquarium Sea Aquarium initiated a production-scale hatchery using conch egg masses collected from healthy broodstock that inhabit the dolphin lagoons. These hatcheries are gearing up towards production of juvenile conch for restoration and sustainable seafood. An additional project in The Bahamas addresses the decline of conch breeding stocks by translocating adults into Marine Protected Areas. Aggregating conch together will improve reproductive capacity of the population and these grazing herbivores will aid in the health of the seagrass meadows. These community-based partnerships are paving the way for successful restoration of the queen conch.

Scientists as facilitators: building connections between research, industry, and management

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Our oceans are currently undergoing unprecedented changes, resulting in shifting marine species, novel marine communities, varying weather patterns, and unpredictable fish stocks. There will be significant social, ecological, and economic impacts for decades to come, which can be lessened or aggravated by the decisions we make in the near future. It is crucial we advance our collective understanding of our changing oceans to improve management outcomes. As an Assistant Professor of Practice with Oregon State University (OSU) and Oregon Sea Grant (OSG), I am fortunate enough to do research and act as a community educator and facilitator. The 'Professor of Practice' position is unique; while I am expected to conduct primary research and engage in traditional scholarship, the majority of my time is spent on community education and outreach, engaging directly with coastal community members and stakeholders. My primary area of research and outreach is commercial fisheries, and I work closely with fishermen along the West Coast. Additionally, I am linked with local managers and decision-makers, helping to ensure consistent communication across my network on issues such as ocean acidification, bycatch reduction, whale entanglement, and shifting fish stocks. The goal of my position is to enhance learning across the spectrum, from fishermen to academics and resource managers, as well as identify emerging research needs and collaborate across disciplines to address these gaps and requirements. As an outreach and Extension specialist, I am often working with non-scientific audiences, including marine resource users, community members, and decision-makers. In most cases, my role is not to be "the social scientist" or "the natural scientist," but the person in the room able to speak both languages and bring different perspectives and expertise together to address issues at a systems level. Shifting marine species distributions are almost certain to result in no-analog systems, and we are trying to identify how these shifts will affect local fishermen, the socioeconomics of fishing communities, and pathways to proactive management at the state, regional, and federal levels.

Seafood Processing – Exploring the Hidden Faces in Seafood

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Much of the focus in seafood is on fishing, but there are other equally important parts of the industry, they are often just not as visible. This research looked at the seafood processing industry in Coos Bay, Oregon; documenting the current seafood processor workforce, while looking at changes over time. Our results show that there have been demographic changes, that the industry and workforce is still largely hidden and misunderstood, that access to product is a limiting factor for the work and thus workforce, and that even with the precarity in the workforce, they find survival tactics. This talk will explore the results and ask how we can support the WHOLE seafood industry in a no-analog world: challenging all of us to think beyond the sustainability of the "fish" and "fisher", to what sustainability and resilience might look like for the broader seafood industry.

Informing estuary restoration through mapping and data compilation

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The Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) is a nationally recognized partnership that advances regional and national goals relating to juvenile fish habitat. As a consortium of organizations focused on West Coast fish habitat in the region's estuaries and nearshore marine waters, we invite local, state, tribal, and federal governments and non-governmental and private organizations in California, Oregon, and Washington to join our partnership. PMEP partners have developed several foundational datasets and reports needed to support estuary restoration work in our region. Following an initial Inventory and Classification of U.S. West Coast Estuaries, PMEP compiled several spatial datasets providing consistent mapping of West Coast estuarine habitats: the West Coast USA Current and Historical Estuary Extent, West

Coast USA Estuarine Biotic Habitat, and Indirect Assessment of West Coast USA Tidal Wetland Loss. In addition, PMEP documented nursery functions of estuaries in Nursery Functions of U.S. West Coast Estuaries: The State of the Knowledge for Juveniles of Focal Invertebrate and Fish Species and Nursery Functions of West Coast Estuaries: Data Assessment for Juveniles of 15 Focal Fish and Crustacean Species. Recommendations from these reports led to PMEP compiling a spatial dataset on West Coast USA Eelgrass (Zostera sp.) Habitat, since eelgrass is an important estuarine habitat for juvenile fish and invertebrates. These and other PMEP efforts focus on filling data gaps with comprehensive assessment reports, mapping, and easily-accessed data tools including the Estuary Explorer and Estuary Viewer. These efforts were developed through active collaboration from our many partners. Our assessments, maps and data tools bring restoration practitioners and researchers historic and current information about estuary extent, functions, and loss. This provides important baseline information against which we can assess impacts from climate and ocean change and the response of our estuaries to stressors and to restoration efforts.

Summer Habitat Preference of Juvenile Chinook in the Middle Fork John Day River

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One of the primary factors limiting Chinook population viability throughout the Columbia River Basin is rearing habitat. As such, the recovery of Chinook (Oncorhynchus tshawytscha) populations have driven conservation projects within the John Day River Basin. 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 used mobile PIT tag antenna surveys in conjunction with habitat surveys to quantify juvenile Chinook habitat use in both restored and unrestored reaches. The results of this study will inform the design of ongoing restoration.

Willamette Anchor Habitat Investments: A Public/Private Funding Partnership to Support Large-scale Restoration on the Willamette River

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In 2010, the Bonneville Power Administration (BPA), Meyer Memorial Trust (MMT), and Oregon Watershed Enhancement Board (OWEB) formed a funding partnership to meet large scale restoration demands on the mainstem Willamette River. A collaboration of restoration practitioners in the Willamette Valley, known as the Willamette Anchor Habitat Working Group, coalesced around the funding partnership. While the funding partnership evolved in response to needs on the ground, the learning curve for all was steep because few practitioners had previously focused efforts on the mainstem Willamette River. Early in the funding partnership, MMT committed to building the capacity of core implementers, OWEB and the Willamette Wildlife Mitigation Program (BPA-ODFW) secured key parcels from willing sellers (working with several tribes and the land trust community), and all funders worked to fill information gaps. To help fill these gaps, the funders

supported an effort to synthesize existing Willamette River conservation studies and assessments, which produced a map illustrating areas of high ecological significance, termed Anchor Habitats. The Anchor Habitats approach is premised on prioritizing a series of relatively intact habitats with high conservation values and protecting and restoring these in a stepping stone fashion along the river corridor. The funding partnership has since supported the Working Group practitioners in pursuing strategic restoration opportunities in Anchor Habitat locations, based on three primary objectives: floodplain reconnection, floodplain reforestation, and side channel enhancement. This framework resulted in a significant increase in the number of restoration projects on the mainstem Willamette River and associated efforts to monitor ecological impacts and native fish communities. This talk will explore the goals of the funding partnership, accomplishments and challenges faced over time, lessons learned and adaptive management of the program, and where we go from here…

Initiation of a Sentinal Program to Monitor Herpes Virus in Juvenile Pacific Oysters at Commercial Farms along the US West Coast

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Ostreid herpesvirus 1 (OsHV-1) has significantly impacted Pacific oyster (Crassostrea gigas) production globally. Within the United States, OsHV-1 was first detected in 1995 in Tomales Bay, California, and has subsequently been found in neighboring bays. In 2018 a microvariant of OsHV-1 was detected in San Diego Bay, California. Recognizing the risk of regional spread of OsHV-1, a multi-state oyster sentinel program was initiated to monitor the prevalence and pathogenesis of this virus in juvenile Pacific oysters planted at commercial growing grounds in California, Oregon, and Washington. In Spring 2020, two sentinel oyster families were created: 1) a hybrid cross susceptible to OsHV-1 ("YxP"); and 2) a cross tolerant to OsHV-1 ("29.001"). In June/July 2020, YxP spat were planted in San Diego Bay (CA), Tomales Bay (CA), Tillamook Bay (OR), Willapa Bay (WA), and Totten Inlet (WA). Tolerant spat (29.001) were planted alongside susceptible spat (YxP) in San Diego Bay and Tomales Bay. Industry partners determined spat survivorship every two weeks and sent samples to us for analyses which included OsHV-1 presence and viral load. Field sampling continued through early Fall. Sentinel spat at sites in Oregon and Washington demonstrated high survival and tested negative for OsHV-1. The virus was detected at both California test sites. Sentinel spat from both crosses planted in San Diego Bay experienced nearly 100% mortality over a four-week period and tested positive for the OsHV-1 μvar. The OsHV-1 reference strain (not the μvar) was detected in Tomales Bay where spat survival was higher for the tolerant (29.001) family than for the susceptible (Y x P) family. In addition, spat planted in June had higher survival than those planted in July.

Fine-scale analysis of wild summer steelhead homing patterns in the John Day River basin

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Thirtymile Creek, a tributary to the lower John Day River, contains a population of wild steelhead (*Oncorhynchus mykiss*) that is critical for the recovery of the listed steelhead in the John Day River basin. Thirtymile Creek is a mix of ephemeral and perennial sections during baseflow conditions, but maintains continuous flow, from spring rains and snowmelt, when steelhead are spawning. Despite continuous flow during spawning season, the majority of steelhead spawning occurs in the perennial reaches. The disproportional distribution of steelhead spawning in perennial reaches indicates wild steelhead may be homing at a reach scale. While it is well documented that anadromous O. mykiss, upon returning from saltwater into freshwater habitat, predominantly return to the stream where they were reared. Large knowledge gaps still remain in our understanding of fine-scale homing behavior. We hypothesize that wild steelhead not only return to the same stream, but express fine-scale homing behavior by returning to and spawning in the same stream reach from which they reared. To test the reach-scale homing hypothesis we used PIT tag array detection data from 2005 to 2020 to reconstruct the complete migration history of wild steelhead that were tagged as juveniles in perennial tributaries of the John Day River. We then estimated how closely adults spawned to the stream reach where they were tagged as juveniles. Homing pattern results from these perennial streams will be used to contextualize our Thirtymile Creek observations, and provide guidance for habitat restoration and monitoring.

Agricultural Lands and Native Fish Species in the Willamette River Valley

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Historically the upper Willamette River Valley, western Oregon, was characterized by seasonal floods and large expansions of its stream network. During the past century, human activities have altered or eliminated many intermittent stream and floodplain habitats in the valley. As a result, the remaining intermittent streams and drainage channels still provide habitat critical for native fish. Our study objectives were to determine: (a) fish presence; (b) spatial gradients of fish distribution (including species identity, native vs. non-native, and numbers); (c) fish use of these intermittent watercourses as spawning and nursery habitats; and (d) the main factors influencing both numbers of fish and species richness. In winters and springs of 2002 through 2004, and again in 2013, we examined the distributions of fish species in five sub-basins within the Willamette Valley. Sampling sites were in intermittent watercourses that drained grass seed producing fields. We collected water samples and sampled fish December to May with minnow traps and by electrofishing, and recorded standard fish habitat variables at all sites. Fifteen fish species were found, only four of them were exotic. The presence of recently hatched and juvenile fish shows intermittent watercourses offer conditions suitable for spawning and juvenile rearing. The two watershed-scale variables with the most influence on fish species richness were % watershed covered by forest and distance to perennial water, which showed a direct and inverse relationship, respectively, to species diversity. In turn, fish abundance showed a negative, albeit modest, relationship with distance to perennial water. Among local-scale variables, water velocity and conductivity were inversely related to species richness and fish numbers. Our results highlight the relevance of intermittent watercourses for native fish species in the agricultural lands of the Willamette Valley, and call for promotion of conservation practices that benefit farmers while maintaining aquatic biodiversity in these floodplain habitats.

Status of sablefish (*Anoplopoma fimbria*) aquaculture in the Pacific Northwest: A new marine species for commercialization

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Development of new marine finfish species for aquaculture has been slow even though there is a strong desire to increase the local production of domestic seafood in the U.S. and to decrease our reliance on imported seafood. Sablefish (black cod), is a long-lived species with wide distribution throughout the Pacific. The high value of sablefish, decreases in wild population levels, fast growth, and superior flesh quality have stimulated aquaculture of this species, and they have been commercially produced by a small number of Canadian companies in British Columbia. Many of the bottlenecks in rearing sablefish have been addressed by research conducted primarily by NOAA biologists over the past decade, but development of commercial grow-out in the U.S. has lagged. In part, this is a result of difficulties in net pen rearing of fish in the Pacific Northwest. While land-based rearing (e.g., recirculating aquaculture) of marine fish is technically feasible, net pen grow-out of sablefish is currently the only economically viable method. Rearing of nonnative fish species (e.g., Atlantic salmon) has been banned in Washington State but commercial producers such as Cooke Aquaculture Pacific have received permitting from the Washington Department of Fish and Wildlife to rear a native species, steelhead trout, in Puget Sound. Cooke Pacific Aquaculture also signed a business agreement with the Jamestown S'Klallam Tribe (Sequim, WA) to rear sablefish and steelhead trout in certain net pen locations in Puget Sound. The Jamestown are currently involved with NOAA and the University of Washington in a quasi-commercial scale net pen trial of sablefish to determine the economics and environmental impacts of sablefish net pen grow-out and to transfer grow-out technologies to the Jamestown Tribe. It is hoped that this trial will provide the basis for environmentally sustainable commercialization of sablefish to supply locally sourced seafood for the U.S.

Go with the flow (hyporheic that is): Processes controlling thermal regimes in secondary channel features on the Willamette River

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The thermal regime of rivers plays a key role in aquatic ecosystem health. In the Willamette River, main channel temperatures can be too warm for cold water fishes, causing fish to concentrate in secondary channel features including side channels, ponds, and alcoves. However, temperature regimes vary among and within features. Improved understanding of physical processes controlling thermal regimes in gravel-bed rivers is needed for targeted conservation action. This study characterized thermal regimes on the Willamette through field observations of temperature continuously measured at one side channel, eight alcoves, and six beaver ponds over a two-month period. Insight into these measurements was provided by two dimensionless quantities. The Richardson number, characterizing stratification, was calculated with temperature and flow data. Values showed two well-mixed sites and 13 stratified sites. Stratification allowed calculation of the hyporheic-insolation number, characterizing the ratio of cooling flux from hyporheic discharge to heat transfer from incoming solar radiation. As calculated hyporheic-insolation numbers for sites increased, measured temperatures at sites decreased. Results further indicate secondary channel features that provide cold water habitat are characterized by stratification and cool hyporheic discharge. Stratification is a necessary yet insufficient condition for cold water to provide habitat for aquatic biota because cold areas may still be anoxic, as suggested by dissolved oxygen point measurements. The hyporheic-insolation number has the ability to predict and thereby classify the thermal regimes of secondary channel features based on minimal field measurements and could guide future floodplain restoration efforts.

Density-dependent habitat limitations for juvenile Chinook salmon in estuarine wetlands

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Efforts by people to restrain tidal inundation to promote agriculture and development has led to large amounts of tidal wetland habitat loss in large river deltas across the Pacific coast. These losses are one of multiple threats facing estuary-dependent species such as Chinook salmon, yet concomitant declines in these populations have raised questions about the extent to which juvenile Chinook salmon compete for limited estuary habitat and how estuary restoration will help recover populations. To examine the potential for habitat limitation, we used a cross-system approach to combine outmigrant and population density data in four large river deltas of Puget Sound. By adjusting outmigration abundance to natural-origin outmigrants/ha of delta channel, we were able to develop a statistical stock-recruit model that standardized outmigrations across all four estuaries. Our analysis revealed evidence for negative density dependence throughout the range of observed outmigration sizes. This was despite substantial variation in densities in deltas, even when

outmigrations from rivers were high. Within each large river delta system, fish densities approached predicted capacity levels at some site or time in most years, although the frequency with which this occurred varied greatly by system. Furthermore, exceedance frequencies systematically varied across the season and in different habitat types. Capacity exceedance depended in part on hatchery releases, which have the potential to contribute to density dependence due to co-occurrence with natural-origin fish. Habitat-specific variation also existed in the highest observed population densities (90th and 95th quantiles) within deltas, and these levels were not greatly influenced by densities of hatchery-origin migrants in tidal deltas. Additional bioenergetics modeling indicated that all wetland habitats contributed to capacity at different times of the rearing season. These findings have important implications for monitoring programs, estuary restoration, and hatchery management.

History and Recovery of the Native Fish Assemblage of the Willamette River

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The native fish assemblage in the Willamette River reflects long-term influences of volcanic processes, glacial events, and major floods. Human have influenced fish assemblages of the river for thousands of years, beginning with Native American fisheries, especially at Willamette Falls, and intensifying over the last 175 years through land use, pollution, harvest, dams, and introduction of non-native species. The early 1900s was a period of major decline because of unregulated industrial pollution and extensive harvest. Water quality has improved in response to environmental protection regulations after 1950 and efforts of local communities. Floodplain protection and dam operations also have improved, but also remain as ongoing challenges for recovery. River surveys since 1905 have documented the river's fish assemblages. The Willamette River basin now contains 35 native fish species and 31 non-native fish, representing 10 families of native fish and 12 families of non-natives. More than 90% of the total number of fish captured in recent surveys of the mainstem and 99% in selected tributaries are native species. Species richness of native species decreases from more than 90% in mainstem of the upper river to approximately 70% in the lower river. Non-native fish species comprise a greater proportion of the assemblage in sloughs and isolated floodplain ponds than in the mainstem. Surprisingly, no extinctions of native fish species in the Willamette River have been documented. Legal protections, land stewardship, and restoration efforts of local communities, management agencies, and landowners continue to restore the abundance and diversity of Willamette fish assemblages. In coming decades, the effects of human impacts on hydrology, ecology, and climate might be mitigated through restoration, but those efforts need to be guided by defensible science-based tools. One of our greatest challenges is to anticipate the future Willamette River that will be shaped by the legacy of human actions over the last 175 years, demands of a growing human population, and environmental trends related to a changing climate. Better scientific understanding of the aquatic ecosystem and collaboration of the diverse communities of our basin will improve our ability to restore and enjoy the future Willamette River.

Coastal climate change impacts to U.S. West Coast estuaries

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Sea-level rise and climate change are projected to modify coastal ecosystems for important fisheries, and an increasing concern is how they will maintain function particularly where constrained by human development. In addition, estuarine habitats that have experienced widespread degradation due to land use and significant planned or ongoing investments in their restoration are vulnerable to coastal change. Along the U.S. West Coast, our understanding of the historic variability of physical processes like stream flows, sea-level rise, storms, and waves that influence estuaries is relatively well established. However, our ability to predict and assess future conditions, including the cumulative effects of environmental feedbacks (for example, sedimentation, geomorphic responses), across estuaries is relatively limited. It remains even more ambiguous yet important to understand and be able to predict changes to habitat suitability (for example, crossing specific thresholds of suitable water depths, flow velocities, substrate type, and foundation species in the coming decades) for identified focal species that rear in and use estuaries during key life history stages. Many habitat suitability traits are linked to sedimentation and erosion, and changes in water quantity and quality, and are expected to change in magnitude, spatial extent, timing, and frequency in the coming decades. This presentation will discuss the state of knowledge of impending climate change impacts to estuaries along the U.S. West Coast with respect to focal species of concern to the Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) ecosystem and restoration program goals. This initial cross-cut of impact pathways to specific species life-history needs will in turn help identify the level of detail of information that exists, and that is needed to evaluate coastal change impacts to PMEP goals and help define metrics and models required to inform resilient ecosystem restoration investments along the U.S. West Coast.

Upper Willamette River Floodplain Restoration - A 10 Year Review

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Beginning in 2010, River Design Group, Inc. (RDG) with funding provided by the Meyer Memorial Trust and the Oregon Watershed Enhancement Board, collaborated with MMT, OWEB, Oregon State University, University of Oregon, and The Nature Conservancy to initiate restoration prioritization on a 160 mile reach of the Willamette River between Eugene and Oregon City, Oregon. The goal of the project was to apply existing information to help guide restoration planning for the Willamette River. Restoration planning is intended to address limiting factors identified in the Willamette BiOp that are in part, believed to be limiting the recovery of Upper Willamette River spring Chinook and winter steelhead. RDG used an existing LiDAR data set, stream gage data and flood frequency information, and surveyed 2 year flood water surface elevations to create a 2 year flood water surface layer that was overlaid onto the historical Willamette River floodplain. The resulting 2-year inundation maps were used in part to identify potential restoration projects between

Eugene and Corvallis. Since 2013, RDG has worked with project partners to implement floodplain restoration projects at Green Island (RM 173), Harkens Lake (RM 153), Sam Daws Landing State Park (RM 145), Snag Boat Bend (RM 143), Horseshoe Lake (RM 125), Bowers Rock State Park (RM 123), and the Luckiamute State Natural Area (RM 108). Completed projects have included gravel pit rehabilitation, floodplain channel reconnections or development, road crossing upgrades, and aquatic and riparian habitat enhancement. Project areas sustained over 2 and 5-year flood events in December 2015 and April 2019, respectively. A review of completed projects, preliminary monitoring observations, and suggestions for future floodplain restoration efforts will be presented.

Who Speaks for the Fish in 50 Years?

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How do we engage the children of today to become the Natural Resource Managers of tomorrow? Why is this so important? I often hear "I am too busy. I have an international treaty, instream water right, fish passage criteria, lawsuit, land use planning rule, or fish management plan to work on. The ugly truth is, as human populations grow, as climate change forces migrations, as fresh water becomes more precious, every treaty we negotiate, every lawsuit we win, every water right we secure, every fish passage and land use planning rule signed into statue today can and will be undone if there is no one to speak for the fish in 50 years. For my presentation, I will talk about how the Salmon Trout Enhancement Program (STEP) works to engage and inspire today's youth to respect and appreciate the natural world, and, why it is so important for today's Fish Biologists to give their time and effort to mentor those who will take our place tomorrow.

Liposome-based microencapsulation techniques for enhanced nutrition and disease prevention in finfish aquaculture.

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Nutrition is a major challenge area in finfish aquaculture, particularly when feeding the early life stages with food items that are meant to substitute for their natural prey. The delivery of water-soluble nutrients to aquatic organisms is particularly challenging since these compounds may be rapidly lost from artificial diets when suspended in water, termed nutrient leaching. Nutrient leaching is particularly problematic with decreasing scales due to a fundamental increase in surface area to volume ratios as objects decrease in size. We have sought to ameliorate this problem by developing microencapsulation techniques and technologies that enhance the delivery of essential water-soluble compounds to marine and freshwater fish. Specifically, we have found that liposomes show high retention of water-soluble compounds and appear to be digestible by aquatic organisms. We have used liposomes in two ways: First, we have used liposomes to elevate the water-soluble nutrient concentrations in cultured live feeds, rotifers and Artemia, thereby increasing their nutritional value for fish larvae. Second, we have incorporated liposomes into larger carrier particles, termed ‘complex particles’, that can be directly fed to fish larvae and juveniles. In this presentation, we will review some of the major outcomes of this research as well as the next steps for these technologies.

Instream Water Rights in Oregon: Data Collection, Application Submission, and Beyond

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The Oregon Department of Fish and Wildlife is one of three state agencies in Oregon with statutory authority to submit instream water right applications. ODFW applies for instream flows for the conservation, maintenance, and enhancement of aquatic and fish life, wildlife, fish and wildlife habitat, and any other ecological values. Once certificated, the resulting instream water rights provide legal protections for instream flows based on water availability and the system of Prior Appropriation. There is a relatively rigorous set of data, analysis, and administrative requirements associated with application submission. This discussion will provide an overview of the current data and analysis methods, procedural requirements, and resulting instream flow protections associated with instream water right applications submitted by ODFW, as well as a brief review of opposition faced. We will conclude the presentation with a look forward to new data collection and analysis techniques, water temperature-based flow targets, and potential locations of future instream water right applications.

Yaquina Bay Tidal Restoration, Oregon

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In summer 2020, the MidCoast Watersheds Council (MCWC) and partners completed a tidal restoration project on a 55-acre site in the Yaquina estuary upriver from Newport, Oregon, enhancing and extending the benefits of a restoration effort completed in 2001. Mapping by PMEP has shown that the Yaquina has lost 67% of its historic vegetated tidal wetlands, habitat important for juvenile coho salmon (endangered), as well as chum and Chinook salmon and multiple other fish and wildlife species. The restoration area, diked and ditched since the 1930s, had subsided compared to reference sites and was vulnerable to sea level rise as shown in an Oregon sea level rise study completed for the MCWC. The project’s goals were to restore ecological process and function and increase both the quantity and quality of tidal wetland habitats, as well as restore forested and scrub-shrub vegetation communities. Over 45% of the perimeter dike that limited natural tidal inundation and sediment inputs was lowered to reference levee elevation, linear drainages ditches were filled to force tidal flow into existing and 2,400 linear feet of newly excavated tidal channels. Fill removed from perimeter dikes was utilized on site to create ecotone slopes, that is, creating elevations for native plantings to transition from high marsh, to scrub-shrub, to spruce swamp vegetation types. Over 200 pieces of large wood were installed to create habitat structure and function, and measures were taken to protect the City of Toledo's source water pipe. Pre-project photo-points and natural and infrared drone flights were used to map project design elements and vegetation types and will be utilized to assess the change in vegetation type on the site, including the reduction in invasive species and the increase in tidal influence.

Field-based Caribbean Acropora coral cultivation and restoration in Southeast Florida and the Bahamas

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Caribbean acroporid corals, which includes *Acropora cervicornis*, *A. palmata*, and their hybrid *A. prolifera*, were a major reef-building scleractinian group throughout the greater Caribbean region for thousands of years. Since the late 1970s, their populations have declined severely, primarily due to disease. To promote recovery, Acropora coral nurseries have been established throughout the region with goals to collect, propagate, and outplant corals to depauperate reefs. Since 2009, Nova Southeastern University (NSU) has managed two offshore coral nurseries in Fort Lauderdale, FL to study *A. cervicornis* restoration. Currently, more than 1,500 *A. cervicornis* fragments are grown at the nurseries on floating or fixed structures and over 6200 nursery grown colonies have been outplanted in southeast Florida. A yearlong comparison of nursery attachment techniques in 2011 found line suspended corals had significantly higher survival, growth, and less disease and predation compared to direct line attachment. A separate study evaluated outplant attachment techniques and density for 1-2 years and found significantly greater survival using nails and cable ties in low density plots. Continued evaluation of outplant sites revealed outplant site structural complexity had a significant positive relationship with both fish abundance and species richness. In 2018, three offshore acroporid coral nurseries were established at Great Stirrup Cay (GSC), The Bahamas to investigate growth and survival among all three Caribbean acroporids. One year of monitoring found nursery site significantly affected fragment survival. Taxa, site, and fragment type all had significant effects on mean growth, with apical *A. prolifera* fragments being the most prolific combination. The results of these studies identify techniques that improve the efficacy of Acropora restoration programs by providing scientific based tools for practitioners and further promoting the recovery of these endangered species.

The Willamette Basin: Is the Glass Half Empty or Half Full?

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Beginning in the mid-19th century, Willamette basin streams were changed from complex stream/wetland systems to simplified channels; similar processes occurred in the mainstem in the early 20th century. Point and diffuse pollution led to the Willamette being deemed an open sewer by 1911. The most serious point sources of pollution were controlled in the 1960s but were associated with markedly altered flow regimes and abundant non-native fish species. Currently, diffuse pollution from agriculture and sediment toxics remain major problems throughout the mainstem and summer water temperatures limit salmonid distributions, making oxygenated cold water refuges critically important. Nonetheless, winter-wet agricultural ditches continue to host native fish species, an endangered fish species has been delisted, and the mainstem supports 2 life histories of juvenile Chinook Salmon. Beginning in the 21st century, collaborative federal, state, tribal and private rehabilitation programs have been successful in improving flows and Anchor Habitat complexity and connectivity in the Willamette floodplain. What will the basin and channel network look like in 2120 and why?

Species traits and landscape resistance mediate native fish distribution shifts and vulnerability to climate change in a Rocky Mountain riverscape

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Climate change poses a substantial risk to freshwater biodiversity, but most studies focus on understanding impacts to popular cold-water fishes (e.g., salmon, trout, and char) that have relatively large body sizes, are often highly mobile, and may be adept at tracking habitat shifts or dealing with natural disturbances. Small, less mobile fish species often constitute significant portions of aquatic communities and could be more vulnerable to environmental change, so a broader understanding of how species traits and landscape resistance influence climate change vulnerability is needed. By revisiting 280 sites over a 20 year interval throughout a warming riverscape in western Montana, we described changes in species site occupancy and assessed the environmental conditions associated with those changes for four fishes spanning a range of body sizes, thermal niches, and habitat preferences. Two larger-bodied trout species exhibited small changes in site occupancy, with bull trout showing a statistically significant 9.2% reduction, mostly in warm, low elevation stream reaches, while westslope cutthroat trout showed a nonsignificant 1% increase. The small-bodied slimy sculpin that prefers cold temperatures was originally distributed broadly throughout the network but experienced a 48.0% reduction in site occupancy with declines common in warmer stream reaches and areas subject to wildfire disturbances. The small-bodied longnose dace which prefers warmer temperatures was originally constrained to reaches at low elevations but expanded its distribution upstream in many areas. Distribution shifts for sculpin and dace were often constrained by barriers, which included anthropogenic water diversions at low elevations and natural step-pools and cascades in steeper upstream reaches. Our results suggest that aquatic communities exhibit a range of responses to climate warming, that effects on non-salmonids may be underappreciated, and that improving passage and fluvial connectivity will be important climate adaptation tactics for conserving aquatic biodiversity. This study was published in Global Change Biology and is available for download from TreeSearch (https://www.fs.usda.gov/treesearch/pubs/61372).

Description of juvenile anadromous salmonid habitat density relationships using large interagency databases and spatial stream network (SSN) models

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Significant investments have been made by numerous agencies to monitor anadromous salmonids by conducting thousands of density surveys within streams across the Columbia River Basin. We aggregated these surveys from CRITFC, ODFW, IDFG, USFS, CHaMP, and BioMark for the period of 2000–2018 for Idaho and northeastern Oregon streams into a single database and applied spatial stream network (SSN) models to describe habitat relationships of juvenile Chinook salmon (n = 6,757) and steelhead (n = 7,436). Twenty-eight covariates were assessed, but only seven were statistically significant for Chinook salmon (reach slope, mean summer flow, mean August temperature, baseflow index, riparian canopy density, brook trout density, and inter-annual variation in juvenile densities) and these explained 57% of the variation in densities at the survey sites. The final model for steelhead accounted for 48% of the variation in densities and included six of the same seven covariates as the Chinook salmon model. Response curves describing habitat relationships indicated Chinook salmon densities were highest in medium sized streams with low reach slopes, cool temperatures, higher brook trout densities, and intermediate levels of riparian canopy and baseflows. Conversely, steelhead densities were highest in small streams with greater slopes, warmer temperatures, low brook trout densities, high proportions of watershed conifers, and intermediate levels of riparian canopy. The SSN models were used to create 24 prediction scenarios of juvenile densities for all reaches in the study area networks, and included baseline composite scenarios of average densities for 2000-2018, annual density scenarios, and three future scenarios indicative of climate warming (scenarios available online as ArcGIS shapefile at the StreamNet Data Store: https://app.streamnet.org/datastore_search_classic.cfm). Our results highlight the utility of existing fish density survey data for creating new information when integrated to a consistent database and used with SSN models and other publicly available geospatial resources.

Factors contributing to present and future occurrence of relict headwater bull trout populations in the northern Rocky Mountains

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Bull trout declined significantly during the 20th century as populations were exploited, non-native trout species expanded geographically, and stream habitats were degraded—leading to federal protections under ESA in 1997. Although the species remains widespread in patchily distributed headwater populations across the Pacific Northwest, climate change is gradually reducing and fragmenting the remaining habitats. Using an extensive new dataset of species occurrence results from 9,908 eDNA and electrofishing site samples in 991 bull trout patches throughout most non-wilderness basins in Idaho, Montana, and northeastern Oregon, we developed bull trout occupancy

models to assess the relative importance of 24 covariates that represented patch size, connectivity among patches, thermal and hydrologic regimes, internal patch refugia, geomorphic attributes, wildfire prevalence, road densities, occurrence of adfluvial bull trout, and brook trout prevalence. The best model correctly predicted bull trout occupancy status in 82.6% of the patches and included statistically significant effects for (in decreasing order of importance): patch volume, length of patch reaches below 9 °C mean August temperature, distance to nearest occupied patch, road density, brook trout prevalence, and frequency of high flows during winter. Subsequent analyses are using the model with climate projections to create probabilistic scenarios of bull trout occurrence in the study streams and to perform sensitivity analyses for understanding where and why occurrence probabilities are most likely to change. In particular, we are interested in determining the degree to which habitat geometry (i.e., patch size and connectivity) might buffer or worsen the deleterious effects of climate change, and whether realistic assumptions about habitat restoration and management interventions could effect meaningful climate mitigation that would enhance the long-term persistence of some populations or bull trout as a species in the northern Rocky Mountains.

Improving distribution predictions for invasive fishes by combining the riverscape concept, habitat intrinsic potential and ecological niche models

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Modeling that enhances and improves distribution maps for invasive fish species can enhance management prioritization for restoration and identify areas that may need to be monitored closely for colonization. Ecological niche models are often used to predict species geographic distributions by integrating environmental covariates with species presence/absence data. Commonly used covariates are climatic layers, landscape morphology, land cover, and soil features. Until recently, the predictive accuracy of ecological niche models (ENM) for freshwater fishes (either native or invasive) has been hampered by the limited availability of in-stream datasets. Although terrestrial covariates have been used as surrogates for in-stream variables, they do not capture river network connectivity or basin configurations (including the directional nature of rivers). All modelling approaches have strengths and weaknesses (i.e., some have robust methodology, others good theoretical foundation) and traditionally they have been used independently of each other. In this study, we combine the Riverscape Concept, Habitat Intrinsic Potential (HIP) and ENM. The Riverscape Concept provides a conceptual foundation to incorporate continuous, spatially heterogeneous instream covariates at the reach-scale over the geographic range of the species of interest. These in-stream variables will be developed from high resolution open-access digital elevation models and climate models. Subsequently, ENMs will be used to combine in-stream variables via robust machine learning algorithms with species presence data for model calibration. Calibrated models for the native range of a fish species will then be transferred to predict HIP in places where they have been introduced. Different sets of covariates will be tested to find the best explanatory variables. We will create dynamic prediction maps for species expansion or decline over time by adding a temporal dimension to ENMs. We anticipate that combining riverscape, HIP and ENM will improve the accuracy of fish distribution models for invasive species.

Simulations of a Mixed-Stock Salmon Fishery Provide Fish Behavioral Insights and Evaluate Harvest Models

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Management of mixed-stock recreational fisheries presents challenges in balancing fishery access and conservation of vulnerable stocks. Although accurate and timely estimates of stock-specific harvest are crucial in achieving competing objectives, limited sample sizes of stock assignments (e.g., through physical tags) frequently limit the usefulness of harvest estimates. Using simulations of fishery processes for a high-effort, recreational, and mixed-stock fishery on Chinook salmon in the Columbia River, we assessed the performance of competing model frameworks, types of prior information, and extents of data aggregation in estimating stock-specific harvest using limited data. We sought to improve accuracy for both snapshot estimates of cumulative harvest and harvest trajectories over time. Simulated fishery processes were empirically-informed and included stock-specific behavior, temporally-variable harvest rates, and creel sampling efforts to "observe" coded wire tags (CWTs) for stock identifications. Parameterizing the simulation framework revealed new insights into stock-specific behavior in the lower Columbia River, including arrival timing in the estuary, estuary residence time, and spawning migration velocity. Based on simulated datasets, Bayesian likelihood-based models performed similarly to existing model structures and provided novel estimates of uncertainty. Incorporation of prior information in harvest models was valuable for estimating harvest for stocks with fewer tag returns and produced flexible estimates of harvest trajectories over time. Furthermore, aggregating CWT recoveries over five-day windows produced the most accurate harvest trajectories when we incorporated prior information. Model results highlight the balance between obtaining sufficient tag sample sizes and capturing variability in harvest rates over time. Although our final simulation framework is specific to one fishery system, our approach to simulation and assessment may be applied to similar fisheries in the future.

Synthesizing the state of the science for coldwater refuges and summer water temperature in the Willamette River basin

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Multiple regulatory, management, and conservation organizations are interested in protecting and increasing thermal diversity and coldwater refuges (CWR) for Chinook salmon, steelhead, and other fishes in the Willamette River basin of northwestern Oregon. The Oregon Department of Environmental Quality regulatory standards define coldwater refuges as "portions of a water body where or times during the diel temperature cycle when the water temperature is at least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed flow of the water body" (OAR 340-041-0002(10). Coldwater refuges are considered critical fish habitats because main channel temperatures often exceed those that are protective of cool water fishes. This inter-

disciplinary study is synthesizing current and emerging science related to thermal diversity and CWR. This effort will develop conceptual frameworks for understanding how geomorphic, hydrologic, and riparian vegetation processes create CWR as well as when, where, and how the thermal mosaics and CWR influence salmon, steelhead, lamprey, and other native fishes in the Willamette River. Information resulting from this collective effort will be used in collaboration with the habitat restoration community in the Willamette River basin to identify strategic process-based actions at the site and reach scales to protect, enhance, and restore CWR where possible.

Resilience of the Confederated Tribes of Siletz Indians, focusing on traditions around resource use and management

Robert Kentta
Tribal Council Member, Confederated Tribes of the Siletz Indians

Robert Kentta has been the Cultural Resources Director at the Confederated Tribes of Siletz Indians (CTSI) since the early 1990's. He has also concurrently, for the past 16 years, served on the elected Siletz Tribal Council, having been elected to several successive 3-year terms. He has also been a member of the Board for the Elakha Alliance, an Oregon 501(c)(3) dedicated to the successful reintroduction of Sea Otters on the Oregon Coast. He was born and raised in the Siletz River Valley at a time when the federal policy of Termination still held effect over the CTSI, and Tribal rights to exist and be recognized as a Tribe, let alone any acknowledgment of Siletz Tribal rights to land or resources. The 1.1-million-acre Siletz Reservation was established in 1855, in fulfillment of several treaties. However, the reservation was reduced by approximately ¾ its mass by 1875, and most of the remaining 225,000 acres were wrestled from the CTSI's hands for 74 cents an acre in 1892. The remaining Tribal lands continued to shrink through awful policies regarding Indian lands. In 1954, the Western Oregon Termination Act was passed by Congress, establishing a 2-year timeline when the last of the Siletz Reservation lands would be disposed of by the Bureau of Indian Affairs, and the Siletz Tribe would no longer exist. Robert will talk about traditions around resource uses, Treaty history of the Siletz Tribe and its reservation history, and how the Tribe has endeavored since Restoration as a federally recognized Tribe in Nov. 1977 to re-establish recognized rights to co-manage resources within its reservation and the 21-million-acre homelands, and adjacent coastline. The Tribe is involved in a number of habitat and species restoration efforts. Robert will share some of those areas of interest - born of both traditional values around responsibility to our environment and necessity of current circumstances and changes since the arrival of others to our homelands.

Assessment of Habitat Availability for Juvenile Chinook Salmon in the Willamette River

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Streamflow in the mainstem Willamette River is highly regulated by the Willamette Project, a system of 13 dams owned and operated by the U.S. Army Corps of Engineers in western Oregon. The Project provides flood control and other purposes throughout the Willamette Valley but is home to ESA-listed winter steelhead and spring Chinook salmon. Efforts to restore these species include habitat restoration, passage improvements at Project dams, and operational modifications aimed at improving in-river conditions for juvenile and adult steelhead and Chinook salmon. Substantial information is required to establish operational benefits for Willamette River fish species including determining when various life stages are present in the river, identifying which habitats they use, and describing how operations affect factors such as habitat availability and water temperature. In this presentation we provide an overview of existing datasets and describe new data collection efforts that can inform operational improvements for steelhead and Chinook salmon in the basin. Specifically, we will focus on data collection currently underway to describe habitat use patterns by juvenile Chinook salmon in the mainstem Willamette River. These data will eventually inform modeling efforts that describe how Project operations influence habitat availability in the Willamette River.

Potential for growth of marine aquaculture on the Oregon Coast

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Aquaculture is globally filling the gap between increasing consumer seafood demand and limited harvests of wild fishery stocks. About 50% of all seafood consumed in the USA is derived from aquaculture, mostly imported from Asia. It is predicted that this trend of increasing dependence on aquaculture in meeting consumer demand will continue in the 21st century. Oregon is blessed with highly productive, pristine coastal waters, an equitable climate, relatively inexpensive coastal lands, and a high-potential for abundant renewable energy from wave and wind sources. Currently, Oregon's aquaculture activities focus on the cultivation of oysters in estuaries and bays as well as the newly emerging, land-based culture of the sea vegetable Pacific dulse. Net-pen production of steelhead occurs in Washington's portion of the Columbia river. Additional potential aquaculture species for Oregon's coast include abalone, sea urchins, scallops, sea cucumbers, sea vegetables, striped bass, sturgeon, sablefish, and some herbivorous marine fish species, such as opal-eye and halfmoon. Offshore aquaculture is challenging in Oregon's stormy waters but it may be possible to link it with offshore wave energy production systems. Care should be taken in expanding Oregon's marine aquaculture to ensure that products do not economically under-cut current wild fisheries, so that a combination of sustainable wild fishery harvests and aquaculture can meet increasing consumer demands.

Fishes of Harney Basin Revisited: A contemporary assessment of the distribution of fish fauna throughout Harney Basin

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The Harney Basin in southeastern Oregon is an endorheic (closed) basin that supports a unique fish fauna. The last publication on the full assemblage of fishes in the Harney Basin was published exactly 50 years ago by Peter Bisson and Carl Bond (Copeia 1971, No. 2). Since that time, the basin has experienced a host of hydrologic changes, human developments, and other factors that could have influenced native fish as well as invasions of nonnative species. Our objective in this work was to revisit this fish assemblage after a half-century to determine if 1) native fish distributions in the Harney Basin are now different relative to the initial assessment by Bisson and Bond, 2) evaluate invasions of nonnative fishes, and 3) link the distribution of these fishes to newly available datasets that track stream temperatures, drying, and discharge. We collaborated with local agencies and partners, Oregon Department of Fish and Wildlife (ODFW) and High Desert Partnership (HDP), to gather available fish distribution data (1990 – 2019), and also conducted additional electro-fishing and environmental DNA (eDNA) surveys in 2018 and again in 2019 to assess the contemporary status and distribution of native and nonnative fish fauna throughout the basin. We are combining these data with a digital elevation model, probability of streamflow permanence (PROSPER), stream temperature (NorWEST), stream discharge, wetted width, suspected fish barriers, and the presence of invasive species data to assemble species distribution models for several focal species in order to better understand the attributes most influencing and limiting their distributions.

Toward a Working Willamette

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The Willamette Mainstem Anchor Habitat Working Group is a collection of sixteen organizations focused on implementing restoration actions within high priority areas located at major tributary confluences and river sections where there are opportunities to re-connect the river to its historic floodplain. Our action plan calls for expanding the extent and quality of floodplain forests, reconnecting the river to it's historic floodplain and increasing the channel's complexity and length. These priority actions were chosen for their ability to enhance native fish habitat. Working to adaptively manage a restoration initiative across such a large geography and number of partners presents unique challenges and opportunities. Challenges include keeping all partners up to speed on developing science and a shifting funding landscape while cohesively telling the story of our collective impact and garnering community support for continued collaboration. These challenges also present unique opportunities to come together around a shared set of strategies and the ability to allocate funds to their highest and best use amongst restoration practitioners. The vast majority of restoration projects along the mainstem of the Willamette River come in through this working group and because the working group develops the project pipeline and internally prioritizes projects--this creates a community driven approach to restoration. A new project prioritization approach is being developed by the partnership and piloted on a stretch of the river between Eugene and Albany. Today's talk will explore this emerging framework in the context of the existing partnership structure and the shifting landscape along the Willamette River."

Against the Current: Creating and Navigating Space for an Ever-Changing World
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In an ever-changing world, what are you doing to keep up with the support your students and volunteers need? How are you ensuring the space you're creating is enough? This presentation explores the connection between fisheries science, educators, and civic engagement and how crucial it is to create a more welcoming environment. This presentation is insightful for folx wanting to learn about the retention and recruitment of diverse individuals and how to best support them in natural resources fields. I'll provide insight and examples on how professionals can work towards achieving a more inclusive and equitable workplace and outdoor environment for students, volunteers, and professionals. Language use that are more culturally inclusive and sensitive, ethical concerns behind the various approaches to the skills presented will be addressed. I'll also share insight on some of the challenges individuals may have to succeed in their fisheries career or be civically engaged.

The Role Volunteerism in South West Oregon Fisheries – A look forward at the Oregon Department of Fish and Wildlife's Salmon Trout Enhancement Program in the Umpqua River Basin
Evan Leonetti
Oregon Department of Fish and Wildlife

The State of Oregon realized an idea about 40 years ago that the public needs to be involved fisheries resources in their state in order to instill the value of those resources into the public. The Salmon Trout Enhancement Program (STEP) was enacted in 1981 to do just that. Fisheries management has significantly changed since that time and will likely continue to adapt into the future. It's important that STEP change, however there are serious challenges to do so.

Where do they go when the flow is low?
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Headwater streams in the coastal range of Oregon are fed predominantly by rainfall and ephemeral snow, causing intermittency of stream flow later during the dry season in summer. This intermittency of flow may create fragmented habitats, affecting freshwater animals. Yet, the importance of features within pool habitats as refuge for salmonids during low flow events remains overlooked. Here, we PIT tagged over 600 Coastal Cutthroat Trout in a small headwater stream in Western Oregon before the dry season and monitored movement of animals on a weekly basis using mobile tracking surveys. We observed the largest drop in detection rates of tagged trout during the annual flow minima. It is assumed that trout have nowhere to go when there is disconnect of flow in the stream reach. We hypothesized that trout may have burrowed into the sediment or beneath

boulders to cope with seasonal low flow, resulting in a lack of detection. Here we provide results of an experimental procedure that involved burying tags at various depths and under varying substrate compositions in a stream to provide evidence of the feasibility of our hypothesis.

Conservation Engineering in Eastern North Pacific Groundfish Trawl Fisheries
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In eastern North Pacific groundfish trawl fisheries, minimizing catches of constraining species, ESA-listed species, and improving catch composition has increasingly become a priority to fishers and management. Thus, developing techniques that can improve trawl selectivity would be beneficial to fishers (e.g., increase their net economic benefits, and improve their fishing efficiency), coastal communities, the resource, and ecosystem. In this presentation, research activities including evaluating off-bottom sweeps of a bottom trawl and its influence on demersal groundfish catches and seafloor interactions, the effect of artificial illumination on Chinook salmon behavior and their escapement out of a Pacific hake midwater trawl, and testing of a Pacific halibut bycatch reduction technique will be presented.

Successful Fish Habitat Restoration on a Private Ranch, Demonstrated by Intensive Monitoring
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Documentation is very important in recruiting new agricultural landowners for restoration efforts. Engaging small, local landowners especially ranchers can often be a limiting factor to some of our watershed-scale restoration work for improving riparian habitats. In fact, some ranches are those most in need of restoration, and some ranchers the most resistant to restoration. Throughout coastal Oregon watersheds and specifically in the Umpqua Basin there is a lack of scientific data that shows the effectiveness of instream and riparian restoration best management practices (BMP) in high intrinsic, low gradient, coho bearing streams that run through agricultural ranch lands. The Partnership for the Umpqua Rivers had a unique opportunity to demonstrate BMP effectiveness in one of the most highly degraded streams in the basin. Careful pre-project planning allowed us to establish an intensive monitoring program measuring many parameters that are indicating the success of the project in ways that can demonstrate to other ranchers the benefits of participating in such projects. The Rice Creek Effectiveness Monitoring project is collecting scientific data on water quality, stream processes, and macroinvertebrates before and after a full suite of restoration applications were implemented, including, fish habitat structure placement, livestock exclusion fencing, and riparian restoration. By partnering with an extremely willing and gracious landowner, ODFW, BLM, and DEQ using the most suitable and approved protocols for all parameters monitored, we are documenting pre/post changes in both water quality and fish habitat quality throughout the treated stream reach. Monitoring will result in the distribution of the scientific documentation of the results of this effort. Monitoring was started three years before the project and has now continued for three years of post-project completion.

Ghostbusting: Habitat Selection Theory, Restoration, and the Ghost of Competition Past

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Habitat selection theory is frequently employed to study density dependent habitat selection, but it is not commonly used in studies of fish habitat restoration efficacy. A theory driven approach enables inferences across a range of population densities, rather than from single comparisons of mean density across habitat types. Additionally, habitat selection theory can provide important insight when restoration is targeted at more than one species and overlap is likely to occur in improved habitat. Here we used isodar theory, which describes density dependent habitat selection, to confirm similar habitat preferences for restored habitat in two juvenile salmonids. We then used isoleg theory, which describes habitat selection strategies of more than one species, to project conditions of habitat partitioning/overlap. We found that juvenile Chinook salmon (*Oncorhynchus tschawytscha*) behave as habitat specialists whereas steelhead trout (*O. mykiss*) are generalists. Resource selection functions showed that habitat partitioning was modulated by pool depth. In shallower, unrestored pools, steelhead occupied the whole range of depth values, whereas Chinook specialized on deeper habitats. In habitat restored with engineered log jams (ELJs), steelhead were more abundant in the shallower pools and Chinook in deeper ones. We further confirmed that this was evidence of the "ghost of competition past" in restored habitat via a mark-recapture experiment showing that the interference of Chinook immigration/settlement by steelhead that occurs in unrestored habitat was absent in ELJ-enhanced pools. The demonstrable competitive effect in unrestored habitat with clearer partitioning in restored habitat, in effect, "busts" the ghost. This combination of behavioral theory with observational and experimental data allows a robust understanding of the effect of habitat restoration on competition.

Promoting Dialog about Science within our Communities

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The process of science is an important and critical link to protecting our planet today and in the future. Moreover, for those who work in science, the methodology of discovery is part of our psyche. In recent years, our communities have become especially polarized over the role of scientific analysis and understanding, and how science can be used to protect us and the environment. We have many citizens that deny human related climate change, reject basic understanding of disease transmission, and have disregard the influence of air and water quality on human and environmental health. We need to find ways to reach out to break down these barriers that have been erected. These barriers are even more cemented in the past year because of forced isolation due to COVID-19. To move forward, we must begin to work on simple respectful communications and begin what

will be a slow process. I suggest potential ways to begin to engage using examples within our community such as programs within the schools, churches, community based outdoor activities, art and musical events.

Are contemporary timber harvest practices modifying the structure of stream food webs?

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Between 2006 and 2016, the 10-year Trask River Watershed Study was conducted in the headwaters of the Trask River near Tillamook, Oregon to observe the effects of contemporary forest harvest practices on aquatic ecosystems. Recently, it was observed that community factors such as species omnivory, along with geophysical factors including basin size and gradient are strongly associated with variation in food web structure and connectance. Based on these findings, our work will assess the temporal variation in food web structure and potential impacts before and after disturbance events. Specifically, we are focusing on potential changes between pre-and-post timber harvest years at sites with different treatments (full riparian buffer, thinned riparian buffer and clearcut). Quantitative metrics including connectance, linkage density and characteristic path length, will be extracted from modeled food webs. These metrics can provide insight to aquatic community resiliency, recovery rates and the ability to withstand varying levels of harvest disturbance intensity. Through these analyses, we hope to inform decisions in forest management practices in relation to treatment intensity and how stream community composition may influence biotic structure and processes following a disturbance.

Willamette River Basin Water Quality

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Oregon's Willamette River Basin is the hub of the state's population and economy with 70% of the state's population and 75% of the state's employment, but only 12% of the state's area. Water quality monitoring data shows that the Willamette River is cleaner today than it has been in many decades. Despite this progress, many challenges remain, including controlling non-point source pollution from land use and cleaning up contaminated sediment in the lower reaches. Water temperature exceeding criteria to protect cold-water fish species is the most extensive water quality impairment in the basin. Global climate change and continued human population growth in the basin will likely present complex challenges to improving and maintaining water quality.

Effects of parasitic copepod infection on saltwater transition of juvenile Chinook salmon
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Anadromous salmonids rearing in in Upper Willamette Valley Reservoirs reportedly experience greater growth rates and have better body condition relative to conspecifics rearing in riverine environments. The larger size and better condition of these fish is believed to confer an advantage during migration to and entering the ocean. However, reservoir rearing fish are also known to experience severe infections by a native, freshwater parasitic copepod, *Salmincola californiensis*. The effects of this parasite on juvenile salmonids transitioning to saltwater are not fully understood. We experimentally infected juvenile salmonids by exposing them to the infectious stage of the parasite. We then conducted three saltwater challenges by exposing experimentally infected fish and control fish in 34 ppt saltwater for 24 hours. Copepod infection prevalence and intensity of the experimentally infected fish was slightly less than observed in wild salmonids in Willamette Valley reservoirs (4 vs. 6 adult copepods per fish). Nonetheless, experimentally infected fish experienced relatively high mortality (10%) prior to initiating the saltwater challenges. Necropsies revealed significant gill damage due to juvenile copepodid stages that cannot be readily observed in the field. During the saltwater challenges, we found that groups of juvenile Chinook salmon exposed to *S. californiensis* copepodids experienced high mortality rates (44.4%) compared to groups of control fish (4.8%). A significantly greater percentage of copepod exposed fish (40%) also could not regulate plasma Na+ concentrations when transitioned to saltwater compared to control fish (13%). The negative effects of copepodid exposure on juvenile salmon ability to transition to sea water also lasted up to four months since initial infection. Our findings indicate that the performance, survival, and saltwater transition of juvenile Chinook salmon is negatively affected by exposure to the parasite *S. californiensis*.

Salmon survival and selective mortality: Selection for faster growth prior to marine entry in juvenile Interior Columbia River Spring Chinook salmon
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Size selective mortality (SSM) is a process by which individuals within a population experience differential survival based on size or growth. Besides providing evolutionary and ecological insights, understanding SSM is essential to implementing management actions. Early marine residence is a critical period in Chinook salmon (*Oncorhynchus tshawytscha*) during which SSM occurs. Larger, faster growing fish, therefore, may have a survival advantage. It is also likely that size and growth prior to ocean entry affects survival. Using otolith analysis, we determined if, and when, SSM of juvenile chinook salmon occurs in the lower Columbia river, estuary (LCRE), and during early ocean residence. In 2016 and 2017 we successively sampled four sites in the LCRE, and coastal waters off Oregon and Washington to follow a cohort of yearlings from the Interior Columbia River Spring

Chinook stock group (determined by genetic stock identification). The two years examined exhibited contrasting environmental conditions. River conditions were more favourable for salmon survival in 2017 than in 2016, however overall survival as indicated by smolt-adult returns was lower in 2017. To examine size selection, we compared fish size on the same calendar day across sites. To examine growth selection, we compared growth rates over the two weeks prior to ocean entry which was inferred from otolith microchemistry. We found no evidence for size selection in either year. We did find evidence of growth selection during early ocean residence in 2017. In 2017 individuals which grew faster in freshwater were more likely to survive early ocean residence. There was no evidence of growth selection within the LCRE in 2017 or anywhere in 2016. These results indicate that in the years investigated, fish which were growing faster in freshwater are more likely to survive when overall survival is lower. Actions which promote growth in freshwater are likely increase survival of Chinook salmon during the early ocean residence critical period.

Identifying the upper most fish in streams

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The management of species that occur in low densities is a conservation concern worldwide across taxa with consequences for managers and policymakers. The distribution boundary at the upper extent of fish in North America receives extra attention because stream reaches with fish are managed differently and often have more protections than fishless reaches. Here, we examine the relative reliability of water environmental DNA (eDNA), polymerase chain reaction (PCR)-amplified for Coastal Cutthroat Trout (Oncorhynchus clarkii clarkii) to detect the upper extent of fish across streams as a potential management tool compared to standard electrofishing methods. We provide estimates of fish detection probabilities from eDNA analyses, and probabilities of detection for both eDNA field samples and quantitative PCR (qPCR) given covariates of habitat characteristics and fish densities from electrofishing. We present a primer and probe based on the cytochrome oxidase I gene using qPCR to detect trout DNA across water samples from 60 forested streams in the Pacific Northwest, USA using high-resolution spatial sampling. In 28% of streams, the upper extent of fish matches between methods. In over half of the streams, Coastal Cutthroat Trout eDNA was detected above the electrofishing last-fish boundary. Although some detections could be attributed to false-positive errors, eDNA results extend the upstream, leading edge of fish by 50–250 m from the electrofishing boundary. In 20% of the streams, detections of last-fish occurred higher in the stream network with electrofishing rather than eDNA, but generally by only 50 m. Modeled results revealed that the occurrence of trout eDNA was higher in wider-stream locations, and that eDNA detections occurred at lower electrofishing densities (<5 trout per 50 linear m). We also showed that three replicate eDNA samples were sufficient to capture trout eDNA when eDNA was present. Although eDNA constitutes an effective addition to approaches to delimit the upper extent of fish, its effectiveness depends on previous knowledge of the last-fish boundary to apprise where to start sampling and targeting fish species anticipated to be last-fish. We present evidence that eDNA is a valuable tool in investigating fish distributions taking its place alongside traditional high-effort catch-release tools.

More Than a Tradition: A tribal perspective on salmon recovery and treaty rights in the face of an uncertain climate in the Columbia River Basin

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In the face of climate change, the co-management of threatened, endangered, or at-risk natural resources is growing more complicated. For indigenous nations, natural resource management actions (past and present) have had significant impacts on the fundamental components of subsistence, ceremony, economy, and identity. While the "duty to consult" indigenous nations has not always been historically honored, the relationship between indigenous and non-indigenous sovereigns and stakeholders is improving. However, an inherent challenge for many indigenous nations is the complication of false equivalencies related to "fair-play" and compromise in the context of recovery. For most indigenous nations, resource losses are a direct consequence of the resource gains of non-indigenous counterparts. In other words, they have already given or ceded rights to the benefit of non-indigenous nations and citizens. This is one tribal perspective that exists within the Columbia River Basin. My goal in this presentation is to highlight perspectives and baselines of four treaty tribes in the Columbia River with respect to treaty rights, mitigation, recovery, and co-management of salmon and steelhead. It is essential for fisheries professionals to understand historic baselines when engaging with indigenous nations, as historical gain/loss balances weigh heavily against them, and a rapidly changing landscape and climate will likely exacerbate natural resource conflict in the future.

Willamette Instream Flow Project: Integrated tools for the evaluation of alternative flow management strategies

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The Willamette River has been altered by impoundments, flow regulation, and human land development, which has affected fluvial-dependent fishes, such as federally threatened spring Chinook salmon Oncorhynchus tshawytscha and winter steelhead O. mykiss. We developed an integrated decision support tool that incorporates flow, habitat, and temperature models with ecological models for predicting the response of Chinook salmon and winter steelhead to alternative flow regimes. We use the integrated model to identify the optimal distribution of streamflow through time for maximizing (1) the number of Chinook salmon redds with eggs that survive to emergence; (2) the number of juvenile Chinook salmon and (3) steelhead smolts surviving to passage at Willamette Falls; and (4) the number of age one steelhead. We then use the model to predict the response of salmonids to four alternative flow regimes. Preliminary modeling results suggest that the optimal distribution of streamflow varies by life history stage. Sensitivity analyses of the models indicated that the models were most sensitive to water temperature and variation in survival rates and passage timing. These key uncertainties can be reduced within an adaptive framework where

decision support model components are iteratively improved to gain better understanding of the mechanisms linking flow management actions to fish response.

Detailed Description of the Willamette Valley and Puget Lowland Ecoregions – Past, Present, and Future

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Natural conditions in the Willamette Valley and Puget Lowlands region has changed dramatically since 1840-1850 where land use changed from subsistence hunting and fishing with minimal agriculture as practiced by Native tribes to widespread agriculture, mining, forestry and permanent settlements introduced by European and Early American settlers. This transformation includes the elimination of beaver populations due to trapping and commercial interests that profoundly transformed the landscape from a complex, multi-habitat, floodplain system to a more simplified river channel network to allow for the transportation of goods and the reduction of flood risk to protect permanent ports and towns and foster European style farming practices. To a large degree, the 1850s marks the end of the beaver-dominated landscape but is before the landscape had been unalterably transformed by agriculture, mining and forestry. The objective of this exercise was to gather as much information as possible about historic freshwater stream habitats and biological communities within the Willamette Valley and Puget Lowlands ecoregions, and to track how conditions have changed over time. The focus was on smaller streams (drainage area <100 mi2), spanning from low gradient, valley bottom streams to high gradient, foothill streams. This retrospective look back in time was used to inform magnitude of change that has occurred in the macroinvertebrate and fish communities as a response to the human stressor gradient. We also included information about fish because they play such a critical role in aquatic ecosystems in the Pacific Northwest. An obvious question is how might historical information on stream habitat and land use be applied today? Clearly, it is not possible to return to the land cover and land use conditions that existed before European settlement occurred. A clear understanding of historical conditions, however, provides a powerful tool for understanding the context of the biological communities found in streams today, and the factors that may be limiting their health and/or recovery. Also, a comparison of historical conditions with those found today can help guide future efforts in restoration and protection.

Does Accounting for Short-Term Population Dynamics Improve the Use of No-Take Marine Reserves for Fishery Management?

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Populations in no-take marine reserves can serve as a reference point to determine the status of exploited stocks as they build back up to an unfished state. One method developed in the past decade uses the ratio of fish density outside to inside the reserve to serve as a proxy for depletion. From this, we can determine catch based on control rules. The density ratio is especially useful because it does not require a long time series of catch and abundance data and can be applied at a local spatial scale more appropriate for smaller or recreational fisheries. Two limitations to the original method include failing to account for short-term transient dynamics – which dominate as the stock transitions from a fished to an unfished state following protections and are distinct from the long-term, unfished dynamics – as well as uncertainty in natural mortality, recruitment, and sampling. Using age-structured spatial population modeling of Black Rockfish (*Sebastes melanops*) and other commercially and recreationally important Oregon fish species, I explored the extent to which taking these factors into account helps to determine consistent, sustainable catches following the implementation of a no-take marine reserve. On average, control rules that take transient control rules into account result in higher biomass and yield, but these differences may be washed out with the incorporation of stochastic recruitment and observation error.

Engaged or Enraged? Considerations for planning and conducting community-engaged fisheries research

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Novel research activities are critical for understanding changes to fisheries, ecosystems, and the human communities that are coupled to them. However, determining how to best conduct this research, what questions are most important, what counts as appropriate data, and who is positioned as "expert" can often result in disagreement between managers, scientists, and fishers who are involved in the process. Further, research activities, the knowledge it produces, and the management decisions it informs all have the potential to act as unintended disturbances to fisheries communities and their dynamic relationships with scientists and managers. To help reduce the potential for unexpected or counterproductive shifts in these existing connections, and to create knowledge that is applicable to local needs, we propose a series of questions for scientists to consider when planning their work. These questions are grounded by the needs of fisheries communities and guided by the professional obligations of fisheries science. We provide a theory-driven approach to suggesting best practices and apply them to existing and forthcoming examples of community-engaged research of fishers on the Oregon Coast. We end by proposing that engaging local expertise is a way to gain buy-in to research projects, ensure that findings are returned to communities, and improve the scientific project itself. These questions are guided by the principle that all stakeholders make decisions for the safety and cultural continuity of their communities in the face of an uncertain future.

Remote sensing of wetland habitat with multisensor drone technology

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Tidal wetland habitats critical to endangered juvenile salmon recovery efforts are complex topographic and floral communities. Society has committed significant funds toward restoration of these habitats degraded by years of anthropogenic impacts. Yet until recently, the means to comprehensively monitor and evaluate the outcomes of restoration actions has been lacking. Our project has been working with remote sensing technologies deployed on low altitude uncrewed aerial vehicles (UAVs) to solve this problem. The protocol is designed to fuse plant species identification (using an imaging spectrometer and ground-truthed "spectral signatures" of taxa) with fine-scale topographic measurements (by LiDAR and high resolution RGB orthomosaics). The fusion of these remotely acquired data streams not only enables the rapid and comprehensive identification of complex wetland plant communities, but the topographic information allows species distributions related to tidal inundation to be precisely mapped. Taxa-specific metrics of interest can be extracted from the data sets to evaluate project status, for example incidence of invasive species. Repeated surveys over selected time periods will lend insight toward taxa-environmental functional relationships as restoration projects evolve (the restoration trajectory). This crucial element can foster improved ecological engineering techniques and focus management priorities. Examples from restoring and reference wetlands in the tidal freshwater lower Columbia River are provided.

Pacific Lamprey Dam Passage Study at Leaburg Dam – McKenzie River, Oregon.

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Counts of adult Pacific Lamprey passing Leaburg Dam have been recorded since 1970, but no information existed regarding the efficiency of the counts or efficacy of ladders to pass lamprey. In June 2019, we double tagged (radio/PIT) 26 and radio tagged 3 additional Pacific Lamprey then released them directly below Leaburg Dam. We tracked lamprey movement through July 1st, 2020 using video monitoring stations and PIT-tag detection antennae installed in the fish ladders on each side of the dam, stationary tag detection sites upstream and downstream of the dam, and mobile tracked them by foot or drift boat throughout the McKenzie River Basin. This project was highly collaborative and reliant on volunteers and engagement from the community. The project was supported by Eugene Water and Electric Board, the Confederated Tribes of the Grand Ronde (lamprey collection at Willamette Falls), the U.S. Army Corps of Engineers, landowners (detection stations), Cascade Family Flyfishers, hatchery staff from Leaburg and McKenzie hatcheries (read video 2019-2020). ODFW hired a local fishing guide (Aaron Helfrich) to float the McKenzie River and the Salmon/Trout Enhancement Program (STEP) trained 27 volunteers to build lamprey traps and/or radio track lamprey. Crews floated from Frissell Boat Ramp (Rkm 114) to Armitage Park (Rkm 0) monthly December 2019 – July 1, 2020. An emergent goal of this project was to engage and

educate the local community about Pacific Lamprey. The effort generated newspaper articles in McKenzie River Reflections (June 4 and 11, 2020) and a television news interview (NBC16 KMTR). Results: 15 of the 29 radio-tagged lamprey (51.7%) passed Leaburg Dam. 5 later detected in the South Fork in or upstream of the U.S.Forest Service's 201-2019 Stage-0 restoration project. 80 lamprey were observed on video June 13 - August 25, 2019. 77 (96.3%) were detected in the Vertical Slot design ladder and three in the Half Ice Harbor design. It doesn't appear that Pacific Lamprey have issues navigating the Vertical Slot design. Farthest upstream detection was in the South Fork Rkm 93.5 (37.5 km upstream from Leaburg Dam). No tags detected in the mainstem McKenzie upstream of the South Fork confluence (Rkm 89). No detections in major tributaries that we surveyed other than the South Fork.

Stream food web responses to riparian thinning in second-growth redwood forests

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Resource managers are actively thinning second-growth forests in the redwoods of coastal Northern California to accelerate the recovery of old-growth forests. These forest restoration practices have largely taken place in upland forests to date and now there is an interest in thinning second-growth forests in riparian zones. In this study we evaluated the effects of riparian forest thinning in a watershed-scale manipulative field experiment following a Before-After-Control-Impact design. We hypothesized that experimental thinning treatments would increase solar radiation and these increases in light would then increase the abundance of stream periphyton, which in turn would influence the seasonal and spatial dynamics of the food webs supporting stream fish and amphibians. To test these hypotheses we measured: stream periphyton abundance and the macroinvertebrate communities in the diets of top predators occupying these streams - coastal giant salamanders and coastal cutthroat trout. In this presentation we share preliminary results on how stream food webs responded to thinning. Data from this study provide a whole-system, mechanistic understanding of how the food webs that link streams and riparian forests may shift in response to proposed forest restoration actions in second-growth riparian forests.

Skim, 1%, 2%, or full fat? How ocean temperature and productivity influence Black Rockfish (*Sebastes melanops*) body condition

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The California Current Ecosystem is highly dynamic, driven not only by natural climate oscillations and seasonal upwelling but also by anthropogenic, directional climate change. Extreme anomalous events such as marine heat waves are predicted to occur with increasing frequency and intensity. Our study investigates (1) how these ocean processes influence Black Rockfish (*Sebastes melanops*) body condition on interannual and seasonal scales and (2) potential time lags between environmental drivers and biological response. We collected muscle tissue samples from Black Rockfish caught on recreational fishing charters off the central Oregon coast from June to October of 2015 to 2020. Body condition was quantified using proximate analysis as the percent fat in muscle tissue. Using generalized additive models in a hierarchical modeling framework, we predicted body condition response to sea surface temperature (lagged 0-6 months), El Niño-Southern Oscillation (seasonal and lagged 0-12 months), and coastal productivity associated with upwelling (lagged 0-6 months). Results of this study provide insight into a fitness-related response of Black Rockfish to environmental conditions that may be scaled up to population productivity under various climate change scenarios.

Clean Water Act Cliff's Notes: What the law covers and implications of the recent changes

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The Clean Water Act was passed some 48 years ago in 1972. For most of our AFS members, this law has been around for their entire lives. The CWA's purpose is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Recent changes to key portions of the act have the potential to dramatically affect biologists' ability to manage waters in the United States, especially in more arid regions like eastern Oregon. This 15-minute crash course will cover what the Clean Water Act is, what parts are in flux, and what may change in your regulatory authority and project planning now that the proposed changes are being enforced. We will also cover what you can do to voice your professional opinion on the changes to decision makers who may be able to revise or rescind the changes.

Web-based mapping tools for characterizing estuary habitats on the West Coast

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The Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) has created an integrated spatial data framework from a diverse array of estuarine datasets. The resulting web-based mapping tools give restoration practitioners, resource managers, and researchers the ability to characterize habitats and synthesize information from a wide assortment of sources in support of habitat conservation and restoration goals. The tools provide easy access to compiled information on estuaries of California, Oregon, and Washington, including the Salish Sea. Data themes in the framework include current and historical estuary extent, estuarine biotic habitat (including eelgrass) extent, presence data for fifteen focal fish species, an indirect assessment of tidal wetland losses including restored areas, and risk to fish habitat degradation. This presentation will include a demonstration of PMEP's tools to show how users can explore and filter data, on a regional scale, for conservation and restoration planning and management, and also on a local scale where specific planning site information may be limited.

Towards a deeper molecular and morphological understanding of Oregon's native non-game fish diversity

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Despite more than a century of detailed study, Oregon's diverse native non-game fishes have not yet yielded all of their taxonomic secrets. Resolution of species-level lineages within Cottidae (sculpins) and Cypriniformes (minnows and suckers) has proven particularly challenging due to widely varying morphologies within nominal species, major geographic gaps in sampling, possible genetic introgression, and other confounding factors. As a result, many nominal species lack clear diagnoses, the available identification keys can be maddening to use, and the true geographic, genetic and anatomical boundaries of species and populations remain uncertain. Indeed, recent studies of two of Oregon's most widespread freshwater fishes (*Cottus rhotheus* and *Rhinichthys osculus*) revealed deeply divergent genetic lineages that suggest the presence of multiple species within each. This presentation outlines a new phase of studies that will link reduced-representation genome sequencing to cutting-edge digital morphometry of museum specimens to investigate the taxonomy of *Cottus* and *Rhinichthys* in Oregon with unprecedented detail. When available, results will have the potential to improve identification keys, refine distribution maps, unravel remaining thorny knots in sculpin taxonomy, and clarify when and how the population of *Rhinichthys osculus* in Foskett Spring came to occupy that remote and isolated body of water.

Water-Quality Diversity and the Effects of Surface-Water Connection in Off-Channel Features of the Willamette River, Oregon

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Water-quality conditions (including temperature) in the Willamette River and many of its adjacent off-channel features, such as alcoves and side channels, were monitored between river miles 67 (near Salem, Oregon) and 168 (near Eugene, Oregon) during summers 2015 and 2016. One or more parameters (water temperature, dissolved oxygen, pH, specific conductance, and [or] water depth) were continuously measured at sites in the main channel (9 sites in 2015; 5 sites in 2016) and select off-channel features (20 features in 2015; 22 features in 2016). Field monitoring was focused on documenting water-quality conditions during low summer streamflows and during fluctuations in streamflow, including when side channels became alcoves and reconnected to become side channels again. Water in the main channel of the Willamette River upstream from river mile 50 near Newberg typically is well mixed during summer, with warm water temperatures (greater than 18 degrees Celsius) and high dissolved-oxygen concentrations (often greater than 7.7 milligrams per liter). During low summer flows, a diverse suite of off-channel features exists adjacent to the main channel of the Willamette River. Despite temporal and spatial variability within individual features, comparison of continuous water-temperature data between the main channel and off-channel features indicated that off-channel features could be grouped as consistently warmer, consistently

cooler, or frequently fluctuating compared to the main channel. Site-specific characteristics including upstream connection, depth, and presence or absence of aquatic or riparian vegetation were factors that seemed to affect the water quality of a feature. Data confirmed that many features that can be classified as cold-water refuges based on water-temperature standards also contained low concentrations of dissolved oxygen that may not be suitable for sensitive fish species. A simplified site classification scheme is proposed that links water-quality conditions in measured off-channel features with site-specific characteristics and summer streamflows.

The Thermal Mosaic of the Willamette River: Patterns and controls on stream temperature and implications for cold-water salmonids

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Thermal conditions are a major limitation to the health and survival of federally protected, cold-water adapted winter steelhead and Spring Chinook salmon in the Willamette River Basin. To better understand controls on stream temperature in regulated rivers, the effectiveness of flow augmentation as a tool to suppress high temperatures, and the implications for threatened salmonids, this study uses a two-dimensional hydrodynamic and water-quality model (CE-QUAL-W2) to investigate spatial and temporal patterns of stream temperature in the upper 160 river miles of the Willamette River across three representative climate years and a series of flow-augmentation scenarios. Key insights into thermal conditions include: 1) the Willamette River generally warms downstream, but the pattern is complex and seasonally variable; 2) major tributaries create thermal discontinuities in the river profile such that the Willamette river upstream of the McKenzie and Santiam River confluences tends to be several degrees warmer than immediately below; and 3) export of heat from Lookout Point/Dexter Dams on the Middle Fork Willamette causes the Willamette River to cool from upstream to downstream in autumn. These and other findings allow the division of the river into four 'thermal reaches' that contextualize temperature data from continuous temperature monitors. Key insights for the health and survival of cold-water salmonids include: 1) adversely warm temperatures are routine in summer and may extend into the uppermost reaches of the Willamette River except in cool, wet years; 2) lethally warm temperatures are less pervasive but may extend well upstream of the Santiam River confluence during heat waves; 3) sustained flow augmentation can reduce the duration and extent of adverse conditions for spring Chinook in the Willamette River, but the effect is modest; but 4) event-based flow augmentation can reduce the duration, extent, and, in certain conditions, occurrence of lethal conditions for spring Chinook in the Willamette River.

Pilot Sea Cucumber Aquaculture Trials in the PNW

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The giant red sea cucumber (*Apostichopus californicus*) is an emerging aquaculture species with substantial economic and ecological value in California, Oregon, Washington State, British Columbia and Alaska. It is the largest sea cucumber species on the U.S. West Coast and the predominant species commercially harvested in the region. As a detritivore it also serves as the "oceans recycler" of nutrients, including kelp detritus and shellfish waste. Declining wild stocks, high commercial value and nutrient recycling ability make *A. californicus* an excellent candidate for aquaculture and enhancement. The Pacific Shellfish Institute (PSI) and its partners have worked for over 5 years to develop aquaculture for this species building on previous work in the field in British Columbia and Alaska. A pilot scale co-culture of sea cucumbers with mussels produced market size individuals using juveniles collected on the mussel farm. Significant progress has been made for establishing preferred food resources for hatchery reared juveniles and the transition of these juveniles into upland and marine trials.

Restoring dynamic tributary channels in the estuarine floodplains of the coastal Siskiyou Mountains

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The Siskiyou Mountains on the southern Oregon coast produce relatively steep river systems with short tidal reaches and naturally small estuaries; where winter rearing habitat is often the key limiting factor for coho salmon. Prior to Euro-American settlement, valuable winter rearing habitat would have existed in tributary channels that ran across the lower mainstem floodplains; often through Sitka spruce swamps in orphaned riverine depressions. By the mid-twentieth century nearly all of this land had been cleared, and the stream channels and swamps were ditched to create livestock pasture or residential development. Restoring floodplain connectivity and dynamic fluvial processes within these High Intrinsic Potential tributaries is now the focus of multiple recovery plans, but the type and scale of restoration largely depends on willing landowners, and our ability to implement projects that maintain and protect their interests (i.e., ranching, farming, residential, etc.). These projects typically require compromises; in some cases, ongoing manipulation of the fluvial and/or biological systems; and nearly always, a long-term commitment to management. This presentation is a case study of a recent restoration project in the Elk River estuary, where ~4,000 feet of ditched tributary channel was modified or replaced with constructed stream channel to restore winter rearing habitat and productive livestock pasture. Past restoration projects at the site had failed to produce lasting results, in part because underlying causal factors were not well understood. This project was constructed in 2019-2020, so it is too early to evaluate its long-term performance, but at a minimum,

it has yielded valuable insight for future estuarine floodplain restoration in the Siskiyou Mountains of the southern Oregon coast.

The road to underestimation of iteroparity is paved with shed PIT tags: Using scales to avoid tag shed bias

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Viability metrics for wild summer steelhead in the interior Columbia River basin are often monitored via passive integrated transponder (PIT) tags that are intra-peritoneally implanted into juveniles. Tag expulsion by spawning females may cause PIT tag-based monitoring of wild populations (which were tagged as parr or smolt) to underestimate iteroparity. To understand the magnitude of negative bias from PIT tag-based monitoring, we have enlisted and trained recreational fishing guides to collect scales from adult steelhead that are caught and released in the John Day River. We used scale pattern analysis to identify re-spawning adults. Coupled with visual classification of the sex of each sampled fish, these data will provide insight into the annual proportion of the John Day River steelhead return which is on a repeat spawning run. These estimates can contextualize and potentially calibrate PIT-tag based monitoring of iteroparity, and ultimately improve life-cycle models and fishery management.

Genetic architecture of migration timing in Chinook salmon

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Chinook salmon (*Oncorhynchus tshawytscha*) display a wide range of migration times which have been grouped into ecotypic life histories. A single region of the genome on Chromosome 28 (Chr28) has been associated with seasonal migration timing between ecotypes, but few studies have investigated how fine-scale genetic variation within this genomic region is associated with run-timing and other phenotypes within the early- or late-migrating ecotypes. We identify fine-scale genetic variation within multiple early-run ecotypes from the Sacramento River basin in California. Mixed effects modelling indicates that genetic variation at multiple locations within the broader, associated Chr28 region influence migration timing within a season. We test those effects across winter-run and spring-run ecotypes, as well as across multiple Central Valley spring-run populations. We also identify two gene regions that may contain modifier genes that further contribute to the most diverse portfolio of migration timing found in the species. Our research furthers the understanding of the genetic basis of migration timing within salmon populations and further elucidates how the Chr28 region influences early-run ecotypes, demonstrating that the region is associated with gross ecotypic differences as well as finer scale, within population migration timing variation. In addition, we demonstrate the Chr28 region functions as a small super-gene with distinct segments additively contributing to variation in migration timing.

Aquaculture Opportunity Areas within a local context

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NOAA has been directed to Identify Aquaculture Opportunity Areas (AOAs) under Executive Order 13921, "Promoting American Seafood Competitiveness and Economic Growth" (May 7, 2020). An AOA is a small defined geographic area that has been evaluated to determine its potential suitability for commercial aquaculture. Over the next several years, NOAA will use a combination of scientific analysis and public engagement to identify areas that are environmentally, socially, and economically appropriate for commercial aquaculture. While the first two AOAs are proposed in federal waters, future ones could be identified in federal or state waters, or a combination of the two depending upon local interest. This talk will discuss the variety of science-based tools and strategies that can support consideration of AOAs within a local context, and help communities thoughtfully consider how and where to sustainably develop aquaculture that will complement wild-capture fisheries, working waterfronts, and our nation's seafood processing and distribution infrastructure.

Utility of Commercial Fish Traps for Lower Columbia River Salmon Fisheries

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The utility of commercial salmonid *Oncorhynchus spp.* traps in the U.S. Pacific Northwest was recently revisited for the first time in decades to enable selective harvesting of hatchery-origin salmonids while reducing mortality of Endangered Species Act (ESA) listed salmonids. Modifications to historical gear designs resulted in dramatic improvements in salmonid bycatch survival rates relative to conventional commercial gears in the lower Columbia River. Expanding upon this work, an experimental commercial fish trap was further modified to largely eliminate net contact, air exposure, handling, and crowding of fishes. Studies were conducted in 2019 and 2020 in the lower Columbia River to estimate survival of bycatch and evaluate potential benefits from the modified passive capture design. Analyzed through two separate survival estimation techniques, the modified trap demonstrated no detectable effect on salmon release survival and a significant improvement over the previous prototype design. Estimated through a paired release-recapture methodology, the relative survival effect of catch and release compared to controls over a 400-km migration was 1.017 ((SE)ˆ= 0.032) for adult Sockeye Salmon *O. nerka*. For adult Coho Salmon *O. kisutch* held captive in floating net pens for a short and long-term post-release period, survival was 1.000 (CI ($S \geq 0.978$) = 0.95) over 48-h and 1.000 (CI ($S \geq 0.975$) = 0.95) over 96-h. These results suggest that trap modifications can be made to significantly reduce bycatch mortality of ESA-listed salmonids and provide increased harvest opportunity for hatchery-origin salmonids.

The Effects of Smallmouth Bass in the Coquille River Basin.

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"Smallmouth bass (*Micropterus dolomieu*) were illegally introduced and first documented in the Coquille River basin by the Oregon Department of Fish and Wildlife (ODFW) during the summer of 2011. This presentation will focus on the change in distribution of smallmouth bass in the Coquille River basin over the past 9 years and the potential impacts they may have on native fish.

A new era of restoration and research for Willamette River floodplain habitats: what we have learned, where we can improve and a vision for the future

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The Willamette River is entering a new era for both the large-scale restoration programs that aim to increase floodplain habitats and the science that inform habitat improvement efforts. Since 2008, major investments by the Bonneville Power Administration, Meyer Memorial Trust, the U.S, Army Corps of Engineers, and the Oregon Watershed Enhancement Board has proven foundational to the improvement of scientific understanding, establishment of large- and small-scale restoration projects, and the development of a community of practice engaged in habitat restoration in the Willamette Basin. As many of these investments begin to sunset, and the future of large-scale Willamette River restoration programs is uncertain, several restoration programs are utilizing practical lessons and new scientific insights to adaptively refine restoration program goals and actions. This process highlights areas where restoration goals and actions could better address critical habitat limitations by utilizing emerging science, but also highlights the many challenges of adaptively refining restoration goals and actions to reflect new science. This presentation will describe ways that scientists could better support adaptive refinement of Willamette River restoration programs through a) stronger partnerships between science community and restoration programs, b) improved reporting of habitat conditions and c) the creation of more platforms for information sharing to establish a common knowledge base of habitat and restoration issues and develop realistic expectations for restoration actions. This talk will draw upon three distinct but closely related sources: a) restoration goals and actions of the Willamette Anchor Habitats Investment Program 2008-2023 b) findings from habitat research and monitoring projects completed 2008-2020, and c) a basin-wide monitoring 'visioning' effort conducted from 2018 through 2020 that included a series of stakeholder workshops. When woven together, these efforts each yield insights that can be used to inform a new era of Willamette River floodplain restoration and research.

Looking beyond the restoration site: Lessons from the Columbia River estuary

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The Columbia River estuary comprises one of the largest habitat restoration programs in the United States. Thousands of acres of former wetlands have been hydraulically reconnected to the mainstem, in part to benefit juvenile Pacific salmon and steelhead. We used a multi-pronged study to document direct and indirect benefits of estuarine restoration for juvenile salmon. Study elements measured: 1) prey production and direct salmon use in tidal wetlands; 2) export of prey from tidal wetlands; 3) consumption of wetland-produced prey by mainstem salmon; and, 4) PIT-tagged salmon using wetland habitats. Our results demonstrated that restored and reference tidal wetlands produced large quantities of invertebrate prey, which were readily consumed by subyearling Chinook salmon occupying wetlands (=direct benefits). Unexpectedly large quantities of wetland-produced prey (chiefly Chironomid insects) were also exported from wetlands during ebb tides. In the mainstem, juvenile salmon (mainly yearling smolts) were actively feeding and growing; dominant prey included species originating from tidal wetlands (=indirect benefits). PIT tag arrays in tidal channels detected juvenile salmon from interior stock groups that may directly benefit from tidal prey production. Overall, our study found that restored tidal wetlands produced large quantities of insects and other invertebrate prey that were consumed by salmon within wetlands but were also are exported to the mainstem where they fueled the growth of interior stocks of salmon. Our results highlight the need to look beyond the restoration site by considering the flux of material exported from productive wetlands. Our study indicates the "footprint" of benefits extend far beyond the restoration site itself, something that is overlooked in assessments of restoration benefits.

Fisheries conservation success in an uncertain future: Evolution towards a human dimensions perspective in the upper Grande Ronde River

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Fisheries conservation successes in an uncertain future will require bridges across socioecological disciplines and fostering connections between scientists, managers, policy makers, and the public. We document an evolving definition of "fisheries conservation success" to include human dimensions—rather than a strictly data-driven approach—through the lens of our work in the Grande Ronde River basin of Northeast Oregon. Despite immense resources directed towards habitat restoration, recovering fish populations remains a daunting and perplexing issue. In 2015, recommendations for a comprehensive approach to habitat restoration in the Columbia River basin were published in Fisheries which included elements of landscape ecology and resilience, broad public support, governance for collaboration and integration, and capacity for learning and adaptation. We convened a working group consisting of local restoration practitioners, managers, and researchers involved in habitat restoration research, monitoring, and evaluation to assess

progress towards meeting these recommendations. We concluded that partnerships and collaborations in governance have been formed and research using a landscape perspective has been integrated into decision-making, but efforts would benefit from gaining broader public support, formalizing an adaptive management strategy, and defining objectives and indicators for biological and ecological diversity. We additionally conclude that those who are willing and able to reach across the science-management and science-public divides will be more effective agents of change thereby achieving success in fisheries conservation.

Predicting patterns and documenting successes in marine protected areas by linking models and data

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Marine protected areas (MPAs) are an increasingly common conservation and management tool worldwide. Typically, managers expect that after fishing ceases inside an MPA, previously fished populations will steadily increase in abundance as they return to unfished levels. However, the expectation of a steady, positive increase in population density inside MPAs is complicated by two factors. First, the expected increase depends on the level of fishing pre-MPA, which is usually unknown, and whether fishing actually stops after the MPA is put in place. Second, high variability in larval recruitment to populations in MPAs, both over time (pulses and droughts) and over space (hotspots and coldspots) makes post-MPA trajectories variable. We use examples from California MPAs to show how we can use mathematical models to address these problems. First, statistical modeling reveals that interannual variability in larval recruitment has a much stronger influence on overall fish abundance at a site than whether that site is protected inside an MPA. However, fitting dynamic models to the same data indicates that the size structure of populations inside MPAs look like unfished populations, while non-MPA populations are heavily fished. Together these approaches reveal the success of MPA design and enforcement, but also guide our understanding of the factors driving fish population dynamics, which can help guide short-term management decisions in an uncertain and highly variable coastal environment.

Where, When, and How Much Juvenile Chinook Habitat is There on the Willamette?

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The Willamette River is home to at least 69 species of fish, including ESA-listed spring Chinook Salmon and winter steelhead. These fish have specific habitat requirements to survive and complete their various lifestages. Water depth, velocity, and temperature are known to be important habitat parameters for juvenile salmonids, and all three are influenced by the amount of streamflow in the river. Streamflow in the Willamette River is largely controlled by 13 USACE dams operated as part of the Willamette Valley Project. To help inform how water released from these dams affects

downstream habitat, USGS has developed high-resolution models of juvenile Chinook and steelhead habitat on the Willamette River between the cities of Eugene and Newberg, encompassing approximately 120km of the river. Several findings have come from these models: 1) habitat is most abundant at high streamflows and least abundant at low and moderate flows; 2) habitat patterns and response to streamflow shows that the Willamette River is starkly different upstream and downstream of Corvallis and 3) temperature, not physical habitat parameters such as depth and velocity, limits habitat availability in summer months. This presentation explores these findings and shares implications for water management and habitat restoration.

Life Histories of Spring Chinook Salmon in the Willamette River

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Juvenile spring Chinook salmon in the Willamette River follow many different life history pathways as they migrate to the Columbia River estuary. We quantified the number of fish following different pathways by sampling and tagging them at sites throughout the basin. Juvenile Chinook salmon were caught with beach seines or at fishways, then implanted with passive integrated transponder (PIT) tags. PIT antennae at sites downstream provided data on migration timing for different groups of fish. The two primary life history types are those juveniles that migrate to the ocean as subyearlings and those that migrate as yearlings. Both types spent some time rearing in the mainstem Willamette River. Growth and migration timing of smolts varied by year, likely from river conditions such as temperature and flow. Adult spawners were sampled for scales, which were analyzed to identify total age and whether they migrated as subyearlings or yearlings. These results provided additional data on life histories, by return year or brood year. The proportions of the two primary life history types observed from scale also varied from year to year, likely because of conditions in the rivers, the Columbia River estuary, and the ocean. Multiple life histories provided a portfolio effect that stabilized adult returns back to the Willamette River. Analyzing observed changes life history expression will provide insights for fishery and water managers in the basin.

AFS and the Waters of the United States Rule

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The 2015 Waters of the U.S. Rule or WOTUS rule sought to clarify which waters were subject the jurisdiction of the Clean Water Act based on the best available peer-reviewed science on the connectivity of waters. During the last Administration, the U.S. EPA and the Army Corps of Engineers replaced it with a much narrower rule based on a legal-policy construct. Ultimately, a narrower rule will allow activities like land development, water resource projects, infrastructure development and industrial expansion to proceed without the safeguards of a federal permit. The proposed rule has serious implications for the nation's streams and wetlands, including headwater streams and millions of acres of seasonal wetlands that provide valuable habitat for many species of

fish especially in the face of climate change. AFS Policy Director Drue Banta Winters will discuss the policy history behind the rule including significant legislative and judicial action or inaction that led to the 2015 rule, AFS' policy efforts to support a science-based rule, the current status of the re-definition, and the Biden administration's plans to reverse the most recent rulemaking.

Habitat Enhancement at River-Reservoir Transitional Reaches

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Reservoirs can experience high anadromous fish utilization despite limited habitat complexity. Often the best available habitat is concentrated at the head of the reservoir and along shorelines where food is delivered, and vegetation provides cover and organic material. As rivers enter reservoirs, a hydraulic transition occurs resulting in velocity attenuation and sediment deposition effectively simplifying habitat features of the original river channel. Hydraulic, geomorphic, food delivery and water quality conditions in this transitional zone can create a favorable setting for spawning and rearing, and therefore a unique opportunity to improve habitat. In September 2020, 15 large wood habitat structures were built in the transitional zone at the head of North Fork Reservoir on the Clackamas River, Oregon. The primary project objective was to design and construct large wood habitat structures that have the integrity to withstand winter high flow hydraulics while (1) emulating natural aggregation of woody material and (2) creating desired habitat cover and complexity to increase utilization of the transitional zone. Post-project biological monitoring showed a near-immediate increase in adult anadromous salmonid use. Other observed physical changes at many structures included additional natural accumulation of small and large wood materials, as well as localized shallow scour and fill. The project gives promise for similar applications in other reservoirs to increase long-term fish habitat and use in river-reservoir transitional reaches.

Posters

Clarifying *Clarias*: Sorting out taxonomic confusions within a cryptic genus

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Many fishes in Subsaharan Africa are poorly researched and described, including catfishes of the genus *Clarias*, a diverse group with a maddeningly confusing taxonomy. This cryptic genus was last revised in 1986, but this work did not yield a generally useful identification guide to the species level. To help resolve that problem, we provisionally identified approximately 200 specimens of *Clarias* collected in Gabon using the most recent identification key and compared those identifications to the clustering of 20 of the same specimens in a cytochrome oxidase I (COI) phylogeny. There was a significant mismatch between the morphological and genetic species sorting, suggesting that the current key does not identify genetic lineages reliably. The next step of this project will investigate and establish which morphological traits can accurately determine the species of *Clarias* found in Gabon.

Delineating the species boundaries for two freshwater sculpin fishes, the Riffle Sculpin and Reticulate Sculpin

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Sculpins of the Pacific Northwest (genus *Cottus*) are a diverse group of bottom-dwelling fishes that occupy nearly all freshwater drainages. Although our understanding of sculpin diversity has progressed considerably over the last century, many species-level designations remain unresolved due to overlapping morphological traits and meristic characters between putative species. Consequently, sculpins in scientific studies at the species level are lacking, and field identifications prove challenging when included, potentially leading to misidentifications and erroneous conclusions. With reliable diagnostic characters, several sculpin species can be available for a multitude of scientific inquiries. For example, when present in streams, sculpins are typically the dominant vertebrate group and support several ecological links within freshwater food webs, including predator-prey interactions with juvenile and adult salmonids and from benthic arthropods to piscivores. They can also serve as short- and long-term stream health indicators due to their abundance and acute sensitivity to water pollutants and low oxygen environments. Two sculpins with unresolved species-level boundaries, and wide-ranging distributions in the Pacific Northwest, are the Reticulate Sculpin, *Cottus perplexus*, and Riffle Sculpin, *Cottus gulosus*. This presentation reports the latest effort to delineate this species complex using the latest genetic and morphometric tools.

Are there differences between temperate and tropical marine reserve effects?

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Fully protected marine protected areas, or marine reserves, need to be monitored to increase our understanding of what reserve characteristics have the greatest effect on biological responses in order to sustainably manage fished populations. Lester et al. 2009 performed a comprehensive, global meta-analysis exploring the biological effects of marine reserves and found that marine reserves have a strong positive effect on biomass, density, organism size, and species richness. We performed a follow-up meta-analysis of marine reserve primary literature to calculate the percent change in biological effects of populations in and around marine reserves in the Pacific Ocean and compared temperate and tropical reserves. We extracted the change in biomass, density, organism size, and species richness from peer-reviewed journal articles that monitored marine reserves. Our results demonstrated that the largest percent change was in biomass but did not find it to be statistically significant. Finally, similar to the Lester global analysis, we found there was no statistical difference between the biological effects of temperate and tropical reserves in the Pacific Ocean.

Thunder Struck – A June Thunderstorm Triggers a Massive Downstream Salmonid Migration Pulse

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Biologists often speculate that extreme rain events may trigger extreme downstream migration of fish, but rarely get to sample it due to dangerous flow conditions and damaging amounts of debris which clog sampling gear. We had a serendipitous opportunity to sample such an event, and document that the downstream movement of juvenile salmonids was an order of magnitude higher during the brief event than before or after it. The fish captured included steelhead (*Oncorhynchus mykiss*), spring Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and brown trout (*Salmo trutta*). The thunderstorm event was accompanied by nearly 2 inches of rain which fell mostly within 30 minutes in the upper North Umpqua River basin, causing rapid runoff and surface erosion during the afternoon and evening of June 20, 2018. Although the flow increase was modest (from 90 to 150 cfs in Fish Creek, and 900 to 1,200 cfs in the North Umpqua) and water temperature dropped only 1 degree, turbidity increased drastically from a background of <1 to a peak of 27 NTU within the mainstem North Umpqua River. Debris immediately plugged our Rotary Smolt Traps, but our Fish Evaluation Building was operated throughout the event by a crew of 6 people working feverishly to pass debris and fish in real time. Downstream fish migration increased and then decreased directly with turbidity. Spring Chinook salmon parr were excellently camouflaged in the turbid water. Whereas few fish were normally caught in the daytime, and the nighttime catch during adjacent weeks was under 1,000 fish, the catch on June 20 from 1500 to 2400 hours was over 12,000 fish. This one-date catch comprised about 1/3 of all the fish captured at that site between April and December 2018.

Sampling Efforts for Estimating Fish Species Richness in Western USA River Sites

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Fish species richness is an important indicator of river ecological condition but it is particularly difficult to estimate in large unwadeable rapidly flowing rivers. Intensive multi-gear sampling is time consuming, logistically complex and expensive. However, insufficient sampling effort underestimates species richness and yields inaccurate data about the ecological condition of river sites. We raft-electrofished 10 large river sites in 10 different ecoregions and six western USA states for distances equal to 300 times their mean wetted channel widths (MCWs) to estimate the effort needed to approach asymptotes in fish species richness. To collect 90% of the observed fish species at the sites, we found that an average of 150 MCWs (ranging 80-210 MCWs) were needed, with the number of MCWs increasing in rivers with a higher proportion of spatially rare species. Frequently, the second or third additional 100 MCWs produced only one or two additional singletons or doubletons (species occurring only once or twice at a site). Before initiating sampling programs for estimating species richness, we recommend assessing sampling effort, particularly if rare or uncommon species are expected or desired.

A GIS-based approach to Instream Flow Study site selection for Oregon streams

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The Oregon Department of Fish and Wildlife (ODFW) Water Quantity and Quality (WQQ) Program has developed a GIS-based site selection approach to identify potential streams for Instream Flow Incremental Methodology (IFIM) studies. The WQQ Program conducts IFIM studies annually to determine water quantity needs for fish (in cubic feet per second of flow), which are ultimately used to apply for new Instream Water Rights (ISWR). Selecting potential sites for an IFIM study is a time consuming and complicated task due to a need to evaluate multiple decision criteria. Benefits to fish populations and the potential to keep water instream are evaluated at numerous prospective study sites exhibiting a range of physical, hydrologic, and land use characteristics to identify streams with the greatest benefit from ISWRs. A GIS platform is an ideal tool to evaluate sites as it allows for multiple readily available spatial datasets to be combined and efficiently compared between potential streams. We use information found in the National Hydrographic Dataset, Oregon Water Resources Department (OWRD) downloadable data, and ODFW feature classes to compile site-specific data and prioritize sites based on program and department goals. In 2020 we used this tool to identify streams in the Rogue and Mid-coast watersheds. We identified 944 sites suitable for IFIM studies based on fish presence, lack of a current ISWR, and capacity to model site characteristics. Of those sites, 93 ranked highest based on the number of salmonid species present, available water for ISWR applications, existing land and water use, and site accessibility. This selection approach is a useful initial screening tool to evaluate and communicate high values sites, expert knowledge, and reconnaissance aids in determining final study streams for new instream water rights.

Using State-Space Models to Reduce the Sensitivity of Fishery Assessments to Hypoxia

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In recent years, there has been an increase in episodic coastal hypoxia along the mid to inner-shelf waters off the Oregon Coast. Wind-driven coastal upwelling events have been shown to affect the magnitude of these hypoxic events, reaching levels of severe hypoxia (<0.5ml l-1) along the continental shelf. Consequently, these events have the potential to impact the spatial and temporal distributions of nearshore species. Fishery-independent trawl surveys along the Pacific Northwest have reported low fish catch for a variety of demersal species overlapping with hypoxic events. These absences could reflect a behavioral response to severe hypoxia that drives species displacement, or that hypoxic events may be affecting the mortality rates of nearshore species. This uncertainty impacts the ability of fishery managers to accurately assess stock levels in a changing climate. I am fitting a state-space models to fishery-dependent and fishery-independent datasets to quantify how hypoxia affects the detectability of nearshore groundfish, specifically, Lingcod, Yellowtail Rockfish and Greenstriped Rockfish. The model structure is a state-space integral projection model that uses a Markov Chain Monte Carlo (MCMC) algorithm to estimate model parameters. The key parameter we are estimating describes the probability of non-detection of fish as a function of dissolved oxygen concentrations. Simulations have demonstrated that the model is able to estimate the non-detection parameter. Estimating this probability will provide a way to account for false negatives in fishery assessments by reweighing survey data to account for hypoxic conditions. Results from our work could be exported to formal stock assessment models to provide more robust assessments in the face of increasingly frequent hypoxic ocean conditions.

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

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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 will test the stereo-video system during fall recreational charter surveys with two separate collaborators, the ODFW Marine Reserves Program and The California Collaborative Fisheries Research Program. During these surveys, we will record via stereo-video all fish caught during the charter trips. We will then compare the accuracy and total effort of the stereo-video methodology against traditional methods of collecting size, length, and species composition data. If stereo-video proves to be more efficient in terms of effort, and/or significantly increases the accuracy of bycatch data, we will then evaluate stereo-video as an electronic monitoring tool in the recreational fishery itself.

Evaluating the explanatory value of instream habitat variables for assessing fish populations in Tongass National Forest

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Instream habitat parameters are routinely collected during stream surveys and provide valuable insight into the substrate and habitat type that is available to resident and anadromous fishes for both spawning and seasonal holding. The number of high-quality stream survey parameters that can be measured in a season is limited by training, time, and funding. Therefore, it is important to determine which are the most useful parameters to measure in the field. We analyzed more than 30 instream habitat parameters collected coincident with fish sampling using a 4-year return interval between 2012 and 2019. The sampling was part of a Tongass Forest Plan monitoring project that sought to evaluate the status and trends of dolly varden, cutthroat, and coho following forest management activities. A total of 114 sites from 21 watersheds of the Tongass National Forest in southeast Alaska were sampled. Habitat data were used to model population estimates of the previously mentioned native resident and anadromous fishes. Redundant parameters were determined and removed mathematically using Pearson correlation and further reduced using Principle Component Analysis. Biologically important variables were determined based on previous literature. Finally, we used log linked generalized linear mixed effects modeling to estimate the response of fish populations to the selected instream habitat parameters with the intercept varying among watershed and the sampling year within the watershed. Our analysis indicates at least 8 different instream habitat parameters are maximally important for resident and anadromous fishes in Tongass National Forest including stream network distance, pool and riffle related parameters, and sediment and wood delivery parameters. The adjusted R2 for predictive capacity of the GLMMs for coho parr, coho fry, cutthroat, and dolly varden were 0.68, 0.79, 0.67, and 0.42, respectively. The results of this analysis will provide a foundation for simplifying future stream survey monitoring efforts.

Investigating the muddled taxonomic status of two African tetra species

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The genus *Bryconalestes* includes several species of small alestid fishes residing in west Africa. *Bryconalestes* has a messy taxonomic history, and the systematics of the clade remains muddled, as in the case of *B. bartoni* and *B. longipinnis*. While *B. longipinnis* is a well-studied species and occurs widely throughout western Subsaharan Africa, B. *bartoni* was described based on a single specimen from Gabon's Ngounie River, and its validity has never been examined thoroughly in the subsequent literature. We examined *Bryconalestes* specimens from drainages across Gabon (including some from the same locale as the *B. bartoni* holotype) to test the validity of *B. bartoni* as an independent species. We applied 46 morphometrics, digital imaging, and genetic analysis of the Cytochrome oxidase I gene to 22 different specimens. Of these specimens, we provisionally identified ten as *B. longipinnis*, 11 as *B. bartoni*, and one as the phenotypically similar species *Brycinus intermedius* based on caudal pigmentation. Following the three-pronged analysis, morphometrics showed little variation between species. Still, genetics and imaging supported the separation of the two species: the genetic analysis clustered individuals into two distinct clades diagnosable by pigmentation. Both species display a distinct spot of dark pigmentation on the caudal peduncle, but that spot tapers anteriorly in *B. bartoni* and is centered on the lateral line, while *B. longipinnis* has a more prominent spot that does not taper anteriorly, and shifts so that its greatest intensity occurs ventral to the lateral line. Only one individual displayed a color pattern inconsistent with its genetic assignment. The evidence derived from this study supports the recognition of *B. bartoni* as a species distinct from *B. longipinnis* and helps to resolve a genus with convoluted taxonomy.

White Sturgeon spawning habitat availability and use in the John Day Reservoir

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Examining recruitment success is a key component to understanding the life history of White Sturgeon (*Acipenser transmontanus*) in the Columbia River. Since 1997 age-0 recruitment surveys conducted in John Day Reservoir have documented only intermittent recruitment despite generally adequate numbers of broodstock-sized White Sturgeon. Particularly concerning, from 2013-2020, there has been only one age-0 White Sturgeon captured during annual recruitment surveys (mean recruitment index (Ep) value = 0.003). Conversely, from 2009-2012 there were 85 age-0 fish captured (mean Ep = 0.19). In 2018, ODFW began a supplemental study to assess White Sturgeon spawning habitat availability and use in the John Day Reservoir using acoustic telemetry on mature White Sturgeon. A total of 26 mature White Sturgeon were tagged in 2018 (15 male, 11 female) using Vemco V16-6H acoustic tags with a 5 year battery life and a 600s ping interval. In 2019, an additional 23 (15 male, 8 female) fish were tagged using Vemco V16-6H and V16T-6H

(temperature sensing) acoustic tags with a ten year battery life and 80s ping rate. A spatially dense array of passive receivers (Vemco models VR2W and VR2AR) was deployed within known spawning habitat below McNary Dam tailrace to capture fine-scale movements during the spawning season. Paired receivers serving as acoustic gates were also deployed to characterize year round seasonal movement patterns throughout the reservoir. We will use exploratory plotting of detection data and examine sex specific differences in movement across time and space. Documenting White Sturgeon behavior and habitat use during the spawning period provides key management insight and has implications including expanding the duration and size of the spawning sanctuary.

Examining Wildlife Interactions with Large Wood in Streams

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It is well known that large wood in streams affects river channel shape, sediment deposits, stream flow, and available habitat for aquatic species. However less is known about how wildlife interact with this large wood and how it might facilitate links between the aquatic and terrestrial food webs. This study aims to capture behaviors that wildlife use while interacting with large wood in streams to gain a better understanding of the role of large wood in riparian ecology. Thirteen trail cameras were placed at naturally occurring and artificially placed large wood structures in streams within the same watershed. These cameras capture terrestrial interaction with the log structures through collecting photo sets and short videos. The cameras have been operational for five months and will continue to collect data for another seven in order to capture seasonal and daily variations in behavior and use. Preliminary results show 29 observed species including 15 birds and 14 mammals. Several distinct behaviors have been observed falling into categories such as communication, food handling, grooming, hunting/foraging, movement, predator avoidance, and rest. It is expected that species occurrences and behavior will change seasonally. This study will provide foundational information for future studies focusing on restoration ecology and the use of large wood in streams as well as studies wishing to make population estimates in riparian areas.